STEVENS INSTITUTE OF TECHNOLOGY

ACADEMIC CATALOG

2019-2020

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STEVENS
INSTITUTE *of* TECHNOLOGY
THE INNOVATION UNIVERSITY®

TABLE OF CONTENTS

Click ● to return to Table of Contents

ABOUT

The Academic Catalog is a resource designed to help students prepare for and plan their studies. The Academic Catalog contains information about undergraduate and graduate education including information about each degree and program offered and the requirements and curricula for earning each degree. It also contains information on academic procedures and requirements, financial aid, student life, student services and university policies.

It is the personal responsibility of each student to acquire a working knowledge of all pertinent information set forth in the Academic Catalog.

The policies and requirements listed in the Catalog are in effect for the entirety of the listed academic year. The edition of the Catalog that contains a student's degree and graduation requirements is determined by their academic year of entry or reentry and academic year of acceptance to their major or program. Archived catalogs are available online or by contacting the Office of the Registrar.

Stevens Institute of Technology reserves the right to change the information, regulations, requirements, procedures and policies announced in this catalog including but not limited to: requirements for admission; graduation or degrees; scheduling; credit or content of courses; fees; and calendars.

School and departmental websites and departmental curricular and course information are maintained independently and do not necessarily reflect university-approved curricula and course information. In case of discrepancies between departmental information and the Academic Catalog, the Academic Catalog is considered definitive.

OUR HISTORY & MISSION

Founded in 1870 by "America's First Family of Inventors," the Stevens family, Stevens Institute of Technology is a premier technological research university with a legacy of leadership in fields including engineering, finance, cybersecurity and coastal resilience.

Stevens graduates co-founded both General Motors and Texas Instruments, engineered the world's first urban power plant, engineered and erected the steel frames of New York City's Empire State Building and Chrysler Building, and directed the design and preparation of spacecraft modules for NASA's Apollo moon launch missions. From Frederick Winslow Taylor, the father of scientific management, and Mark Crispin (inventor of the IMAP email protocol), to Nobel Prize-winning physicist Frederick Reines (discoverer of the neutrino, confirming the 'big bang' theory), artist Alexander Calder (inventor of the hanging art form known as the mobile), award-winning journalist and political commentator Richard Reeves and cloud-software pioneer Gregory Gianforte, Stevens has produced a long line of technical and business leaders, innovators and entrepreneurs.

Stevens laboratories and facilities continue to enable groundbreaking research. The Davidson Laboratory features the fastest wave tank complex located at a U.S. university and has played a role in virtually every major maritime and coastal engineering advance of the past century and a half, including the development of modern submarines and the re-engineering of Apollo space capsules. The Hanlon Financial Systems Lab features a state-of-the-art simulated Wall Street trading room complete with Bloomberg terminals streaming real-time market data and a full suite of leading-edge software tools for financial analysis. The Systems Engineering Research Center (SERC), a Stevens-led consortium of approximately twenty institutions, is supported by the U.S. Department of Defense (DoD), producing important insights in the creation and evolution of complex systems and the development of systems engineers. The Immersion Lab enables high-definition visualization of complex concepts and data for professional audiences and non-professional audiences and stakeholders. Stevens is home to three National Centers for Excellence, research facilities selected by the U.S. government to lead national research, development and education efforts to address critical global needs including port security, ship design and development and systems engineering.

The Stevens mission is clear:

To inspire, nurture and educate leaders in tomorrow's technology-centric environment while contributing to the solution of the most challenging problems of our time.

We believe that the solutions to many of the critical problems that face humanity can be found in the improved use and understanding of technology, and that it is our duty to produce engineers, scientists and business leaders prepared for this challenge. This vision is embodied in our Stevens curriculum, which uniquely blends hands-on innovation, entrepreneurship and marketing education with engineering and technical training with the goal of helping students learn to think outside of the box and develop real-world products, services, applications and intellectual property. Stevens' small size and multi-disciplinary environment provides students and researchers alike the opportunity to continually collaborate in projects that cut across departmental lines.

Our vision — outlined in our strategic plan, "The Future. Ours to Create." — is to become a premier, student-centric technological research university.

We will achieve this goal through five key strategic priorities:

▶ Student-Centricity. Stevens will place an extraordinary emphasis on the development of its students, their academic and leadership development, career preparation and personal growth.

▶ Excellence in All We Do. Stevens will maintain an unrelenting commitment to excellence in all that it does.

▶ Through Collaboration, Impact. Building on our agility and collaborative spirit, Stevens will break down internal barriers to collaborative education and research to maximize the impact of the work of our faculty and students.

▶ Technology at Our Core. Proud of our legacy, we will embrace the power of technology as a differentiator to offer a distinctive educational experience to our students, drive our research and scholarship programs, devise novel teaching and learning methods and enhance our administrative, outreach and communication activities.

▶ Strengthened Reputation, Increased Prestige. Stevens alumni, faculty and research have made a significant positive impact on the world for more than 140 years. We will continue to ensure that our graduates continue to play a critical role in solving the technology-based problems of the future.

Stevens will directly address key areas of societal and global interest including healthcare and medicine, STEM (science, technology, engineering and mathematics) education, finance, coastal resilience and systems engineering through a comprehensive research program and new course and degree offerings.

As we move forward into the future together — a future that will be defined by the nation's and the world's appropriate and ethical use of technology for societal benefit — Stevens will continue to be at the forefront of discovery and innovation, and we will continue to train designers, inventors, managers and leaders for this exciting new era.

ACCREDITATION

The Commission on Higher Education of the Middle States Association of Colleges and Schools, an institutional accrediting agency recognized by the U.S. Secretary of Education and the Commission on Recognition of Postsecondary Accreditation, accredits Stevens Institute of Technology. Stevens Institute of Technology has been continually accredited by the Middle States Commission on Higher Education since 1927. Stevens is accredited until 2027 and the next self-study evaluation is scheduled to take place during 2026-2027.

The following programs at Stevens are currently accredited by the Engineering Accreditation Commission (EAC) of ABET, https://www.abet.org: biomedical engineering, chemical engineering, civil engineering, computer engineering, electrical engineering, environmental engineering, engineering management, mechanical engineering, and engineering. The computer science program is accredited by the Computing Accreditation Commission (CAC) of ABET, https://www.abet.org.

The chemistry and chemical biology program at Stevens is approved by The American Chemical Society (ACS), a congressionally chartered independent membership organization which represents professionals at all degree levels and in all fields of chemistry and sciences that involve chemistry. The Chemistry Bachelor of Science Degree is certified by ACS and the Chemical Biology Bachelor of Science Degree can also be certified if certain courses are completed.

All of Stevens' undergraduate and graduate business programs are accredited by AACSB, placing Stevens among the 5 percent of business schools globally to earn this distinction. AACSB provides internationally recognized, specialized accreditation for business and accounting programs at the bachelor's, master's and doctoral levels. Some Stevens master's degree programs in project management are accredited by the PMI Global Accreditation Center for Project Management Education Programs. This accreditation publicly confirms these programs meet comprehensive quality standards within academic degree programs related to project management, and that they can prepare students for success in project management careers.

ACADEMIC INTEGRITY

ACADEMIC INTEGRITY

▸ Honor System for Undergraduate Students

The Stevens Honor System is the rigorous ethical and moral standard to which undergraduate students are held, and which seeks to ensure that all academic work is bona fide. This standard was formally established in 1908 with the creation of the Stevens Honor System as well as its governing body, the Stevens Honor Board. The Honor System at Stevens fulfills two objectives. First, it seeks to ensure that work submitted by students can be trusted as their own and was performed in an atmosphere of honesty and fair play. Second, it promotes a sense of honor and integrity throughout campus and for Stevens' students in preparation for the professional world.

Enrollment into the undergraduate student body at Stevens Institute of Technology signifies a student's commitment to the Honor System and the University's ethical and moral standards. It is the responsibility of each student to become acquainted with and to uphold the ideals set forth in the Honor System Constitution. Specific student responsibilities include:

- ▸ Maintaining honesty and fair play in all aspects of academic life at Stevens
- ▸ Writing and signing the pledge, in full, on all submitted academic work
- ▸ Reporting any suspected violations to the Honor Board
- ▸ Cooperating with the Honor Board during investigations and hearings

Student responsibilities are further outlined in the constitution and bylaws of the Honor System, which may be reviewed online at www.stevens.edu/honor.

The Honor Board is the Honor System's governing body. It is comprised of undergraduate students who are elected by their peers. Members of the Honor Board investigate all suspected breaches of academic integrity, and assign penalties to students who are found responsible for Honor System violations. When investigating a case, Honor Board members meet with the accused student, pertinent witnesses, and relevant faculty. The investigation culminates with one of three outcomes: the case is dropped due to insufficient evidence to support the suspected violation, the accused student confesses, or a hearing is held and the case is presented to a jury of the student's peers.

The Honor System also includes a two-level appeals process. Any student who believes the Honor Board did not properly follow procedure or who is dissatisfied with a penalty after confessing or being found responsible by a jury may appeal to the Academic Appeals Committee for a reduced penalty. If unsuccessful, the student may submit a final appeal to the Provost or appointed designee.

▸ Graduate Student Code of Academic Integrity

The Graduate Student Code of Academic Integrity holds that integrity is essential to the ethical pursuit of knowledge and is expected of all Stevens graduate students in all academic endeavors including coursework, research, scholarship, and creative activity.

While all members of the Stevens Community have a responsibility to uphold and maintain the highest standards of integrity in study, research, instruction, and evaluation, the Graduate Student Code of Academic Integrity is concerned specifically with the conduct of graduate students.

By enrollment at Stevens, all graduate students promise to be fully truthful and avoid dishonesty, fraud, misrepresentation, and deceit of any type in relation to their academic work. A student's submission of work for academic credit indicates that the work is the student's own. All outside assistance must be acknowledged. Any student who violates this code or who knowingly assists another student in violating this code shall be subject to discipline.

Individual departments or schools within the Institute may adopt additional policies and procedures above and beyond those set forth in this code, but any and all purported violations must be reported to the Office of Graduate Academics no more than seven business days after the instructor becomes aware of the issue.

For more information on the Graduate Student Code of Academic Integrity, including types of violations, the process for handling perceived violations and the types of sanctions that can be applied, please visit https://www.stevens.edu/sites/stevens_edu/files/Graduate-Student-Code-Academic-Integrity.pdf

STUDENT LIFE

Undergraduate Student Life

The Office of Undergraduate Student Life fosters learning experiences for all students at Stevens through intellectual, personal, and social development that occurs beyond the classroom. We prepare students holistically through leadership development, co-curricular programming, community engagement, and dialogue around inclusion and diversity. We strive to create a community of learners that think critically and act responsibly both within the Stevens community and beyond.

Specifically, we advise and provide organizational support to more than 100 student organizations, facilitate Diversity Programs and Safe Zone, oversee the Lore-El Center for Women's Leadership, and oversee Fraternity and Sorority Life at Stevens. Additionally, our office coordinates annual campus wide programs from Orientation and Techfest to First Year Family Weekend.

The Stevens campus community is always brimming with activity and diverse offerings for involvement outside of the classroom. Students participate in informal get-togethers, cultural celebrations, musical performances, community service, and more. Throughout the year, there are also off-campus trips, comedy nights, recreational excursions, and other activities sponsored by the Entertainment Committee. Additionally, the Student Government Association sponsors annual events such as the Founder's Day Ball and Techfest, Stevens' annual music festival.

For students interested in developing their leadership skills, the Office of Undergraduate Student Life hosts three leadership programs through Stevens LEADS (leadership education and diversity series), in addition to a yearly leadership retreat and workshops. We are also committed to preparing students to be active global citizens by engaging in meaningful service activities that enhance the quality of life for the local, national, and international communities. Students can get involved in one of our many service and philanthropic organizations, like Engineers Without Borders, StevensTHON or Habitat for Humanity.

Student Government Association (SGA)

The Student Government Association (SGA) serves to facilitate the vast interests of the undergraduate student body, as well as to provide a means of communication between the students and the faculty, administration, and staff. Its fundamental purpose is to improve the student experience in a variety of ways. Primarily, this involves providing guidance to the 100+ student organizations that allow the campus to thrive, and representing student interests on important issues regarding the future of Stevens. All students are encouraged to reach out to their representatives and let their voice be heard!

At Stevens, you are an important member of the community. The keystone of the undergraduate division is the SGA; it directs and funds all student activities with the assistance of the Office of Undergraduate Student Life. For a complete listing of student organizations, please visit our website. Members of the administration frequently hold informal meetings with small groups of students, providing an opportunity for an exchange of ideas and opinions.

Gradute Student Life

There is a vibrant and diverse graduate student community that has a major presence on campus, much of which stems from graduate student clubs and organizations. Becoming involved in a student organizations is a great way to enhance your collegiate experience and acquire important skills such as team building, leadership, communication, and time management. At Stevens, graduate student clubs organize speaker series, cultural presentations, and student networking opportunities for the Stevens community. These are a variety of cultural and academic clubs comprised of students from diverse backgrounds.

Graduate Student Life staff ensure that graduate students have access to opportunities for social engagement and personal development through participation in student clubs and organizations, social events, cultural activities, and health and wellness programming.

Graduate Student Council (GSC)

The purpose of this governing organization is to provide a structure through which graduate students work together to improve the quality of graduate student life. The objectives of the Graduate Student Council at Stevens are as follows:

To represent graduate students (certificate, masters, doctorate) on all matters pertaining to their general welfare as graduate students with the administration.

▸ To build a graduate student community via graduate student co-curricular activities.

▸ To approve and oversee all graduate student organizations and allocate budgets appropriately.

▸ To provide a formal means of communication among graduate students.

Athletics

Stevens competes at the NCAA Division III level for intercollegiate sports. Men participate in baseball, basketball, cross-country, fencing, golf, lacrosse, soccer, swimming, tennis, indoor and outdoor track and field, volleyball and wrestling. Women represent Stevens in basketball, cross-country, equestrian, fencing, field hockey, lacrosse, soccer, softball, swimming, tennis, indoor and outdoor track and field and volleyball. Most sports are affiliated with the Empire 8 Athletic Conference. Other conferences include the Mid-Atlantic Collegiate Fencing Association (MACFA) for men's fencing, Eastern Women's Fencing Conference (EWFC) for women's fencing, wrestling in the Centennial Conference, men's volleyball in the United Volleyball Conference and the equestrian squad holds membership in the Intercollegiate Horse Show Association (IHSA). As of July 1, 2019, Stevens is joining the Middle Atlantic Conference's Freedom Conference, and this organization will serve as the single conference for all sports other than men's fencing, women's fencing and equestrian.

Stevens also offers a wide variety of intramural sports, club sport teams, an outdoor recreation program, and an extensive offering of informal sport/recreational opportunities including wellness classes and two well-equipped fitness centers. Students enjoy a full program of athletic activities throughout the year.

Club sports teams compete in national and regional conferences and tournaments. The current club sport offerings include: archery, baseball, bowling, climbing, crew, ice hockey, men's lacrosse, sailing, ski and snowboard, men's soccer, women's soccer, ultimate frisbee, men's volleyball and women's volleyball. Be sure to go to www.stevensrec.com for complete details.

For a closer look, visit Stevens' impressive athletic and recreational facilities which include the Charles V. Schaefer, Jr. Athletic and Recreational Center, Walker Gym, DeBaun Athletic Complex, six tennis courts and beach volleyball court. Our websites, www.stevensducks.com and www.stevensrec.com, as well as our social media sites, are great resources for additional information and news updates.

STUDENT SERVICES

Undergraduate Academics

The Office of Undergraduate Academics provides general academic advising and support services to the entire undergraduate student body, in addition to the major specific advising provided by the faculty advisor (see Faculty Advisors). Questions regarding academic policies, procedures, or advising issues can be directed to the Office located in 9th floor of Wesley J. Howe Center, (201) 216-5228. Or, visit the website at http://www.stevens.edu/directory/undergraduate-academics.

All undergraduates are assigned a freshman faculty advisor. The faculty advisor may change later in a student's career based upon the major, concentration, or other considerations.

Advising in the freshmen and sophomore years generally focuses on degree requirements, course selection and the transition from high school to college. In the junior and senior years, advising generally focuses on career options and/or graduate school.

Transfer students are assigned a freshman or upperclass advisor as appropriate.

Academic Support Center (ASC)

The Academic Support Center (ASC), located on 9th floor, Howe Center, provides a variety of support programs and services to assist undergraduate students in achieving academic success. These services include: Academic Tutoring, Freshman Quiz Review Sessions, the Peer Leader Program and Academic Success Workshops.

Tutoring for technical courses is provided free of charge by trained undergraduate students. The ASC offers both individually assigned tutors and a walk-in tutoring center located in the Library room 306, to support undergraduate students with understanding course material and becoming effective learners.

Freshman Quiz Reviews for many first year technical courses are sponsored by ASC and conducted by skilled undergraduate and graduate students. The goal of a review session is to provide the student with additional insight into material previously presented in class. Please note, these review sessions are intended solely as a review, not as a substitute for attending class or preparing on one's own.

The Peer Leader program, a collaboration between Undergraduate Academics and Student Life, provides an opportunity for new first year students to connect with an undergraduate student who has completed at least one year at Stevens. Peer Leaders assist new students in their academic and social transition from high school to college. The mentoring process intends to provide new students with the information, support and encouragement they need to be successful at Stevens.

Academic Success Workshops are offered throughout each semester. Workshops cover a variety of topics aimed to assist students in their transition to college and success at Stevens. Topics include: Time Management, Getting Organized and Setting Goals and Preparing for Final Exams.

For more information, please visit the ASC website at: http://www.stevens.edu/directory/undergraduate-academics/academic-support-center

Graduate Academics & Student Success

Graduate Academics & Student Success provides graduate students with wrap around support from enrollment through graduation. The Office of Graduate Academics & Student Success coordinates new student orientation, peer mentoring programs, academic support programs, career exploration programs, and personal development programs; provides academic advising; monitors students' academic progress; maintains academic records; establishes, interprets, and upholds institutional policies pertaining to graduate students; and helps resolve student concerns. Through the Graduate Curriculum Committee, the Office of Graduate Academics & Student Success approves new and revised degree and program requirements and performs regular review of all graduate degree and certificate programs. Office of Graduate Academics & Student Success is guided by the Master's Student Advisory Board, the Doctoral Student Advisory Board, and the Graduate Faculty Advisory Board and advocates for graduate student needs and represents the interests of this population on university-wide committees.

Writing & Communications Center

The Writing & Communications Center (WCC), in the College of Arts and Letters, empowers students by helping them develop the written and oral communication skills essential to their success in academic coursework and beyond Stevens. The goal of the WCC is to help students become autonomous and capable writers in their own right. To that end, the WCC provides one-on-one, group, and online conferences as well as workshops and seminars, specifically for the following:

▸ essays
▸ public speaking
▸ slide show presentations
▸ English conversation
▸ resumes
▸ cover letters
▸ interview preparation
▸ graduate school applications

▸ personal statements
▸ poster presentations
▸ journal publications
▸ fellowship applications
▸ dissertations
▸ collaborative work
▸ time management
▸ PhD coaching
▸ and more.

International Student and Scholar Services

The International Student and Scholar Services (ISSS) supports the academic mission of the university by providing specific programs and services to international students and scholars. The main role of the ISSS is to facilitate compliance with federal regulations that govern the immigration status of international students and scholars during their time at Stevens. The ISSS provides educational workshops, information, and services in support of these regulations.

The ISSS office is responsible for all international student and scholar immigration-related matters, including the issuance and/or processing of:

▸ Form I-20, F-1 visa

▸ DS-2019, J-1 visa (students and scholars)

▸ H-1B applications for temporary workers in specialty occupations

▸ University-sponsored Lawful Permanent Resident (LPR) applications

▸ Employment authorization documents (EADs)

The ISSS also promotes international and multicultural understanding by providing cross-cultural opportunities and events for Stevens' international population.

Registrar

The Office of the Registrar, stewards of academic records maintenance, is committed to serving the Stevens Institute of Technology community and the public in a courteous, accurate, and expeditious manner. With knowledge, integrity, and energy, we aim to improve the client experience and University reputation through coordinated, customer-centric services that exceed expectations.

The Office of the Registrar provides students with access to their academic records and transcripts; classroom and final exam scheduling; student athlete and veteran certification; transfer credit processing; grade collection and updates; performs degree audits and issues diplomas and certificates; enrollment and degree verifications; develops and maintains the academic calendar; and upholds the university's academic policies.

Through an integrated mix of personal and online services, we have developed a system that supports Stevens students in managing all aspects of their education. Through the University's convenient myStevens portal, you can execute the following Registrar-related actions: register for classes, check your grades, view unofficial transcripts, review class schedules, search for classes, view graduation checkout status, change contact information.

In addition to online services, students may receive the personal attention that is the hallmark of Stevens Institute of Technology education by visiting the Office of the Registrar's located on the 10th Floor of the Wesley J. Howe Center.

Transcripts

Stevens will release a student's transcript upon request, provided that his/her account is not overdue and that s/he requests the transcript online or in writing. Students should allow approximately one week to process the transcript. The transcript is sent directly by Stevens in a sealed envelope to the requested party. Stevens will only release an official transcript directly to the student in a sealed envelope. All transcripts are sent by U.S. mail, unless other arrangements are made. If a student needs the transcripts in less than one week, s/he is required to indicate and pay for overnight, two-day, or priority mail online. All transcript requests must be made online via the Office of the Registrar website using out third-party vendor. No verbal requests for transcripts will be honored under any circumstances, nor will any requests from a third party unless the student has signed a release for the transcript to that third party.

Information on how to order transcripts securely online can be found at www.stevens.edu/registrar.

Office of Financial Aid

The Office of Financial Aid, located in the Wesley J. Howe Center, works with students and their families in estimating the cost of attending Stevens, identifying resources to assist with educational financing and learning about eligibility for the various types of assistance available. Staff are available to meet with students and families to discuss financial aid options and to answer questions. No appointment is necessary during normal business hours. Extended hours are available by appointment only. For additional information, contact the Office of Financial Aid at 201-216-3400 or financialaid@stevens.edu.

Office of Student Accounts

The Office of Student Accounts, located in the Wesley J. Howe Center, assists students and families with questions related to the student's account including payment options, refunds, 1098-T tax statements, and all student-related account information. Staff are available to meet with students and families to answer questions without an appointment during normal business hours. Extended hours are available by appointment only. Contact the Office of Student Accounts at 201-216-3500 or studentaccounts@stevens.edu.

Student Health Services

Student Health Services is an acute care facility located in the Student Wellness Center offering services and care for Stevens students. The goal of the Student Health Center is to improve and maintain physical wellness and productivity. The services are free and include health promotion and disease prevention, care during acute and chronic phases of illness, and referrals to outside providers when appropriate. Student Health Services staff members recognize the basic human rights of all patients who seek treatment and all students are treated with respect, consideration, and confidentiality.

Student Health Services is staffed by a full-time registered nurse and clinicians. Please visit Student Health Services website for information about clinical hours at: http://www.stevens.edu/sit/health. During off-hours, please contact Campus Police at 201-216-3911 for a medical emergency. Students needing emergency medical attention will be transported to the local hospital via ambulance. Charges for healthcare services performed outside of Student Health Services are the individual student's responsibility.

All enrolled Stevens students are required (by NJ state law) to provide a Student Health and Immunization Record to Student Health Services. Failure to provide immunization documentation can result in a Registrar's hold being placed on a student account. This will halt the enrollment process until immunization compliance is satisfied. For additional information and answers to specific questions, please contact Student Health Services at 201-216-5678.

Counseling and Psychological Services

Counseling and Psychological Services (CAPS) is a caring and supportive mental health resource center for the campus community. CAPS offers a variety of high quality services to Stevens students in order to enhance academic achievement, foster personal growth, and promote a culture of wellness. These services include time-limited individual counseling, urgent-care services, group therapy and psychiatric services. In addition to direct clinical care, CAPS also provides a variety of educational, preventative, and consultative services.

CAPS appreciates and celebrates the differences that exist between individuals at Stevens Institute of Technology. Social justice is one of our primary values and we strive to create a safe space where thoughtful and appreciative exploration of diversity is the norm. We aim to deliver care that is both culturally competent and inclusive.

All services provided by CAPS are confidential and free of charge. Student records with CAPS are stored securely and separately from all academic records and transcripts. Information regarding student visits to CAPS are not shared without student permission except in rare cases of emergency, situations involving danger to self or others, or order of a court.

To schedule an appointment, please call (201) 216-5177 or visit in person on the second floor of the Student Wellness Center. For questions about counseling or the services provided by CAPS e-mail CAPS@stevens.edu or visit us online at stevens.edu/CAPS.

Disability Services

The Office of Disability Services exists to assist individuals with disabilities have opportunities for full participation and equal access to campus programs and services, in alignment with federal standards and state regulations.

Who Is Eligible for Assistance?

Services are available to students and visitors on campus with documented disabilities. Individuals eligible for service include, but are not limited to, those with autism spectrum or attention disorders, chronic medical conditions, learning disabilities, and mobility, vision, hearing or speech impairments. Students with food allergies or other dietary restrictions may discuss their dietary needs with the Director of Disability Services and Dining Services staff. Additionally, those with temporary disabilities, such as conditions stemming from concussion, injury or surgery, may also be eligible for accommodation services.

Accommodation Services

Individuals with disabilities have the responsibility to self-identify to the Office of Disability Services and provide relevant documentation from a qualified professional, which is required to support a request for accommodation services. Appropriate and reasonable accommodations that may be beneficial in the classroom, the campus community or other areas will then be discussed. Given the many varieties and intricacies of disabilities, reasonable accommodations are determined on an individual basis.

For additional information, please contact the Office of Disability Services at 201-216-3748 or visit in person in the Student Wellness Center.

Career Center

The Stevens Career Center supports all full time, on-campus students in obtaining career outcomes appropriate to their personal interests and career goals through career exploration programs, experiential education opportunities, and individualized guidance from the Career Center staff. Student programming evolves in accordance with the interests and academic studies of Stevens students and the opportunities and demands of the employment market. Students are encouraged to build their success early through experiential education opportunities that include summer internships, cooperative education assignments, and faculty-mentored research.

The Career Center is located on the 6th Floor of the Wesley J. Howe Center and provides the following services:

Career Advising and Career Exploration

Career education and programming are provided to develop the critical professional skill sets students need to present themselves to employers and to position themselves for future career success. The Career Development workshop series is offered for undergraduate students and the Career Masters workshop series is available for graduate students. One-on-one advising meetings, career planning workshops, corporate site visits, and networking events are provided throughout the academic year.

On-Campus Recruiting Program

More than 300 organizations visit the Stevens campus annually to recruit students for full-time employment, summer internships, and cooperative education assignments. An orientation workshop is required to gain access to employment opportunities posted on Handshake, the interactive on-line system where current, full-time students can post their resumes, review job descriptions, apply for positions, and schedule interviews.

Career Fairs

Career fairs serve as an information exchange between students and corporate representatives. The Career Center hosts four career fairs annually. The September Career Fair is targeted to graduating students. The December and February Career Fairs are open to Stevens students eligible for employment and provide access to full time employment and summer internship opportunities. An Internship fair is provided in October.

Summer Internships and the Full-Time Employment Job Search

Work experience is an integral part of the student career development process that supports attainment of post-graduation career outcomes. Career Center staff facilitate student access to summer internship opportunities. Students are encouraged to attend the career development workshop series as early as their first year and meet with a career advisor for assistance with resume creation and the internship search process. Preparation for the full-time job search begins in the junior year. Students are assigned a career advisor and are encouraged to attend employer information sessions.

Cooperative Education

Cooperative Education (Co-op) is a five-year educational program where students alternate between semesters of full-time study and full-time work in areas related to their academic studies and career interests. The Co-op Program assists students in clarifying their career aspirations while experiencing the connection between the theories learned in the classroom and applied in the workplace.

A student's first year is dedicated to completing freshman year academic requirements and attending the required career development Co-op meetings to understand the rotational nature of the program, prepare for the recruitment process, and gain an understanding of workplace expectations. Over the course of the second through fourth years, Co-op students alternate semesters of study with semesters of full-time employment in accordance with the Co-op work/study schedule that has been approved by their Co-op advisor. The fifth year is devoted to full time study and completing the course requirements of the undergraduate degree.

The many benefits of participating in cooperative education include having the opportunity to work at a maximum of three different employers and the ability to gain knowledge and skills while receiving compensation on a full-time basis when on assignment.

Eligibility

The Co-op Program is available to full-time undergraduate students pursuing degrees in the engineering or science disciplines. Students must commit to following a five-year alternating work/study schedule and attend the required Career Development workshops. All freshman year course requirements must be completed and students must be in good academic standing with a minimum 2.20 GPA and able to complete a minimum of three co-op work terms. For more information, contact coop@stevens.edu, call 201.216.5166, or visit the Career Center on the 6th Floor of the Wesley J. Howe Center.

Living at Stevens

The Office of Residential and Dining Services and the Office of Residential Education are committed to providing a safe, supportive and comfortable living and learning environment that nurtures each student and promotes their growth and development. Living at Stevens leads to some of the most exciting and rewarding times of a student's life. Most Stevens undergraduate students live in Stevens housing (both on and off campus).

Housing contracts are a full year commitment. A housing security deposit is assessed once and returned when the student leaves Stevens. There is a cancellation fee assessed to any students who cancel their housing application.

At Stevens, all residence halls have completely furnished rooms including bed, desk, dresser and closet or wardrobe. All rooms have state-of-the-art Wi-Fi connection service to the campus network, cable TV access and complimentary laundry facilities.

New student residences are located throughout campus just steps from classrooms, laboratories, dining, and recreational facilities. We provide Stevens Leased Housing within the City of Hoboken for upper-class students.

On Campus Housing

- **Davis Hall, Humphreys Hall,** and **Castle Point Hall** provide double and triple occupancy housing for new students.
- **Palmer Hall** houses 90 upper-class students in singles and quads.
- **Jonas Hall** has double and triple rooms with private bathrooms in each room.
- **River Terrace Apartments** provide 2 to 7 person apartments with double and single rooms. All suites include private bath and kitchenette.

Stevens Leased Housing

Our Stevens Leased Housing apartments are within walking distance of the campus. They are fully furnished, double occupancy bedrooms and 2 bathrooms (4 person apartments). They include Wi-Fi, internet and cable TV access. They house upper-class students.

Special Interest Housing

▸ **Lore-El** (Center for Women's Leadership) is located at 802 Castle Point Terrace. It is a beautiful Victorian-style residential house located on the Stevens campus and focuses on Women in STEM fields.

▸ **C.A.R.E House** (Community Awareness Residential Experience) is located at 1036 Park Avenue. It is home to a community that focuses on service learning.

▸ **Greek Housing** (Fraternities & Sororities): offers unique and valuable living opportunities. Eligibility to live in a Greek house is determined by each organization.

Graduate Student Housing

Most Stevens graduate students live in their own apartments in Hoboken, N.J., as well as other cities in the surrounding area. A small number of graduate students live in Stevens Leased Housing. Graduate students are not housed on campus.

UNDERGRADUATE EDUCATION

Applying for Admissions

Admission to Stevens is a process designed to ensure that you have an accurate picture of the opportunities and challenges offered by a Stevens education, and that the Admissions Committee has enough information to assess your potential for success. With these goals in mind, several measures are used in making Admissions decisions.

High School Transcript

The most important criterion in our decision to admit you as a freshman is your academic performance in high school. (If you are already studying at the college level and wish to apply for admission to transfer to Stevens, submit an official copy of all high school transcripts and college transcripts.) Your high school record should show strong performance in the following areas:

▸ **For Engineering, Computer Science, Applied Sciences and Quantitative Finance:** Four years of English; four years of mathematics (one year of algebra; one year of geometry; one year of pre-calculus; and one year of calculus); three years of science (biology, chemistry, and physics).

▸ **For Business and Science, Technology & Society:** Four years of English; four years of mathematics (two years of algebra; one year of geometry; and one year of pre-calculus); three years of science (biology, chemistry and physics).

▸ **For Humanities:** Four years of English; three years of mathematics (two years of algebra and one year of geometry); one year of science – either physics, chemistry or biology. These are minimum requirements. Student planning secondary concentrations in math or science should have more extensive preparation in these fields than indicated above.

▸ **For Accelerated Pre-Medicine Program:** Four years of English; four years of college prep mathematics; three years of science (biology, chemistry, and physics). Students are encouraged to pursue AP Biology and AP Chemistry, if possible. To be considered for the Accelerated Medicine Program, students must have a combined score of at least 1400 on the SAT I (critical reading and mathematics sections) or ACT composite score of 32 in one sitting, and have taken the two SAT Subject Test (Math Level I or II and Biology or Chemistry) . Students may take these tests in the junior or senior year. All tests should be completed by October of the senior year so that we have time to evaluate scores.

Please have your school counselor submit an official copy of your transcript.

College Entrance Examinations

Stevens requires the Scholastic Aptitude Test (SAT I) or the American College Test (ACT).

If you are pursuing the Accelerated Pre-Medicine Program, you must score a minimum of 1400 on the SAT I or 32 on the ACT in one sitting and take the SAT Subject Test in mathematics Level I or II and Biology or Chemistry.

We encourage you to begin taking these exams in your junior year of high school. If you are not applying as an Early Decision candidate we recommend that you take all exams by December of your senior year so we can evaluate your scores in a timely manner. Please keep in mind that the Admissions Committee looks at the highest score in the Evidence-Based Reading and Writing and Math section of the SAT I to compute a total score.

Students applying to Music and Technology and Visual Arts and Technology may submit a portfolio in lieu of submitting test scores. Students who are nominated and being considered for iSTEM@Stevens, may also elect not to submit test scores.

For complete information and registration forms of all tests, see your school counselor or contact the Educational Testing Service (SAT), Princeton, NJ, 08540, www.sat.org, or the American College Testing Program (ACT), Iowa City, IA, 52243, www.act.org.

Personal Interview

Admissions offers an interview option to all students applying for undergraduate admission. Applicants should contact the Office of Undergraduate Admissions at (201) 216-5194 to set up an interview or register online. If you are applying for the Accelerated Pre-Medicine program, an interview is required and we will contact you if you are selected to interview for this program. Interviews can be completed by phone, Skype or on campus.

School Counselor/Teacher Evaluations

We require all applicants to submit at least one teacher evaluation and one school counselor evaluation, so we can learn more about your academic and personal qualities, as well as your potential of becoming a successful Stevens student. You will find the appropriate evaluation forms in your application and on our website.

Written Statement

At Stevens, we give you a written opportunity to provide the Admissions Committee with additional information about yourself in the form of the Personal Statement. Please complete this essay as part of your application to Stevens.

Completing the Application

Go to www.stevens.edu/sit/admissions/apply to access our application instructions. Stevens uses the Common Application in addition to a private Stevens Application.

Deadlines

Applying for Freshman Admission

To be considered for admission to the fall class of first year students at Stevens, please submit your application and additional information required, by January 15. You may submit your application once the next cycle's application is available. Once we receive all of the additional information required the Admissions Committee will meet to review your file and make an admissions decision. Please note that students applying for accelerated programs have a deadline of January 1.

Early Admission

Applying Early Decision - ED I

If Stevens is your first choice, you may apply for admission as an Early Decision candidate by November 15. One advantage of applying Early Decision is that you will receive an admission decision, including notification of an estimated financial aid package if you have applied for it, by December 15. If you are accepted to Stevens, you must submit your tuition deposit by January 10th. You are then required to withdraw applications from any other colleges and universities to which you have applied.

Applying Early Decision - ED II

Stevens also has an Early Decision II process. The application procedures are the same, however, the deadline for application is January 15 with a notification date of February 15. If you are accepted to Stevens, you must submit your tuition deposit by March 10th and then withdraw applications from any other colleges and universities to which you have applied.

To be considered for Early Decision, please indicate this on your application and submit it with all of the additional information required by November 15 for ED I/January 15 for ED II.

Advanced Placement

Stevens participates in the Advanced Placement (AP) Program of the College Entrance Examination Board as well as the IB (International Baccalaureate) Program. You may receive college credit toward your degree for various examinations. For a detailed list and additional information, refer to the section entitled Undergraduate Procedures and Requirements in this catalog. Be sure to list these exams and the scores received on your application.

iSTEM@Stevens

Admission to Stevens through iSTEM@Stevens requires student participation in iSTEM@Stevens Evaluation Day, an invitation-only event held in November in which participants are assigned a task to complete and evaluated on their performance. This evaluation will be a critical component of their application to Stevens for undergraduate admission. Only students who have been nominated by their high school teacher or counselor will be considered for admission to iSTEM@Stevens.

Stevens Link Semester

The Stevens Link Semester is a one-semester, foundational program for a select group of students to be offered conditional admission to Stevens Institute of Technology for entering the fall term. Successful completion of the Link semester includes the achievement of a 2.5 or better GPA in the fall term with a minimum of 12 earned credits, as well as satisfactory conduct. Any students with a lower GPA will be reviewed on a case-by-case basis. Upon successful completion of the foundation semester, Link students will be fully admitted to Stevens in their second semester. It is expected that students will be able to graduate within four years depending on their academic performance. Participation in programs such as cooperative education may result in a five-year timeframe. Questions can be directed to the Office of Undergraduate Admissions at 800-STEVENS or visit: http://www.stevens.edu/sit/admissions.

International Students

Admissions requirements and procedures for international applicants are the same as those for domestic candidates with the exception of test scores. All international applicants may submit one of the following: SAT I, ACT, two AP exams (calculus and either chemistry or physics), two SAT subject tests (math and either chemistry or physics), International Baccalaureate predicted grades with two higher level exams scores in math or science. However, if your first or native language is not English, you are required take the Test of English as a Foreign Language (TOEFL) and earn a score of at least 550 on the paper version or 80 on the internet based version. We also accept the International English Language Testing System (IELTS) with a score of 6 or higher.

At Stevens, international students are not eligible for financial aid. There are limited merit-based scholarships for which you do not need to apply (all applicants for admission are automatically considered). Additional sources of money for international students include loan programs and the Stevens Cooperative Education Program; information about these programs can be found in this catalogue.

Transfer Students

Stevens considers transfer students from community colleges and four-year institutions. To earn a degree from Stevens, you must complete at least 50 percent of your degree requirement credits at Stevens and at least five courses must be technical electives taken in the junior and senior years.

A minimum grade of "C" is required for undergraduate transfer credit. Courses taken on a pass/fail basis are not acceptable. If a Stevens course includes a laboratory, then you must have also taken a laboratory. A syllabus or course description from the institution's catalog must be sent to ascertain equivalence. Since it is essential that all course prerequisites be met, you should provide complete transcripts with descriptions of the courses and all educational experience as early as possible in the application process. It is also advisable for you to visit with or contact the Office of Undergraduate Admissions, Attn: Transfer Admissions, Stevens Institute of Technology, Hoboken, NJ, 07030, (201) 216-5194.

The application deadline for transfer admission to Stevens for the fall semester is June 1; November 1 for the spring semester.

Part-time and Evening Study for Non-Traditional Students

Stevens does not offer the opportunity to pursue an undergraduate degree by attending part-time and/or solely in the evening. If you want to pursue an undergraduate degree, you can do so on a full-time basis only, and you must register for at least 12 credit hours per semester to be considered a full-time student.

The Campus Visit

An important step in selecting a school is visiting the campus. Not only does the admissions staff want to meet you, we very much want you to see our beautiful and historic 55-acre campus overlooking the Hudson River and exciting New York City. During your visit, you may have the opportunity to explore our state-of-the-art laboratories, see our residence halls, and meet professors and current students. A visit to Stevens also gives you an opportunity to present special circumstances, qualifications, or interests that may help us determine your ability to succeed here.

Throughout the year, the Office of Undergraduate Admissions offers Information Sessions and Campus Visit Days for prospective students and families. These events include an overview of the university, academic programs, applying for admission, and filing for financial aid. It also enables you to speak with current students and faculty, and take a tour of campus.

If you live far from campus, there are other options. Admissions representatives travel to a multitude of high schools participating in college fairs and other events. You may also go online and view our virtual tour. During the summer, you may also visit Stevens and make it a part of your family vacation.

Please call the Office of Undergraduate Admissions at (201) 216-5194 to discuss your campus visit plans or visit our Website at http://www.stevens.edu/admissions for updated information.

Degree Programs

▸ Bachelor's Degree Programs

Stevens awards three baccalaureate degrees: the Bachelor of Engineering (B.E.), the Bachelor of Science (B.S.), and the Bachelor of Arts (B.A.).

Degree Option

Degree with Thesis

Students may apply for candidacy for Degree with Thesis in any semester of the junior year or in the first semester of the senior year. A candidate for any Degree with Thesis must report the title of the thesis and the name of the directing professor in writing to the Office of Undergraduate Academics no later than December 15 of the senior year. In April of the senior year, the student must submit the approved thesis to the Library. Some points of interest about the Thesis:

- ▸ the diploma reads "with thesis"
- ▸ the thesis is not for credit and is over and above the other degree requirements
- ▸ the thesis does not affect the GPA
- ▸ the thesis is not treated as an overload for tuition calculation
- ▸ the student may begin work on the thesis before the senior year

▸ Special Degree Programs

There are a number of special programs available to students, depending on their area of study. A student planning to enter any of the following special degree programs should discuss their plans with their Faculty Advisor and the Office of Undergraduate Academics.

Simultaneous Degree Program

The Simultaneous Degree Program permits a student to complete the requirements for two degrees, scheduling and extra credit rule permitting. Two bachelor's degrees (any combination of B.E., B.A., and B.S.) must be completed simultaneously. A student must take at least 24 credits over and above their first bachelor's degree in order to earn a second degree. Students who have completed the credit requirements for the primary undergraduate degree earlier than the fourth year of study, may not be eligible for undergraduate federal financial aid.

Double B.E. Degree Program

The Double B.E. Degree Program enables a student to earn two B.E. degrees, but the students must satisfy all of the requirements in both concentrations; this includes two Junior and Senior Design sequences. In addition, the student must take at least 24 credits beyond the higher of the two program requirements.

Accelerated Master's Program

The Accelerated Master's Program (AMP) lets high-achieving students begin taking graduate-level courses during their undergraduate studies, enabling them to earn both a bachelor's and master's degree at an accelerated pace. Students are able to double-count up to three graduate level courses towards both the bachelor's and master's degree requirements. No more than 9 credits can be transferred and double-counted towards the master's program. Any additional graduate level credits completed while an undergraduate will not count towards the master's program.

Students can either be selected for this program at the time of admission or apply to be accepted in their sixth or seventh semester of undergraduate study. There is no graduate application fee and standardized test scores are not required (some exclusions apply). All students must submit an application for the AMP with their graduate program of interest no earlier than their sixth semester. Applicants must maintain a minimum 3.0 cumulative GPA and fulfill all credit requirements for the first five undergraduate semesters. A grade of "B" or higher is required in all courses that will be double-counted.

Students must first complete their bachelor's degree requirements, or be within 6 credits of completion, before officially enrolling in the master's program. Students must enroll in AMP to complete the sequential undergraduate and graduate degrees. Acceptance into the AMP requires maintenance of a cumulative 3.0 GPA at the time of enrollment into the graduate program and satisfactory completion of the undergraduate degree prior to award of the graduate degree.

The AMP only requires students to spend a minimum of one semester as a full-time graduate student, giving them the option to complete part of their graduate degree online (if applicable) or to take graduate courses as a part-time graduate student.

Double Major Program (College of Arts and Letters Only)

Students studying in the College of Arts and Letters can choose to double major by combining two disciplines from within the College of Arts and Letters. In cases of double majors, just one degree will be conferred and transcripts will designate the two major areas. Students can choose to combine any two CAL majors. If the double major contains a major in Science, Technology, and Society students can choose whether the overall degree is a B.A. or B.S., by fulfilling the requirements pertaining to each type of degree.

The six classes of the common core are counted for both majors. Students then have to take eight additional classes in each major area. No upper-division course may be counted towards both majors. For example: if the first major is in philosophy and the second in history, the two additional upper-division (300/400-level) classes that count toward the major in philosophy must be in a third discipline. The same requirement holds for the combination with interdisciplinary majors, and all other requirements for the single major apply. CAL 301, Seminar in Writing and Research Methods, or a research methods class, only has to be taken in one of the major areas.

Students choose in which major to write the B.A. thesis. The second major requires an extra tutorial course in addition to all the other requirements of the major with one of the following options in place of a second thesis: 1) research paper, 2) creative project, 3) portfolio, 4) musical composition or curated exhibit, 5) performance, 6) other similar project approved and monitored by the student's faculty advisor in consultation with the student. Alternatively, students may also opt for one thesis that incorporates both majors. This work must be more extensive in length and scope than the single degree thesis, and is subject to the approval of both advisors.

▸ Accelerated Degree Programs

Accelerated Seven-Year Program in Medicine

The Combined B.S.-M.D. Program is an opportunity to earn the B.S. degree in Chemical Biology at Stevens and the M.D. degree at Rutgers New Jersey Medical School in a total of seven years. If you are a high school senior who has demonstrated academic excellence, in the top 10% of your class, with a combined SAT score of at least 1400 and a promise for a career in medicine, you can be considered for the B.S.-M.D. program. Admission to this program is highly competitive, and an interview at both Stevens and the medical school is required. If accepted to this program, you must complete three years in the Accelerated Chemical Biology program with a GPA of at least 3.50, grades in all of the premed courses at least B (not B-) or above, and you obtain acceptable scores on the MCAT exam. Stevens awards the B.S. degree upon successful completion of the first year of medical studies.

Accelerated Law Program

The Accelerated Law program consists of three years of undergraduate study at Stevens and three years of study at Seton Hall University School of Law.

Stevens awards the B.A./B.S. degree upon completion of the first year of law school. Students then complete the remaining two years of law school, earning a J.D. degree from Seton Hall University School of Law.

Admission Requirements:

▸ Applicants must apply for admission to an academic program in the College of Arts and Letters.

▸ Applicants must achieve at least a 1300 on the SAT or a score of 27 on the ACT.

▸ Applicants must achieve a high school GPA of 3.7/4.0.

▸ Applicants are required to complete an interview at Stevens.

Additionally, students must maintain the following requirements for law school:

▸ Applicants must maintain a 3.2 GPA at Stevens as well as complete the LSAT.

The minimum LSAT scores are determined by the law schools each year, and typically mimic the national averages.

Approaches To Learning

At Stevens, taking what is learned in the classroom and applying it in a hands-on environment is an integral part of each student's education. Therefore, we offer a variety of opportunities, such as cooperative education, internships, research, and industry-sponsored projects.

▶ The Freshman Experience

All incoming freshmen and transfer students participate in the Freshman Experience program by enrolling in the following courses during their first and second terms: CAL 103 – Writing and Communications Colloquium and CAL 105 – Cal Colloquium: Knowledge, Nature, Culture. There is a special provision for incoming international undergraduate students that places them in CAL 101 – English Skills during their first semester, with CAL 103 and CAL 105 being taken during their second and third semesters.

▶ The Clark Scholars Program

The Stevens Institute of Technology Clark Scholars Program aims to prepare students to emulate the legacy of Mr. A. James Clark—exemplified by leadership, humanitarianism, business acumen, and technical prowess—as undergraduate students and later as professionals in their field. Clark Scholars follow a rigorous technical curriculum in engineering, computer science, or cybersecurity and participate in numerous co-curricular opportunities to enhance their Stevens experience. Clark Scholars will earn a minimum of nine credit hours in leadership, business, and ethics to complement their technical and general education curriculum.

The Clark Scholars Program at Stevens is an invitation-only scholarship program for exceptional, high-performing students who are traditionally underrepresented in the engineering fields and exhibit a passion for "making a difference." Invitations will be extended at the time of admission. There are no additional application requirements, and the program will only be available to incoming full-time, first year students.

Clark Scholars receive the following program benefits:

- ▶ Individualized mentoring and support
- ▶ Additional seminars in leadership ethics and business
- ▶ An annual cultural passport for museum memberships and cultural events
- ▶ The option to participate in the Accelerated Master's Program, which provides the opportunity to complete a bachelor's and master's degree sequentially
- ▶ Access for up to three summers to a $5,000 stipend to support participation in one of the following options:
  - • Research opportunities guided by a faculty advisor
  - • An international experience (e.g. study abroad or internship, approved by the Office of International Programs)

Clark Scholars may remain in the program for up to eight academic semesters provided they maintain a 3.2 grade point average (GPA), make satisfactory academic progress toward the degree, and complete required courses. The cumulative GPA will be reviewed annually.

Required Courses for Clark Scholars

CLK 183 Clark Scholar Seminar I (1-1-0)

In this course, students will develop a personal model for leadership. The class will provide an exposure to key leadership traits and different leadership styles and will provide leadership case studies. The course considers the influence of gender, race, and ethnicity in leadership models. Students will be required to develop and present their own personal leadership philosophy at the conclusion of the course.

CLK 184 Clark Scholar Seminar II (1-1-0)

An introduction to ethics, this course places special emphasis on the responsibilities of leaders. Attention will be given to criteria for choosing between conflicting ethical theories, moral disagreement, the justification of moral judgments, and the application of ethical standards to practical decision-making and ethical questions that arise in everyday life.

BT 181 Seminar in Business (1-1-0)

This course will broadly address the issue of how management decisions are made in a corporate business environment. The focus will be on understanding the tools, people and processes that are used in large public companies to make major decisions. Students will explore this in the context of the major decisions made by senior management, as opposed to day-to-day decision-making. As a survey course it will only highlight the theory and detailed mechanics of complex decision-making. The focus will be to discuss the issues faced by executives in solving complex problems that require their attention and review the methods used by business executives to handle uncertainty, mitigate risk and create outcomes that address the needs of the business. Throughout the course students will examine the decision-making process from the perspective of different departments; marketing, sales, corporate planning, production, financing, etc. While many of the planning, financial and analytical tools are common, their application within different departments can and will vary. The course will consist of two components: 1. Lectures and reading on decision-making tools, methods and procedures. 2. Business case discussion on the application of decision-making tools to timely issues faced by leading corporations.

In addition to these seminars, each Clark Scholar will take two additional three-credit courses related to in Business Social Entrepreneurship. Courses will be selected under the advisement of the program coordinator based on student interest and the relevant academic program requirements and electives.

▸ The Pinnacle Scholars Program

The Pinnacle Scholars Program is an invitation-only program for undergraduate students who want to push the boundaries of their education even further. Students are identified and selected for this highly competitive program during the undergraduate admissions process and are notified through their acceptance letters. Invited students then have the option to confirm or decline acceptance into the program.

Pinnacle Scholars gain unique and extremely valuable hands-on exploration and application of their knowledge through advanced research and international experiences. Among their many benefits, these opportunities give Pinnacle Scholars a distinction in the job market and/or advancement to competitive graduate and doctoral studies.

Pinnacle Scholars receive the following benefits:

▸ An annual cultural passport for museum memberships and cultural events (e.g. Broadway and Off-Broadway plays, opera, symphony, art exhibits). This passport will allow you to experience the special cultural opportunities available only in the New York City Metropolitan area.

- The opportunity to enroll in special honors and research seminars that provide support and guidance for research activities.

- Individualized mentoring and advisement.

- The option to participate in the Accelerated Master's Program, which provides the opportunity to complete a bachelor's and master's degree sequentially.

- An annual $5,000 stipend to support participation in one of the following options for up to three undergraduate summers:

  - Research opportunities guided by a faculty advisor

  - An international experience (e.g. study abroad or internship, approved by the Office of International Programs)

Pinnacle Scholars may remain in the program for up to eight academic semesters provided they maintain a 3.2 grade point average (GPA) and make satisfactory academic progress toward the degree. The cumulative GPA will be reviewed annually.

Courses for Pinnacle Scholars

PIN 183 Pinnacle Scholar Seminar I (1-1-0)

This seminar covers topics that will enhance the undergraduate experience of Pinnacle Scholars. Pinnacle Scholars will learn about and discuss subjects including, but not limited to, the transition to university life, campus resources, conducting research, engaging in entrepreneurial and innovative project development, and international learning experiences. The seminar will also explore content specific to the Pinnacle Scholars Learning Communities themes. Potential themes include: Energy and Resources; Sustainability and the Environment; Bio-Innovation, Medicine, and Health; Technology, Science, and Society; and Technology and Global Security.

PIN 184 Pinnacle Scholar Seminar II (1-1-0)

This seminar will continue to explore content specific to the Pinnacle Scholar Learning Community themes. In addition, the course covers topics that will aid Pinnacle Scholars as they determine in which of the summer involvement opportunities they will engage. In particular, students will participate in tours of multiple research labs, learn how to prepare research proposals, and review how to participate in an international experience. In addition, Pinnacle Scholars will explore graduate programs and associated entrance exams.

▶ Stevens Technical Enrichment Program (STEP)

The Stevens Technical Enrichment Program (STEP) www.stevens.edu/sit/step provides support and encouragement to students from groups frequently underrepresented in the fields of science, technology, engineering, and mathematics (STEM). STEP offers an environment and space in which the students are able to freely engage and support each other, presents programs which facilitate their academic, personal and professional development, and hosts events which celebrate the students' cultural and ethnic diversity. STEP also coordinates the Bridge summer program for pre-freshmen, and oversees the New Jersey Educational Opportunity Fund (EOF) Program http://www.state.nj.us/highereducation/EOF/EOF_Eligibility.shtml.

STEP Bridge is a challenging six-week college-level summer residential program for incoming freshmen. It helps students begin their transition from high school to college in general, and Stevens in particular. During Bridge the pre-freshmen attend classes, network with upperclassmen, create friendships, and develop relationships with STEP staff and faculty members. Students either are required to attend Bridge as a condition of their admission to Stevens, or apply to attend the summer program. Any Stevens' undergraduate who did not participate in Bridge is welcome to join STEP during the academic year.

The New Jersey Educational Opportunity Fund (EOF) Program is a comprehensive student support program that provides financial, academic and non-academic support for eligible students. EOF students receive a financial award and specific support services. All freshmen receiving an EOF grant are required to attend Bridge and are considered members of STEP.

For more information, contact step@stevens.edu, or 201-216-5387, or visit the STEP Office in the Wesley J. Howe Center.

▸ Cooperative Education

Cooperative Education is a five-year educational program where students alternate between semesters of full time study and full time work in areas related to their academic studies and career interests. The Co-op Program assists students in clarifying their career aspirations while experiencing the connection between the theories learned in the classroom and applied in the workplace.

Students' first year is dedicated to completing freshman year academic requirements and attending the required career development meetings to understand the rotational nature of the program, prepare for the recruitment process, and gain an understanding of workplace expectations. Over the course of the second through fourth years, Co-op students alternate semesters of study with semesters of full-time employment in accordance with the Co-op work/study schedule that has been approved by their Co-op advisor. The fifth year is devoted to full time study and completing the course requirements of the undergraduate degree.

The many benefits of participating in cooperative education include having the opportunity to work at a maximum of three different employers and the ability to gain knowledge and skills while receiving compensation on a full-time basis when on assignment.

Eligibility

The Co-op Program is available to full-time undergraduate students pursuing degrees in the engineering or science disciplines. Students must commit to following a five-year alternating work/study schedule and attend the required Career Development workshops. All freshman year course requirements must be completed and students must be in good academic standing with a minimum 2.20 GPA, and able to complete a minimum of 3 Co-op work terms.

For more information, contact careercenter@stevens.edu, 201.216.5166, or visit the Career Center on the 6th Floor of the Wesley J. Howe Center.

▸ Preparing for a Career in the Health Professions

Stevens provides advising services to students interested in pursuing a career in the health professions. To make yourself a desirable candidate for admission to such programs, you will need an education that includes a strong foundation in the sciences, highly developed communication skills, and a solid background in the social sciences and humanities.

Students who are considering a career in the health professions should begin exploring their options early in their career at Stevens. They should inquire about the requirements of specific schools and plan their studies at Stevens accordingly. Students are *not* required to choose a science major in order to apply to medical school, although majors such as Biology, Chemical Biology, or Biomedical Engineering include the courses that are typically required for application to medical school in their curricula. Thus, choosing one of those majors may make a student's course planning a bit easier, but you can incorporate the required courses into many majors including, but not limited to, chemistry, chemical engineering, physics, humanities, arts, business, and other majors.

Students who are planning to begin medical school or dental school immediately after graduation from Stevens should plan to complete all of the minimum required courses listed by the schools in which they are interested by the end of their junior year

at Stevens to help ensure they are prepared to take the appropriate national exam (the Medical College Admission Test (MCAT) for medical school or the Dental Admission Test (DAT) for dental school) by early spring of their junior year. Students need to apply in June of their junior year if they would like to start medical school immediately following their undergraduate program. Many students choose to begin professional school immediately after graduation from undergraduate school. However, there is a strong national trend toward adding one or more years of experience between undergraduate school and professional school, a gap year, providing more flexibility in undergraduate course scheduling and choice of undergraduate major as well as the potential to study abroad. Stevens faculty advisors will help you to decide which plan is best for you. In addition to excellent grades and excellent test scores, you will also benefit from experience in clinical settings (e.g., Emergency Medical Technician/First Aid training, hospital or medical/dental office volunteering), research laboratories where you can develop your power of inquiry and logic, leadership and service. A variety of student clubs as well as your academic advisors can help to make these connections for you.

Health Professions Advisory Committee

The Health Professions Advisory Committee (HPAC) helps students prepare to apply to medical (MD and DO), dental school, optometry and veterinary medicine. HPAC also provides advice for students interested in advancing towards careers in genetic counseling, chiropractic medicine, physician's assistant and physical therapy. The HPAC meets with groups of students on a periodic basis, interviews individual applicants as applications draw near, collects letters of recommendation on behalf of applicants, and writes the Committee letter for the student's applications. HPAC also holds seminars to discuss the application requirements and procedures, and any changes in the application process. The HPAC includes faculty with expertise in science and engineering, literature and social sciences, business/healthcare management, and undergraduate academic administration.

Health Professions Student Organizations

In an effort to support those interested in the healthcare field, Stevens supports two active student organizations: the Stevens Health Professions Club (SHPC) and Alpha Epsilon Delta (AED).

- SHPC is dedicated to providing educational and volunteer opportunities for students aspiring for a career in healthcare. Through programs offered on and off campus, students interested in an array of areas of healthcare will benefit from guest speakers representing various careers, introductions to and advice from members of professional school admissions committees, and access to volunteer opportunities at hospitals and EMS training courses.

- AED is the National Health Preprofessional Honor Society dedicated to recognizing and encouraging those committed to healthcare. The organization strives to organize events each semester focused on philanthropy, scholarship, and social issues to promote the awareness of healthcare on campus and within the Hoboken community.

Recommended Courses

Typically, the following courses are recommended for students who are interested in applying to medical or dental school. These courses usually satisfy the admissions requirements to accredited U.S. medical and dental schools. These courses will also help the student prepare for the MCAT which was revised in 2015 and has a significant emphasis on psychology, sociology and biochemistry.

Subject	Requirement	Stevens Course Offerings
Chemistry	2 years with lab	CH 115, 116, 117, 118 CH 243, 244, 245, 246
Biology	8 credits with lab	BIO 381 and BIO 382 OR BME 482 *Note: BIO 281 is a pre-requisite for BIO 381, 382, and BME 482.
Physics	8 credits with lab	PEP 111, 112, 221, 222
Mathematics	8 credits	MA 121, 122, 123, 124
Humanities	8 credits	CAL 103, 105 *Note: choosing humanities with strong writing and reading components can improve writing, critical analysis, and reasoning skills for MCAT.
Biochemistry	3 credits	CH 580
Psychology	3 credits	HSS 175
Sociology	3 credits	HSS 141
Statistics	3 credits	MA 222 or BT 221
Ethics	3 credits	BME 452 or HPL 457
Others Recommended		Molecular Genetics (BIO 484), Immunology (BIO 686), Physiology (BIO 583), Biological Psychology (HSS 331), Biochemistry II (CH 581)

Please Note: Most U.S. medical and dental schools will NOT accept AP courses from high school, courses taken abroad, or courses taken at community colleges to satisfy the basic chemistry, biology, physics, math, and English courses.

It is strongly recommended that you check the admission requirements with the medical, dental or pre-health professional school you are interested in applying to.

For additional information about the pre-health professions program and to let the HPAC committee know you are interested in the health professions, please e-mail: pmuisene@stevens.edu

▶ ROTC

Stevens offers Air Force ROTC and Army ROTC through programs at New Jersey Institute of Technology (NJIT) in Newark, NJ, and Seton Hall University in South Orange, NJ.

For additional information about the Air Force ROTC program, contact the Department of Aerospace Studies at NJIT, telephone: (973) 596-3626, email: afrotc490@njit.edu.

For additional information about the Army ROTC program, contact the Department of Military Science at Seton Hall University, (973) 763-3078 or (973) 761-9446.

▶ Sponsored Senior Design Program

The Sponsored Senior Design Program provides an opportunity for a team of engineering and/or computer science students to select a two-semester sponsored design project. Typically, the sponsoring organization proposes one or more project topics, establishes the primary goals and works with the design coordinator to develop the design requirements. The student team will **collaboratively** work with professional mentors from the sponsoring organization and faculty advisor(s) to develop and evaluate solutions that meet the design requirements. These projects offer students opportunities beyond the typical senior design project and provide more impactful outcomes. The students are expected to present periodic reviews on design

concepts; analysis, testing and optimization results; detailed designs, and prototypes of hardware and software systems, to the sponsor. Prior to the commencement of the project, the sponsor, the students, and the institute will enter into an agreement that stipulates the project expectations, fees, and assignment of intellectual property rights.

▶ Study Abroad

At Stevens, all students are encouraged to have an international experience. Studying Abroad is one of the most important activities that college students may do for their personal development, their career, and to prepare for the world they will enter after graduation. In the global society in which we live today, it is becoming increasingly essential to have an understanding of and appreciation for different people, cultures, and how others view the world and address challenges, both in business and everyday life. Participating in a Study Abroad Program or other education abroad experience will add another dimension to a student's resume, help them gain a global perspective, and allow them to recognize the value of international cooperation.

Undergraduates with a 2.75 cumulative GPA who have completed at least one year of study at Stevens have the option to participate in a semester-long education abroad experience. They are also able to study on short term faculty led programs, primarily in the summer or winter intersession, engage in research, intern, or enroll in courses at partner universities located around the world. Seniors may also participate in intersession or other short term programs offered by Stevens or other affiliates and partners.

Short-term opportunities include Stevens Faculty-Led Programs at foreign destinations and research, study abroad, intern, and service learning programs with Stevens's partner study abroad providers. Past destinations have included Belgium, Ecuador, England, Greece, Italy, Japan, Spain, and the Netherlands. Some short-term programs may offer students the opportunity to earn academic credits.

Semester abroad programs are study abroad experiences in which students enroll for a semester at partner universities located around the world. Students select a university which offers courses which are then pre-approved for transfer to Stevens and which meet graduation requirements. Stevens offers several established options for study abroad experiences. Among them are exchange programs with universities such as the Universidad Pontificia Comillas in Spain, Shanghai University of Finance and Economics, KTH Royal Institute of Technology in Sweden, the University of Amsterdam in the Netherlands, KU Leuven in Belgium, University of Strasbourg in France, and Queen Mary University of London in England. Stevens also partners with University College Dublin in Ireland, Budapest University of Technology and Economics in Hungary, and the University of Nicosia in Cyprus for direct enroll programs. In addition, Stevens partners with several study abroad providers, including Academic Programs International (API), International Studies Abroad (ISA), The Education Abroad Network (TEAN), G-MEO, and CIS Abroad, to name a few.

The decision of when to study abroad is made after discussions with the Academic Advisor, Co-op Counselor (if appropriate) and the Director of International Programs. Students are advised to select the semester or summer which best fits their academic curriculum and does not delay their graduation.

Stevens students who have participated in study abroad programs and other international education experiences report that it enriched their lives and enhanced their opportunities for employment and/or professional studies. Returnees are invited to join the Global Ambassadors, a volunteer student group coordinated by the Office of International Programs.

For more information view www.stevens.edu/studyabroad, contact studyabroad@stevens.edu, or visit the Office of International Programs, Howe Center, 9th Floor.

Undergraduate Procedures and Requirements

A more detailed description of undergraduate academic policies and procedures can be found at https://www.stevens.edu/about-stevens/university-policy-library/undergraduate-academics/undergraduate-academics-policies-and-procedures.

▶ Grade Scale

Academic grades for courses numbered lower than 500-level are listed below and quality points per credit are indicated in parentheses:

A	(4.00)	Excellent
A-	(3.67)	
B+	(3.33)	
B	(3.00)	Good
B-	(2.67)	
C+	(2.33)	
C	(2.00)	Fair
C-	(1.67)	
D+	(1.33)	
D	(1.00)	Poor
F	(0.00)	Failure
P	(0.00)	Indicates a successfully completed Pass/Fail course.
W		If you withdraw from a course up until one week before the last class meeting of the semester, "W" is posted.
WN		You are administratively withdrawn from the class if your instructor indicates that you have Never Attended.
WU		You are administratively withdrawn from the class if your instructor indicates that you have attended at least once, stopped attending and have not officially withdrawn from the course with a "W" grade.
NG		It is a temporary notation issued to students by the Office of the Registrar in the following situation: – a grade has not been entered on the grade roster for a student
Exc.		If you are excused by a physician from attending physical education classes, you receive an "Exc."

Faculty regulations concerning the abbreviations "Abs." for absent and "Inc." for incomplete can be found on the Undergraduate Academics Web site at https://www.stevens.edu/about-stevens/university-policy-library/undergraduate-academics/undergraduate-academics-policies-and-procedures. Stevens uses the Quality Points System to determine grade point averages (GPA). This means an "A" in a three semester-hour course is worth three times more than an "A" in a one semester-hour course. To determine the number of quality points for any course, the semester hours are multiplied by the value of the letter grade received for the course. To determine the weighted average, the sum of quality points is divided by the sum of quality hours.

▶ Examinations

All students must take a written examination at the end of each term in all major-required core courses. Examinations in all technical, engineering, humanities, and management electives are at the option of the specific department(s).

▶ Grade Point Averages

The Office of the Registrar calculates three different GPAs for each student:

> ▶ The semester GPA is determined from all courses taken at Stevens during a semester.

> ▶ The graduating GPA is calculated from all courses taken at Stevens that are part of the degree requirement. If a course is repeated, the new grade replaces the old grade for purposes of calculating the graduating GPA, even if the new grade is lower than previous grade(s). Please note that if a course that has been passed previously is retaken, and a grade of F or W is recorded for the retaken course, then the course is considered as having been passed and the previous grade will be used in calculating the graduating GPA. If a course is repeated outside of Stevens with a grade of C or better, then a grade of C is used to calculate the graduating GPA.

> ▶ The ranking GPA is calculated from all courses that are part of the degree requirement. In this case, all repeated courses are included and repeated courses taken outside of Stevens are calculated as a "C."

▶ Grade Changes

A final grade in a course may be changed only if an error in grading or grade computation was made, or if an Incomplete/Absence petition was approved and filed before the end of the semester in which the course was taken. If one of these circumstances applies, a grade may be changed within 6 months after the completion of the semester in which the course was taken for an ABS or within 12 months after the completion of the semester in which the course was taken for an INC.

▶ Graduation Honors

Degree with Honor

The undergraduate Degree with Honor is conferred to the student who achieves a grade point average of 3.4 for courses required for the degree.

Degree with High Honor

The undergraduate Degree with High Honor is conferred to the student who achieves a grade point average of 3.6 for courses required for the degree.

Degree with Highest Honor

The undergraduate Degree with Highest Honor is conferred to the student who achieves a grade point average of 3.85 or higher for courses required for the degree.

▶ Graduation Requirements

To be eligible for graduation, a student must have a "C" average (2.00 GPA) and pass all required courses for the student's curriculum. Each course which is part of an undergraduate degree program for the graduating GPA must be passed within no more than three attempts.

▸ Advanced Placement

Stevens participates in the Advanced Placement (AP) program of the College Entrance Examination Board. You may receive college credit toward your degree for the following examinations and corresponding scores.

AP Examination & Score	Stevens Equivalent	Credits
Art History (4,5)	HAR 180	3
Biology (4,5)	BIO 281 and BIO 282	4
Chemistry (4,5)	CH 115, 116, 117 and 118	8
Chinese Language and Culture (4,5)	General Elective (for engineering students), Elective (for majors other than engineering)	3
Computer Science A (4,5)	CS Majors: one technical elective CyS & QF Majors: one Computer Science elective All Other Majors: CS105 or E115	3 or 2
Principles of Computer Science (4,5)	Computer Science (CS) and CyberSecurity (CyS) majors and minors will receive one free elective. Non-majors get credit for CS 105 or E115.	3 or 2
Economics-Macroeconomics (4,5)	BT 243	3
Economics-Microeconomics (4,5)	BT 244	3
English-Language & Composition (4,5)	100 Level Humanities	3
English-Literature & Composition (4,5)	100 Level Humanities	3
Environmental Science (4,5)	General Elective (for engineering students), Elective (for majors other than engineering)	3
French Language & Culture (4,5)	General Elective (for engineering students), Elective (for majors other than engineering)	3
German Language & Culture (4,5)	General Elective (for engineering students), Elective (for majors other than engineering)	3
Government & Politics-Comparative (4,5)	100 Level Humanities	3
Government & Politics - U.S. (4.5)	100 Level Humanities	3
History - European (4,5)	100 Level Humanities	3
History - U.S. (4,5)	100 Level Humanities	3
History - World (4,5)	100 Level Humanities	3
Italian Language and Culture (4,5)	General Elective (for engineering students), Elective (for majors other than engineering)	3
Japanese Language and Culture (4,5)	General Elective (for engineering students), Elective (for majors other than engineering)	3
Latin (4,5)	100 Level Humanities	3
Mathematics - Calculus AB (4,5)	MA 121 and MA 122 Or MA 117	4
Mathematics - Calculus BC (4,5)	MA 121, MA 122, and MA 123 Or MA 117	6 or 4
Music Theory (4,5)	HMU 201	3
Physics 1 (4,5)	PEP 123 (for Business and Humanities majors)	3
Physics 2 (4,5)	PEP 124 (for Business and Humanities majors)	3
Physics C - Mechanics (4,5)	PEP 111	3
Physics C - E & M (4,5)	PEP 112	3
Psychology (4,5)	HSS 175	3

AP Examination & Score	Stevens Equivalent	Credits
Spanish Language & Culture (4,5)	General Elective (for engineering students), Elective (for majors other than engineering)	3
Spanish Literature & Culture (4,5)	100 Level Humanities	3

▶ IB Placement

Stevens participates in the International Baccalaureate (IB) program of the International Baccalaureate Organization. You may receive college credit toward your degree for the following examinations and corresponding scores.

IB Examination & Score	IB Level Stevens Equivalent	Credits
Biology w/Lab (6,7) HL	BIO 281 and BIO 282	4
Chemistry w/Lab (6,7) HL	CH 115,116,117, and 118	8
Classical Language (6,7) HL	General Elective (for engineering students), Elective (for majors other than engineering)	3
Computer Science (6,7) HL	CS and CyS students will receive credit for one free elective and are exempt from CS115, CS284 and start in CS385. Majors other than CS and CYS receive credit for E115 or CS105.	3
Computer Science (6,7) SL	CS majors will receive one technical elective CyS majors will receive one Computer Science elective Non CS and CyS majors will receive credit for E115 or Cs105	3
Economics (6,7) HL	BT 243 and 244	6
History (6,7) HL	HHS 123 or 124; (class for credit chosen with consultation of faculty advisor)	3
Language A1 (6,7) HL	General Elective (for engineering students), Elective (for majors other than engineering)	3
Language A2 (6,7) HL	General Elective (for engineering students), Elective (for majors other than engineering)	3
Language B (6,7) HL	General Elective (for engineering students), Elective (for majors other than engineering)	3
Music (5,6,7) SL/HL	Assessment test given that may allow the student to place out of specified topic and receive full course credit if they pass that assessment. The student can declare any required music and technology major components.	*Dependent upon Exam
Philosophy (6,7) HL	HPL 111 or 112; (class for credit chosen with consultation of faculty advisor)	3
Psychology (6,7) HL	HSS 175	3
Social and Cultural Anthropology (6,7) HL	General Elective (for engineering students), Elective (for majors other than engineering)	3
Theater HL (6,7) HL	General Elective (for engineering students), Elective (for majors other than engineering)	3
World Cultures (6,7) HL	HUM 107	3
World Religions (6,7) HL	General Elective (for engineering students), Elective (for majors other than engineering)	3

▸ Course Options

Course by Examination

Course by examination is open to students with a GPA of 3.0 or better either in the previous semester or overall, and is limited to one per semester. Permission to take a course by examination must be obtained on a Request for a Course by Examination form from the instructor, student advisor, and the Office of Undergraduate Academics.

If the examination is successfully completed, the instructor who administered the examination issues a letter grade in the course. The examination must be taken prior to the start of a semester, and if the examination is not passed, the unsuccessful attempt is recorded as part of the student's permanent record, and the student must enroll in that course in the following semester.

A course that has already been attempted by a student cannot subsequently be taken as a Course by Examination.

Course by Application

If a particular course is not offered through the regular schedule, the course may be taken by application with the approval of the instructor, the Department Chair, and the Office of Undergraduate Academics on a Request for a Course by Application form. Regular enrollment is required, and arrangements are made for the student to study the material and be tested during the semester. A letter grade is issued at the end of the semester.

Extra Courses

Freshman, during the first academic year, are not allowed to take extra classes beyond the number of courses in their major.

Taking extra courses beyond a program's normal load is a serious matter. While the Office of Undergraduate Academics does not encourage overloading, any overload consideration must be discussed and approved by that office. The following are the criteria for overloading:

After the first year, students may enroll in an extra class with the permission of the Office of Undergraduate Academics and a GPA of 3.30 or higher in the previous full-time semester. Students with an extra course and 3.60 or higher GPA may enroll in two extra courses. The GPA requirements above can also be met by the student's cumulative GPA.

The baseline definition for the regular course load is 20 credits a semester. An additional per credit tuition fee will apply for students who overload.

Auditing Courses

To audit a course is to attend classes without receiving credit for the course. A student may do this with approval from the Office of Undergraduate Academics. This course will count as an enrolled course for purposes of computing overload charges, should any be required. In order to change from credit to audit status or audit to credit status in a class, student must file a Change of Enrollment (Add/Drop) form in the Office of the Registrar before the Add/Drop deadline established by the Registrar.

Pass/Fail

If a student is on the Dean's List or has a 3.50 cumulative GPA, one course per semester may be selected under a pass-fail grading system, subject to the Advisor's approval. The course must be an extra undergraduate course beyond the requirements for the undergraduate degree. The course must be clearly designated on the study plan or application for candidacy as either "extra" or "outside the area of concentration." No graduate course may be taken under the pass-fail grading system regardless of its status. Students have until the mid-term date of the semester to designate a course as pass-fail.

Dropping/Withdrawing from Courses

Individual courses may be dropped during the Add/Drop Period in the first two weeks of each semester (one week in summer sessions) online or by submitting a Change of Enrollment Form to the Office of the Registrar. When a course is dropped, no record of the student's enrollment in the course remains on the student transcript.

After the Add/Drop Period has passed, students may withdraw from a course up to one week before the last day of classes. When a student withdraws from a course, a grade of "W" is recorded on the transcript. The grade of "W" does not affect the student's graduating GPA. International students should consult with the Office of International Student and Scholar Services before withdrawing from a course.

Dean's List

The Dean's List is prepared at the end of each academic term by the Office of the Registrar. To be eligible for a given semester, a student must be in good standing, earn at least 12 credits, and have a 3.50 semester GPA with no failures and no more than one course withdrawal.

▸ Reduced Load Program

The Reduced Load Program has two options:

Freshman Option

Permits freshmen to take one fewer technical course for each of the first two semesters. The courses are made up tuition free during the summer immediately following the freshman year. The deadline to sign up is the start of the second semester. To register for the tuition free courses, students must visit the Office of Undergraduate Academics during registration to complete Change of Enrollment form(s).

Reduced Load Option

Reduces the student's work load in each semester by lengthening the time from entrance to graduation from eight to ten semesters. Students who are accepted into the Reduced Load Option receive full tuition waiver in the 9th and 10th semesters. The waiver of full tuition does not extend beyond the 10th semester. The deadline to sign up is the end of the third semester for engineering students and the end of the second semester for all other students.

Students may elect to change their participation from the Freshman Option to the Reduced Load option after their first two semesters. Students who elect to make this change forfeit the free summer classes offered through the Freshman Option.

Continued participation in the Reduced Load Option is contingent upon maintenance of a curricular program that does not exceed "reduced load" status for the appropriate field of study while paying the current full semester tuition. Explicit in this condition is a forfeiture of the student's right to exercise the "extra course" provision. This forfeiture does not prohibit students from pursuing certain program enhancements such as minors following specific approval from the Office of Undergraduate Academics. Students in the Reduced Load Option are not eligible to take graduate courses towards future master's degree.

Students may, during the 9th and 10th semesters, qualify for limited financial aid. Merit scholarships are strictly limited to eight semesters. In all cases, it is the student's responsibility to complete all applicable financial aid forms. Students are strongly urged to contact the Office of Financial Aid for details.

Contact the Office of Undergraduate Academics to discuss the options above and to complete the required Reduced Load Program Agreement.

▸ English Language Requirement for International Students

Undergraduate international students will be placed in CAL 101 during their first semester. After successful completion of CAL 101, international students must take CAL 103, followed by CAL 105. A diagnostic will be administered during the first week of CAL 101 and students who surpass the requirements of the diagnostic may transfer to CAL 103. CAL 101 may be used to satisfy a general or free elective requirement. Subsequently, all undergraduate international students must complete the remaining humanities courses required for their degree program.

▸ Online Graduate Courses for Undergraduate Students

Undergraduate students may, with junior or senior standing, a 3.00 or higher GPA, and the permission of their advisor, enroll in up to two online graduate courses per semester. Students are not allowed to enroll in more than two online classes in any semester. A third online course can be taken in a semester with a 3.20 cumulative GPA and the permission from the Office of Undergraduate Academics. These classes are counted as part of the students' regular semester credit load for purposes of computing overload charges, if any apply. Undergraduates are not permitted to enroll in the winter or the Spring 2 WebCampus semesters. Online graduate courses may not include more than two 600- or higher-level courses per semester and those courses require a separate permission process.

International students in F-1 immigration status should keep in mind that immigration regulations permit them to count only one online course (3 credits) toward their full-time requirement in each regular (fall and spring) semester. Therefore, while Stevens permits them to take 2 online courses per semester at no additional cost, they must generally be enrolled in a minimum of 15 credits, at least 9 of which must be in regular on-campus courses, in order to do this and still maintain their immigration status. For additional details and questions, please contact the Office of International Student and Scholar Services. http://www.stevens.edu/directory/international-student-and-scholar-services

▸ Non-matriculated Students

Students wishing to take a course at Stevens on a non-matriculated basis must obtain approval from the Office of Undergraduate Academics. A minimum 3.00 GPA at the student's current or previous college or university is required, in addition to completion of the equivalent of all pre-requisite courses for the desired Stevens course. Non-matriculated students may not take more than nine credits in one semester and may not take more than 15 credits total. Tuition is charged on a per-credit basis. For details regarding course offerings, visit the Office of the Registrar's web site at http://www.stevens.edu/directory/office-registrar

▸ Academic Leave of Absence/Withdrawal from Stevens

Withdrawing from Stevens

A student who withdraws from Stevens no longer plans to continue his/her education at Stevens. Students seeking to withdraw from Stevens should visit the Office of Undergraduate Academics on the 9th floor of the Howe Center to complete a Withdrawal form.

Leave of Absence from Stevens

A student who takes a Leave of Absence (LOA) from Stevens plans to return to Stevens to continue his/her studies. Students may take a leave of absence from Stevens for up to 6 months. A Leave of Absence may be extended for another six months with permission.

Students seeking a Leave of Absence should visit the Office of Undergraduate Academics on the 9th floor of the Howe Center to complete a **Leave of Absence form**. Students wishing to extend a Leave of Absence should contact the Office of Undergraduate Academics to complete a **Request to Extend Leave of Absence form** before the current Leave of Absence expires.

A student is withdrawn from the Institute if an extension has not been granted. A student who does not return after an approved extension will be withdrawn from the Institute.

Medical Leave of Absence (MLOA)

A student who takes a Medical Leave of Absence (MLOA) plans to return to Stevens to continue his/her studies. A Medical Leave of Absence must be approved. Students seeking a Medical Leave of Absence or extensions related to the medical leave should contact the Dean of Students.

Details regarding the procedure for a Medical Leave of Absence can be found in the Student Handbook located on the Undergraduate Student Life page. https://www.stevens.edu/campus-life/undergraduate-student-life

Students whose application for a medical leave of absence is not approved may take a traditional leave of absence per the policy above.

Students should contact the Office of Financial Aid for questions regarding the impact a leave, medical leave or withdrawal will have on loans and/or scholarships.

Note: Undergraduate students who withdraw or do not return from a leave of absence and subsequently would like to return to Stevens must apply for readmission within 7 years from the date of the withdrawal or leave of absence from Stevens. An undergraduate degree must be completed within 12 years of entrance to Stevens.

▸ Administrative Leave of Absence

Students may be placed on an Administrative (involuntary) Leave of Absence for any of the below reasons:

- ▸ Financial: If a student is not able to meet his/her financial obligations for the semester or has an outstanding balance from a previous semester/year
- ▸ Disciplinary: as determined by Student Affairs or by the Honor Board
- ▸ Academic: as determined by the Academic Promotions Committee
- ▸ Not Enrolled: students who do not register for classes by the end of the drop/add period for the semester

▶ Physical Education (P.E.) Requirements

The Physical Education Department conducts a structured instructional class program which provides students with knowledge and skills in a wide range of lifetime, team and wellness oriented activities.

Students participate in a multitude of sport pursuits which can be enjoyed both during college and beyond. Examples of the types of classes available include: archery, basketball, boot camp, bowling, core and sculpt, CPR certification, fencing, fly fishing, golf, women's golf, indoor cycling, leadership, Olympic weight lifting, outdoor adventure, Pilates, racquetball, soccer, squash, strength and conditioning, swimming, tai chi, tennis, yoga and Zumba.

The following are the P.E. graduation requirements for all Stevens students for non-academic credit. They will appear on the student record as pass/fail. All students must complete four Physical Education (P.E.) courses in non-repeating courses.

> ▶ All four P.E. courses should be completed by the end of the sixth semester.
> ▶ Students can use up to four semesters of Varsity and/or Club sports to fulfill the P.E. requirements.

The Physical Education course offerings are updated on an annual basis to meet the needs and interests of the student body. Course options may vary from semester to semester.

GRADUATE EDUCATION

Applying for Admissions

Application Requirements

Applicants to any graduate program at Stevens are required to have completed a bachelor's degree from an accredited college or university in the United States or the equivalent from a foreign institution.

A complete application includes the following:

▸ Online application

▸ $60 non-refundable application fee

▸ Two letters of recommendation

▸ Official college transcripts from all institutions attended (both undergraduate and graduate) with proof of degree

▸ GRE/GMAT scores for all full-time masters and PhD applicants. Please note that GRE/GMAT scores are valid for 5 years from the testing date.

Additional Requirements for International Applicants

International applicants must provide proof of English language proficiency. Applicants can choose to submit scores from either the Test of English as a Foreign Language (TOEFL) or the International English Language Testing System (IELTS). TOEFL and IELTS scores are valid for two years from the testing date. The minimum required scores for each test are listed below.

IELTS: 6

Paper-based TOEFL: 537

Internet-based TOEFL: 74

Additional Requirements for Doctoral Program Applicants

Applicants to doctoral programs may be required to submit additional information such as a resume, additional letters of recommendation, and/or evidence of written work, as specified by a given school, department, or program.

Current Stevens Undergraduate Students Applying for Graduate Admission

Current undergraduate SIT students applying to a graduate program must complete the online application found on the graduate admissions website.

Application Review

After all required documents are submitted to the Office of Graduate Admissions, accompanied by an application fee of $60, representatives from the relevant academic department will review the materials. Applicants will be evaluated based on several criteria: undergraduate class standing (upper third is desirable); performance in major field; grade-point average; professional experience, where appropriate; and performance on standardized examinations.

Study Plans

Newly-admitted students must meet with their academic advisor during New Student Orientation and complete a plan of study before enrolling in courses. Courses not included in your Study Plan may not count toward your degree requirements.

Change of Program

A student who wishes to change to a different program prior to the first day of the semester is treated as a new student applying for admission and must fill out a new application. Students wishing to change to a different program after the first day of the semester should fill out a program change form which must be submitted to the Office of Graduate Admissions, after which the student's file is then sent to the new department for a separate admission decision. The student must then complete a new Study Plan, and all previously completed coursework must be evaluated for transfer into the new program. Acceptance of such credits is entirely at the discretion of the department and must be approved by the Graduate Academics & Student Success.

Deferring Admission

Newly admitted students may request to defer their acceptance for one semester. Students who have not enrolled within one year of their acceptance must reapply through the Office of Graduate Admissions. The student's file will be reviewed and a decision letter will be sent to the student.

Degree Programs

Stevens Institute of Technology offers graduate programs in engineering, science, systems engineering, management, and the liberal arts. Programs lead to one of over 50 different advanced degree designations from the Master's to the Doctor of Philosophy degree. The graduate programs are intended to enable professionals to advance in industries increasingly influenced by technology and also to enable scholars to explore the frontiers of their disciplines. Students may attend graduate courses on a full-time or part-time basis, with many students attending classes at off-campus corporate cites. Students may complete a prescribed course sequence or engage in research activity that generates new knowledge in pursuit of an advanced degree.

▸ Master's Programs

A Master's program may be thought of as an extension or completion of the higher level of education already achieved in undergraduate studies. It may be an exploration in some depth of a particular area of science, engineering, computer science, information systems, management, or liberal arts, or it may be intended as a first step toward a doctoral degree. Since the master's degree carries with it the designation of the department in which it is earned, you must follow a Study Plan that your faculty advisor approves as satisfactory for the requirements of the degree and adequate to your particular needs. Upon request of the Graduate Academics & Student Success you may arrange an interdisciplinary program designating at least two professors to supervise the major areas of study. *For more information regarding Interdisciplinary programs, please see additional information below.*

For the master's degree, you must earn no less than 30 credits, 15 of which must be in your major's department. Additional requirements may be required by the department offering the program. Interdisciplinary programs are exempt from the requirements of 15 credits in one department. Thesis requirements, if any, vary with the department. In general, a master's thesis is optional for part-time students, but required by some departments of full-time students who are supported graduate assistants or are continuing on to the doctorate. For specific program requirements, please visit your Department's section of the Academic Catalog.

▶ Engineer Programs

The Engineers degree is a terminal professional degree beyond the master's degree. The purpose of the Engineer program is to advance the training of engineers beyond the master's level and to provide modern education for engineers whose master's degrees are not recent. A design project carrying from 8 to 15 credits is required. Five programs, each of 60 credits, beyond the bachelor's degree, are offered, leading to the degrees of:

- ▶ Biomedical Engineer
- ▶ Chemical Engineer
- ▶ Civil Engineer
- ▶ Computer Engineer
- ▶ Computer Science Engineer
- ▶ Electrical Engineer
- ▶ Mechanical Engineer
- ▶ Physics

▶ Doctoral Programs

Doctoral programs are specifically designed for students to ultimately lead an independent investigation of a problem within their field allowing them to make significant contributions to that particular body of knowledge. While part of this involves acquiring existing knowledge in their field, doctoral students' fundamental objective is to develop their skills and capacity to conduct original research. Therefore, the preliminary requirements for the doctorate are regarded not as ends in themselves, but rather as preparation for the dissertation in which the student demonstrates ability.

Institute Requirements

Students admitted into a doctoral program are required to earn a minimum of 84 credits beyond the bachelor's degree. Institute requirements beyond the credit requirement include the following:

- ▶ A written dissertation proposal and a successful defense;
- ▶ The successful completion of the 3-credit course PRV961 (included in the 84 credits), taken after passing the qualifying examination and preferably concurrent with the preparation of the dissertation proposal; and
- ▶ At least one manuscript based on dissertation work submitted to a peer-reviewed journal at the time of the dissertation defense.

Credits

A prior master's degree may be transferred for up to 30 credits with approval of the department within the discipline or equivalent area. Up to one-third of additional course credits may be transferred with the approval of the thesis committee and Graduate Academics & Student Success. Credits may not be transferred towards the dissertation research. The grade of "B" (3.0 GPA) or better is required for such courses and such courses may not have been already used to obtain an academic degree.

Qualifying Examinations

It is recommended that students take the department qualifying examination within on year of the start of the doctoral program. Students are allowed a 3-credit load reduction from their full-time load in order to prepare for the qualifying examination. Students are only allowed to take a 3-credit load reduction twice during the course of one's doctoral program prior to passing the qualifying examination.

Prior to taking the qualifying examination, students are allowed to enroll in a maximum of nine dissertation credits, with permission of their advisor.

Preliminary Examinations

Some doctoral programs require students to take a preliminary examination, but this is not required by the Institute. In some cases the preliminary examination and qualifying examination are combined. It is the responsibility of the student to know his or her specific program requirements.

Residency Requirement

Students must spend one year in residence performing research. In residence means students must spend a substantial portion of each week on campus or at an approved research facility. Details of the residency are subject to the approval of the Dissertation Advisor and Dean of Graduate Academics.

Activity Report

Students enrolled in research credits or Maintenance of Matriculation are required to complete the Doctoral Research Activity Report(link is external) at the end of the semester and submit to his or her advisory committee. The form should be signed by the dissertation advisor and submitted to the Office of Graduate Academics. Students who do not submit the Research Activity Report at the end of the semester will receive an academic hold on their account and as a result will not be able to enroll in additional credits.

DISSERTATION

Dissertation Advisory Committee

Within six months of passing the qualifying examination, a student must select a research advisor and agree upon a research topic. The research advisor will request that the department director nominate additional members of the advisory committee.

The dissertation advisory committee is composed of at least four members, one of whom must be a Stevens faculty member from another department or program. It is permissible to have a highly qualified individual from outside of Stevens serve as a committee member.

The chair or co-chair of the committee must be a tenure-track, full-time professor, professor emeritus or a non-tenure track faculty member who has been approved by the Office of the Provost to serve as a dissertation advisory committee chair. The list of faculty approved to serve as Dissertation Advisory Committee Chair can be found on the Graduate Faculty Intranet page under Graduate Academics & Student Success. Generally, the student's research advisor serves as the chairperson of the Dissertation Advisory Committee.

The student and Dissertation Advisory Committee are required to meet at least once a year and report to Graduate Academics & Student Success that the meeting was held.

Doctoral students in an interdisciplinary doctoral program are required to have five committee members. The committee must consist of two co-advisors, one member from outside of both programs but within Stevens, and two members from within each program.

Once the dissertation advisory committee has been formed, the Doctoral Dissertation Advisory Committee Nomination form must be completed and submitted to Graduate Academics & Student Success for final approval.

Publication Of Dissertation

After the dissertation is accepted, the student and his or her dissertation advisor are required to prepare a manuscript for publication. Details regarding the publication of dissertation can be found on the Graduate Academics & Student Success Intranet site.

Dissertation Defense

After the dissertation has been accepted by the student's Dissertation Advisory Committee, the student, in conjunction with the dissertation advisor and department, is required to schedule the dissertation defense. The dissertation defense must take place at least three weeks prior to Commencement. The last date to defend for each academic year can be found in the Academic Calendar.

All students are required to defend in person, on campus.

A more detailed description of the Doctoral Program Requirements can be found on the Graduate Academics & Student Success Intranet site.

▸ Interdisciplinary Programs

Interdisciplinary graduate programs promote intellectual growth and offer distinct challenges to conventional thinking. They address areas that are too broad or too complex to be dealt with adequately by a single academic discipline. Interdisciplinary programs are essential for the education of graduate students involved in projects concerned with the nurturing of technology from concept to realization. It is also the case that some interesting scholarly areas involve the blending of two or more academic disciplines, for example, management science juxtaposes operations research and business.

Students interested in an interdisciplinary program at either the Master's or Ph.D. level may proceed as follows:

▸ The student applies to Stevens Institute of Technology as an interdisciplinary student and outlines the program he or she would like to undertake.

▸ The Office of Graduate Admissions forwards the application to the Graduate Academics & Student Success. The Graduate Academics & Student Success forwards the application to the appropriate departments/programs for consideration.

▸ The departments/programs render their decisions and report them to the Graduate Academics & Student Success.

▸ If all decisions are positive, the Graduate Academics & Student Success informs the appropriate directors and appoints advisors for the preparation of a Study Plan and mentoring of the student.

▸ The Graduate Academics & Student Success formally informs the Office of Graduate Admissions the status of the application. If all decisions are positive, admission is granted; else admission is not granted.

▸ The student must complete a Study Plan and submit to the Graduate Academics & Student Success for approval. Upon approval, the Study Plan is sent to the Office of the Registrar.

▸ Graduate Certificate Programs

Graduate Certificates are organized for practicing engineers, applied scientists, and managers to keep abreast of the newest techniques and their applications in selected disciplines. Most graduate certificates consist of four graduate courses often of an applied nature, and the information and understanding gained in the courses can be immediately applied to the solution of on-the-job problems. One course taken at another institution may be transferred to the graduate certificate with faculty approval. The grade of "B" (3.0 GPA) or better is required for such a course, and it may not have been already used to obtain an academic degree. A Graduate Certificate is awarded upon satisfactory completion (i.e. a 3.0 GPA in the courses of

the program not including a transferred course) of the graduate courses required for the program. In most instances, these courses may be applied towards a graduate degree.

▶ Online Programs

Stevens students can take courses online for graduate credit and non-credit through WebCampus. A complete listing of WebCampus courses can be found at www.stevens.edu/webcampus. Designed for those who, because of distance or other commitments, cannot attend class at either Stevens' Hoboken campus or at off-campus corporate locations, WebCampus courses are delivered worldwide by the same superior faculty who teach in conventional classroom settings. Currently, there are 45 Graduate Certificates and 19 Master's programs available online through WebCampus.

Graduate Procedures and Requirements

A more detailed description of graduate academic policies and procedures can be found in the Graduate Academics & Student Success Intranet site.

▶ Academic Standing

The lowest passing grade for graduate courses is "C" and "F" is failure.

Students must maintain a "B" (3.0) grade point average to remain in satisfactory academic standing in a graduate program.

Students may be placed on probation if they a) have less than a "B" average b) have received a "C" or higher in three or more courses c) have received an "F" in a course that has been improve by repeating it.

▶ Grade Point Average

Academic grades are listed below and quality points per credit are indicated in parentheses:

A	(4.00)
A-	(3.67)
B+	(3.33)
B	(3.00)
B-	(2.67)
C+	(2.33)
C	(2.00)
F	(0.00)

The Office of the Registrar calculates two different GPAs for each student:

▶ The semester GPA is determined from all courses taken at Stevens during a semester.

▶ The graduating GPA is calculated from all courses taken at Stevens that are part of the degree requirement. If a course is repeated, only the last grade is used, even if the last grade is lower than previous grade.

▸ Special Grades

The following grades are given under the specified conditions:

"AUD" - audit	A student who registers to audit a course, pays the full fee, but does not receive a terminal grade or credit.
"ABS" - absent	This grade indicates that the student was absent from the final examination with approval of the instructor and the Graduate Academics & Student Success.
	The approval must be obtained through the use of the INC/ABS petition form available from the Student Services Center. The petition form must be filed within thirty days of the final examination date. After the student takes the examination, a Change of Grade form will be submitted by the instructor, giving a terminal grade for the course.
	Under normal circumstances, but subject to the discretion of the Dean of the Graduate Academics, a grade of F will be given for the course if the instructor does not submit a terminal grade before the agreed upon date.
"INC" - incomplete	Indicates that the student filed a petition form that is available from the Office of the Registrar. The petition must be filed no later than the last regular class meeting.
	Generally, an incomplete grade is granted to a person having been in the class for at least 10 class sessions, who is in good academic standing in the course, and has completed all the course requirements due within that time period. This grade is given at the discretion of the instructor.
	The incomplete must be made up within one year unless an extension is granted by the Graduate Academics & Student Success.
"S/U" - satisfactory/unsatisfactory	Indicate satisfactory or unsatisfactory respectively and are in progress grades, used as an interim grade for special problems courses, master's theses, engineer projects and doctoral dissertation.
"NG" - no grade	It is a temporary notation issued to students by the Office of the Registrar in the following situation:
	– a grade has not been entered on the grade roster for a student
	– "INC", or "ABS" has been entered on a grade roster, but no petition has been filed or approved
"W" - withdrawal WN - You are administratively withdrawn from the class if your instructor indicates that you have Never Attended. WU - You are administratively withdrawn from the class if your instructor indicates that you have attended at least once, stopped attending and have not officially withdrawn from the course with a "W" grade.	Students are automatically approved to withdraw from a class if it is before the end of the tenth class session. After the tenth class session, students need the permission of the instructor and Graduate Academics & Student Success to withdraw from a course. A "W" will appear on your transcript but does not affect your GPA.

▸ Grade Changes

A final grade in a course may be changed only if a) an error in grading or grade computation was made, or b) an Inc./Abs. petition was approved and filed before the end of the semester in which the course was taken. If one of these circumstances applies, a grade may be changed within one regular (Spring or Fall) semester after the term in which the course was taken.

▸ Graduation Requirements

In order to graduate a student must obtain (1) a minimum of a "B" average (3.0 GPA) average in their major and (2) an overall average of "B" (3.0 GPA) in the courses required to meet the requirements for the degree. A maximum of six years is allowed for completion of the degree, unless an extension has been requested by the student and granted by the Graduate Academics & Student Success.

▸ Transferring Credits

Up to 9 transfer credits may be accepted toward a 30 credit Master's degree or 12 transfer credits toward a 36 credit Master's degree or a 48 credit MBA degree, if these credits have not already been used to obtain an academic degree. All credits for transfer must show grades of "B" (3.0 GPA) or better, and the courses must be approved by the appropriate departments and submitted to the Office of the Registrar.

▸ Course Options

Course by Application

If a particular course is not offered through the regular schedule, the course may be taken by application with the approval of the instructor, the Department Director, the Office of Graduate Academics on a Request for Course by Application form. Regular enrollment is required, and arrangements are made for the student to study the material and be tested out during the semester. A letter grade is issued at the end of the semester.

Auditing Courses

To audit a course is to attend classes without receiving credit for the course. A student may do this with approval from the Office of Graduate Academics. Under no circumstances can you change to credit status or take the course for credit at a future time.

Dropping/Withdrawing from Courses

Individual courses may be dropped during the Add/Drop Period in the first two weeks of each semester (one week in summer sessions) by submitting a Change of Enrollment Form to the Office of the Registrar. When a course is dropped, no record of the student's enrollment in the course remains on the student transcript.

After the Add/Drop Period has passed, students may withdraw from a course up to one week before the last day of classes. When a student withdraws from a course, a grade of "W" is recorded on the transcript. The grade of "W" does not affect the student's graduating GPA. International students should consult with the Office of International Student and Scholar Services before withdrawing from a course because it could have implications on immigration status.

▸ English Language Proficiency Requirements for International Students

The ability to communicate effectively in English—to read, write and speak the language fluently—is vital for Stevens graduate students. Therefore, every international applicant must demonstrate English language proficiency by submitting the results of a TOEFL or an IELTS test.

Depending on TOEFL/IELTS scores, some students may be required to take an English Language Communications course during their first semester at Stevens. Those students will receive a letter from the English Language Communication (ELC) staff during orientation that informs them of their course placement. For detailed information about scores and associated

requirements, please refer to the English Language Proficiency Policy on the Office of Graduate Admissions website. If you have specific questions about the ELC policy or courses, please email Sophie Hales, ELC Coordinator at shales@stevens.edu, or Helene Beck, Assistant ELC Coordinator at hbeck@stevens.edu.

English Language Communication (ELC) Courses

ELC 71: Language and Communication in Academic Contexts (6 hours; 4 credits)

ELC 71 focuses on improving critical reading skills, developing effective listening strategies, gaining intelligibility in speaking, and acquiring familiarity with academic writing conventions. Through a variety of materials and task based activities, students will gain competence in writing well organized, coherent, and grammatically correct texts. Class discussions, text analysis, and teamwork will enhance students' analytical skills and promote confidence in social interaction in an English-speaking environment. Additional required work in the Language Laboratory will also improve informal communication, as well as the ability to give formal presentations.

ELC 81 Writing and Speaking for Academic Purposes I (4 hours; 2 credits)

ELC 81 focuses on improving academic writing skills through emphasis on specific tasks, including email, summary, and problem-solution writing, which are necessary for success at the graduate level. There is additional focus on improving speaking and listening strategies for academic, social, and professional interaction, which includes an understanding of how these two skills are related. A variety of materials and task-based activities help students gain competence and confidence in writing and speaking, both formally and informally. Additionally, required attendance in the Language Laboratory will enhance students' intelligibility in social and academic situations.

ELC 91 Writing and Speaking for Academic Purposes II (4 hours; 2 credits)

ELC 91 helps students position themselves as successful members of the graduate community by exploring the effective use of academic conventions. Resolving questions of rhetoric through text analysis, class discussions, and collaborative activities strengthens critical reading, thinking, and academic writing skills. A variety of genre-specific tasks help students improve communication of both sourced/non-sourced and verbal/non-verbal (graphs, tables, etc.) information. Additionally, refining critical elements of pronunciation through class and Language Laboratory work will improve the quality of formal and informal presentations.

▸ Non-matriculated Students

Students wishing to take a course at Stevens on a non-matriculated basis must obtain approval from the Office of Graduate Academics. A minimum 3.0 GPA at the student's current or previous college or university is required, in addition to completion of the equivalent of all pre-requisite courses for the desired Stevens course. Tuition is charged on a per-credit basis. For details regarding course offerings, visit the Office of the Registrar's web site at http://www.stevens.edu/directory/office-registrar.

▸ Academic Leave of Absence/Withdrawal from Stevens

Students seeking a Leave of Absence or Withdrawal should appear in person to the Office of Graduate Academics located in Howe building Room 130. Withdrawing from Stevens means that the student no longer plans to continue his/her education at Stevens. Leave of Absence (LOA) means that the student plans to return to Stevens to continue his/her education. Students wishing to take a voluntary leave of absence from Stevens can do so for up to one year or two semesters. Transcripts will be reviewed to determine readmission eligibility and conditions. Students who do not return to Stevens within one year or two semesters and have not obtained an extension of their Leave of Absence approved by the Graduate Academics & Student Success will be classified as withdrawn with the exception of those in military service who have been deployed.

▸ Administrative Leave of Absence

Students may be placed on an Administrative (involuntary) Leave of Absence for any of the below reasons:

▸ Financial: If a student is not able to meet his/her financial obligations for the semester or has an outstanding balance from a previous semester/year

▸ Medical/Mental Health: as determined by professional staff member(s)

▸ Disciplinary: as determined by the Graduate Academics & Student Success and the Director of Graduate Student Affairs

TUITION AND FEES

Tuition, Fees & Other Expenses for Undergraduate Students

Tuition & Fees

For the 2019-2020 academic year, the cost of attendance is as follows:

Tuition (full time, 12 – 20 credit)	$52,134
Room and Board estimated, (on campus residents only)	$15,770
General Service Fee	$1,420
Student Activity Fee	$460
Total	**$69,784**

We estimate that a typical student will require approximately $2,050 for books, supplies, transportation and other personal expenses.

Full-Time Students

Students enrolled in 12 - 20 credit-hours are considered full-time academic students and tuition is $26,067 per semester. Students enrolled in more than 20 credit-hours will be charged a per credit overload fee of $1,738 per credit.

Part-Time Students

Students enrolled in fewer than 12 credit-hours are considered part-time. Part-time undergraduates are charged $1,738 per credit-hour. If a student enrolls in fewer than 12 credit-hours, he/she is not eligible for state or Stevens financial aid and may not be eligible for federal financial aid. Students with fewer than 12 credit-hours should check with the Office of Financial Aid regarding their eligibility.

Fees

$230	Student Activity Fee per semester, which is used by the Student Government Association (SGA) to support the many undergraduate clubs and activities
$98	Laboratory Fee for each class taken with a lab (per course)
$710	General Service Fee (per semester)
$20	Fee to replace an ID card
$550	Late Payment Fee
$50	Return Check Fee
$25	International Check Processing Fee

Books & Supplies

Student can purchase all required textbooks at the Stevens Bookstore or through the Stevens Bookstore website at www.stevens.edu/bookstore. The Stevens Bookstore accepts DuckBills, and all major credit cards.

Co-op Students

Students participating in the Stevens Cooperative Education program are not charged tuition but are required to pay the Student Activity, General Service, health insurance, and other applicable fees and are considered attending full-time. Co-op

students are not entitled Stevens Institutional financial aid when they are on a co-op working term. Co-op students who study full-time during the summer term may be eligible for federal, state or Stevens financial aid during that time.

Health Insurance

Stevens requires all undergraduate students to have health insurance. Copies of the student health insurance brochure can be viewed online by visiting www.universityhealthplans.com. Undergraduate students are charged annually for health insurance and may waive the charge if the student has equivalent coverage. Students may go to www.universityhealthplans.com and click on "Stevens Institute of Technology" to submit an online waiver providing proof of comparable coverage by a specific deadline designated each semester by Stevens. If Stevens does not receive the online waiver information by the published deadlines the University cannot waive the insurance charge. The brochure and rate information is available on our **website** at http://www.stevens.edu/directory/office-student-accounts/health-insurance-information

Student Housing & Meal Plans

Residence Halls

Students intending to live on campus should visit the Office of Residential and Dining Services website at https://www.stevens.edu/campus-life/residence-life to view residence hall options and rates. Students apply for housing though the MyStevens page.

Meal Plans

The meal plans are designed to provide students with the most flexibility, variety and value. With a meal plan, students are able to dine in the Pierce Dining Hall, which is all-you-care-to-eat and open seven days a week, or exchange a meal at one of four retail locations if they want a meal to go. Meal plan rates are per semester and meal plan options are assigned by class year and residence. Students who choose to live in Stevens Housing are required to have a meal plan. Students not in Stevens housing are welcome to sign up for a meal plan as well.

For more information about Stevens housing, dining services, and meal plans, please visit www.stevens.edu/housing, email reslife@stevens.edu or by calling (201) 216-5128.

DuckBills

DuckBills are a prepaid, dollar for dollar, declining balance account housed on your Stevens DuckCard that may be used to pay for purchases at participating on and off campus locations. Students, staff and faculty are all encouraged to use DuckBills for their purchases. Visit https://www.stevens.edu/directory/campus-card-office for more information.

eBilling Statements

Stevens provides an on-line student account with up-to-date account activity and electronic billing statements through a portal called eBilling. An email notification will be sent to the student's Stevens email account to notify them when a new statement is available. Students can authorize parents, guardians and employers as an authorized user. Authorize users will also receive email notifications when a new statement is available. You can access ebilling through your myStevens account or directly at www.stevens.edu/studentebilling.

Payment Options

Payment Policy

Tuition, fees, housing, meal plans, and other charges not covered by a payment plan or posted anticipated aid are due by the published semester payment due date. Additional charges incurred after the payment due date are immediately due.

Students who fail to make satisfactory financial arrangement by the semester payment due date are subject to administrative action, including but not limited to, late fee assessments; disenrollment from current and future courses; registration, transcript, diploma, student record, and canvas access holds and, collection agency assignment. **Balances paid after the due date will result in a late payment fee of at least $550.00.**

If assigned to a collection agency, the student will be responsible for the additional collection agency fee, which may be a maximum of 35% of the debt assigned to the agency, in addition to all costs and expenses, including reasonable attorney's fees incurred by Stevens, necessary for the collection of the debt.

Check, e-Check & Credit Card

The Office of Student Accounts accepts check, online e-check and online credit card payments. Payments made by check can be mailed or brought to the Office of Student Account. If you choose to mail a check please make it payable to Stevens Institute of Technology and include your campus-wide ID number on the check. Students or their authorized third-party payees can make e-check or credit card payments online through ebilling. A non-refundable service fee will be added to your credit card payment. Stevens does not charge a fee for e-check (ACH) payments. You can access ebilling through your myStevens account or directly at www.stevens.edu/studentebilling.

Monthly Payment Plan

To assist students and their families, Stevens offers a monthly payment plan through Nelnet. This is an interest free option with an enrollment fee. You can schedule your payments over as many as five payments each semester. Stevens allows students who have an active payment plan to attend classes, reside on campus and participate in other activities while payments are being made to the provider. Enrollment deadline dates apply so enroll on line at www.afford.com/stevens

Should you have any questions regarding this or other payment options please visit our website https://www.stevens.edu/studentaccounts or call the Office of Student Accounts at (201) 216-3500.

Balances paid after the semester due date will result in a late payment fee of at least $550.00, unless the student is enrolled in a monthly payment plan. If assigned to a collection agency, student will be responsible for the additional collection agency fee, which may be a maximum of 35% of the debt assigned to the agency, in addition to all costs and expenses, including reasonable attorney's fees incurred by Stevens, necessary for the collection of the debt. If you have any questions about remitting your payment or to make a payment arrangement please contact the Office of Student Accounts by email studentaccounts@stevens.edu or by phone (201) 216-3500.

Withdrawals & Refunds

Students who enroll and decide not to attend class for any reason must officially drop these classes online through Web for Students within the MyStevens portal or by completing the Drop section on the Change of Enrollment form. The Change of Enrollment form must be submitted to the Office of the Registrar. After the official add/drop period is over, a withdrawal will occur, and a "W" grade will appear on the transcript. The instructor's approval and/or the Dean of Graduate or Undergraduate Academics' approval is required prior to withdrawing from a class after the add/drop period (please refer to the current Academic Calendar). The submission date of the form to the Office of the Registrar will determine the official withdrawal date for tuition and fees. Students must officially withdraw from housing and/or meal plans in writing to the Office of Residence Life. They will determine the official withdrawal date for housing and meal plans (which may be different than the date submitted to the Office of the Registrar). All tuition and fees will be adjusted based on the official withdrawal date and will be calculated from the official opening date of classes in accordance with the Tuition Refunds Schedule.

Student who do not officially drop or withdraw from a class but do not attend are still liable for 100% of the tuition and fees for that course.

Return of Title IV Funds

Federal regulations require specific refund calculations for students receiving Title IV financial aid who completely withdraw from the University. Under the Return of Title IV (R2T4) regulations, a student is considered to have withdrawn from a payment period or period of enrollment if he or she does not complete all of the days in the payment period he or she was scheduled to complete. Title IV financial aid includes the following federal student aid (FSA) programs: Federal Perkins Loan, Federal Supplemental Education Opportunity Grant (FSEOG), Pell Grant, Direct Subsidized/Unsubsidized Loans and Direct PLUS/Graduate PLUS loans.

The amount of federal aid a student earns is determined on a prorated basis and is based on the date of withdrawal. Once a student completes more than 60% of the payment period, all of the federal aid the student is scheduled to receive for the period is considered as earned. If earned funds are not received prior to the date of withdrawal the student may be due a post-withdrawal disbursement. Students eligible for post-withdrawal disbursements will be notified – Stevens Institute of Technology must receive permission from the student before it can disburse these funds. The student will have 14 days from receipt of notification to accept/decline the post withdrawal disbursement.

Calculations for Return of Title IV Funding are performed as follows:

1. Determine the date of withdrawal

2. Calculate the percentage of the enrollment period completed as of the date of withdrawal

3. Calculate the percentage of Title IV aid the student earned as of the date of withdrawal

4. Calculate the amount of Title IV aid that must be returned/repaid to the programs

5. Amounts returned to the Department of Education must be credited to the FSA programs in the following order:

   a. Federal Unsubsidized Loan

   b. Federal Subsidized Loan

   c. Federal Perkins Loan

   d. Federal PLUS Loan

   e. Federal Pell Grant

   f. FSEOG

   g. Other Title IV Grants

Students who receive Title IV funding and who officially withdraw from the University will be subject to the Return of Title IV calculation in determining earned aid. Students who receive Title IV funding and stop attending classes without official notification to the University, whereby a last date of attendance cannot be determined, will be subject to a Return of Title IV calculation based on attendance through the midpoint of the payment period or the last date of an academically related activity in which the student participated.

Charges that were previously paid by federal aid funds which are returned per the Return of Title IV policy calculation will be the responsibility of the student.

Tuition, Fees & Other Expenses for Graduate Students

Tuition & Matriculation Maintenance

Full-Time Graduate Tuition rate of $18,340 is charged to students enrolled in 9 - 12 credits. Overload credits will be charged at the per credit tuition rate of $1,652. Graduate students enrolled in less than 9 credits will be charged $1,652 per credit. Students who have completed all required credits, and who need to maintain matriculation while completing a thesis, special problem, dissertation, project, or other degree requirements, must enroll for Maintenance for Full-Time Status (D 999) and pay a $550 fee per semester, in addition to any other required fees.

Other Fees

For the 2019-2020 academic year, full-time students are required to pay a $485 General Services Fee and a $170 Student Activity Fee for each semester they are enrolled in classes, part of which is used to support graduate activities. Part-time students are required to pay a $306 General Service Fee. Certain classes may have additional laboratory fees of $98 and course materials fees. The amounts of those fees vary and are specific to the departments and locations. Students submit Master's theses and Ph.D. dissertations through the Samuel C. Williams Library at Stevens. Information about fees and formatting requirements is available on the Library website at https://library.stevens.edu/submitDissert/Thesis. Stevens requires all degree-seeking graduating students to pay a $260 graduation fee ($125 for students seeking a graduate certificate). There is a $50 fee for checks that are returned by the bank. There is a $20 fee to replace student ID cards. There is a $550 late payment fee and various deferred payment fees, depending on the option chosen.

Health Insurance

Stevens requires full-time graduate and international students to have health insurance. Copies of the insurance brochure can be viewed online by visiting www.universityhealthplans.com. All full-time students (9 credits or more) and International are charged for health insurance unless they have provided proof of equivalent coverage. Students may go to www.universityhealthplans.com and click on "Stevens Institute of Technology" to submit an online waiver of the Institute coverage by a specific deadline designated each semester by Stevens. If Stevens does not receive the online waiver information by the published deadlines, the University cannot waive the insurance charge. Optional Health Insurance is also available to all part-time students and to students' spouses and children. The brochure and rate information is available on our website at http://www.stevens.edu/directory/office-student-accounts/health-insurance-information.

Books and Supplies

Student can purchase all required textbooks at the Stevens Bookstore or through the Stevens Bookstore website at www.stevens.edu/bookstore. The Stevens Bookstore accepts DuckBills, and all major credit cards.

Graduate Student Housing

Most Stevens graduate students do not live in Stevens housing. They choose to live in houses and apartments in Hoboken, N.J., as well as other cities which surround the university. Our local area is an exciting urban community with a great assortment of shops, restaurants, parks, historical sites, businesses and nightlife. Public transportation options abound, and Stevens also offers a robust shuttle program to make nearby neighborhoods extremely accessible to campus. A small number of graduate students live in Stevens Leased Housing apartments – located in Hoboken within walking distance of the campus. Students not in Stevens housing are welcome to sign up for a meal plan as well. For more information about Stevens housing, dining services, and meal plans, please visit ww.stevens.edu/housing, or email reslife@stevens.edu or by call (201) 216-5128.

Meal Plans

Graduate students, while not required, are welcome to be on any meal plan. For more information, please visit https://www.stevens.edu/campus-life/residence-life, email reslife@stevens.edu or call (201) 216-5128.

eBilling Statements

Stevens provides an on-line student account with up-to-date account activity and electronic billing statements through a portal called eBilling. An email notification will be sent to the student's Stevens email account to notify them when a new statement is available. Students can authorize parents, guardians and employers as an authorized user. Authorize users will also receive email notifications when a new statement

Payment Options

Payment Policy

Tuition, fees, housing, meal plans, and other charges not covered by a payment plan or posted anticipated aid are due by the published semester payment due date. Additional charges incurred after the payment due date are immediately due. Students who fail to make satisfactory financial arrangement by the semester payment due date are subject to administrative action, including but not limited to, late fee assessments; disenrollment from current and future courses; registration, transcript, diploma, student record, and canvas access holds and, collection agency assignment. **Balances paid after the due date will result in a late payment fee of at least $550.00.**

If assigned to a collection agency, the student will be responsible for the additional collection agency fee, which may be a maximum of 35% of the debt assigned to the agency, in addition to all costs and expenses, including reasonable attorney's fees incurred by Stevens, necessary for the collection of the debt.

Check, e-Check & Credit Card

The Office of Student Accounts accepts check, online e-check and online credit card payments. Payments made by check can be mailed or brought to the Office of Student Account. If you choose to mail a check please make it payable to Stevens Institute of Technology and include your campus-wide ID number on the check. Students or their authorized third-party payees can make e-check or credit card payments online through ebilling. A non-refundable service fee will be added to your credit card payment. Stevens does not charge a fee for e-check (ACH) payments. You can access ebilling through your myStevens account or directly at www.stevens.edu/studentebilling.

Employer Tuition Reimbursement Bridge Plan

The Employer Tuition Reimbursement Bridge Plan (ETRBP) option is available to graduate students who are covered under their employer provided tuition reimbursement plan and are in good financial standing (no prior balances), for a non-refundable of $150 fee. This plan is to assist students in "bridging the gap" between the Stevens Institute of Technology tuition due date and their employer reimbursement.

Monthly Payment Plan

To assist students and their families, Stevens offers a monthly payment plan through Nelnet. This is an interest free option with a nominal enrollment fee. You can schedule your payments over as many as five payments each semester. Stevens allows students who have an active payment plan to attend classes, reside on campus and participate in other activities while payments are being made to the provider. You can enroll on line at www.afford.com/stevens

Withdrawals & Refunds

Students who enroll and decide not to attend class for any reason must officially drop these classes online at www.stevens.edu/es/student or by completing the Drop section on the Change of Enrollment form. The Change of Enrollment form must be submitted to the Office of the Registrar. After the official add/drop period is over a withdrawal will occur and a "W" grade will appear on the transcript. The "instructor's approval and/or the Dean of Graduate or Undergraduate Academics' approval may be required prior to withdrawing from a class after the add/drop period (please refer to the current Academic Calendar). The submission date of the form to the Office of the Registrar will determine the official withdrawal date for tuition and fees. Students must officially withdraw from housing and/or meal plans in writing to the Office of Residence Life. They will determine the official withdrawal date for housing and meal plans (which may be different than the date submitted to the Office of the Registrar). All tuition and fees will be adjusted based on the official withdrawal date and will be calculated from the official opening date of classes iin accordance with the Tuition Refunds Schedule.

Student who do not officially drop or withdraw from a class but do not attend are still liable for 100% of the tuition and fees for that course.

Return of Title IV Funds

For more information, refer to page 57 of the catalog.

FINANCIAL AID

Financing a Stevens Education

The mission of the Office of Financial Aid is to identify financial resources and to provide those resources to students who would otherwise be unable to pursue their educational and professional goals. The Office of Financial Aid strives to facilitate the financial aid process by educating students and their families about the availability of aid, as well as by providing solutions and alternatives in educational financing. The staff is committed to ensuring the highest quality of service to Stevens students. This involves evaluating each student's aid application individually and the continual assessment of our application, awarding, and disbursement processes.

Stevens requires the Free Application for Federal Student Aid (FAFSA). Incoming undergraduate students and returning Clark Scholars must also submit the CSS Profile. The priority filing date for incoming students is February 15th prior to the fall semester in which a student begins at Stevens; the priority filing date for returning students is April 15 each year. For more information and to complete the FAFSA online, please visit: www.fafsa.ed.gov. For more information and to complete the CSS/PROFILE, please visit: https://profileonline.collegeboard.com/prf/index.jsp.

Stevens is committed to making education affordable and we work diligently to provide families with the resources to help. For families who qualify for financial need, we structure packages around a core of state, federal, and Stevens aid sources, all of which are considered financial aid components. Independent of need, Stevens also offers merit-based awards to new students who demonstrate a commitment to excellence through a variety of admission factors, known as "need-blind" admissions

Undergraduate Student Financial Aid Information

▶ Institutional Financial Aid Programs

Stevens has a strong commitment to assisting and investing in talented students. We offer a wide range of need-based grants and merit-based scholarships, of which many are made available due to our generous friends and successful alumni. nstitutional merit scholarships received at Stevens are renewable for eight full-time undergraduate semesters, provided the recipient maintains satisfactory academic progress and meets predetermined academic requirements as stated in the original award notification. Eligibility for renewal is determined after each spring semester. A student must enroll as a full-time undergraduate (12 credits per semester) in order to receive any award(s). In no case will the scholarship exceed the tuition cost. Dollar amounts range between $1,000 and full tuition. Merit scholarships are only awarded at the time of admission after review by the Office of Undergraduate Admissions. Merit scholarships are determined by considering the strength of a student's application, including academic record and standardized test scores. Therefore, new merit awards are not available for returning students.

Undergraduate students who are admitted to graduate degree programs are reclassified as graduate students when they are within six (6) credits of completing their undergraduate degree and are enrolled in at least one graduate level course. Students reclassified as graduate students are no longer eligible for undergraduate institutional aid.

Stevens merit-based scholarships include the following:

Global Scholars Awards

A limited number of Global Scholars Awards are offered each year to incoming international students for exceptional academic merit. The Global Scholars Award is renewable for eight full-time undergraduate semesters providing the student maintains satisfactory academic progress.

The Edwin A. Stevens Scholarship

This award is named in honor of the Institute's founder. It provides awards to students who have demonstrated excellence in high school as evidenced by their transcripts, SAT scores and recommendations.

Martha Bayard Stevens Scholarship (formally known as Women In Engineering Scholarship)

This award is available to outstanding young women students in all fields of study at Stevens, based on high academic achievement and leadership.

The Presidential Scholarship

The Presidential Scholarship is a prestigious award for students who have demonstrated academic excellence as evidenced by transcripts, SAT scores and high recommendations. The scholarship may require a minimum GPA for renewal. Renewal requirements are provided at the time of the initial award.

The Ann P. Neupauer Scholarship

Stevens' newest and most prestigious academic honor, named in honor of the late Mrs. Neupauer, a generous friend of the university. The Neupauer Scholarship is a four-year, full tuition award. The scholarship is renewable for a total of eight full-time, undergraduate semesters, based on the student achievement of satisfactory academic progress and an annual GPA of 3.2 or better.

ROTC Matching Scholarship

Students who have been selected to receive ROTC Scholarships (of at least $7,500 per semester) while studying at Stevens will receive an additional supplemental scholarship from the institution. This additional award will be in the amount of the full difference between the ROTC Scholarship plus any merit scholarships, and grants, so that all awards combined will equal full tuition. This award is only available during semesters in which the student is eligible to receive the ROTC Scholarship.

FIRST Scholarship

Admitted students who participated on a FIRST team during their junior or senior year of high school may be eligible for the FIRST scholarship of $6,000 per year. The scholarship application is available only to incoming freshmen and application deadlines apply.

Students may also be considered for the following need-based award:

The Clark Scholarship

The Clark Scholarship provides support for students participating in the A. James Clark Scholars program, an invitation-only program for exceptional, high-achieving students to exhibit a passion for "making a difference." Invitations are extended only at the time of admission. The Clark Scholarship is renewable for a total of eight, full-time undergraduate semesters, providing the scholar continues to meet the academic and service requirements of the program, full-time enrollment, satisfactory academic progress and a minimum GPA of 3.2. As eligibility for the Clark Scholars Program has a financial need component, the FAFASA and the CSS Profile must be filed each year beyond the freshman year for renewal.

The Stevens Grant

The Stevens Grant is a need-based award that may be offered if a student continues to demonstrate significant financial need after all other possible sources of grant and scholarship assistance (from Stevens, federal and/or state sources) have been applied to his/her financial aid package. The student must be a full-time undergraduate and eligibility is determined based

on the data the student and his/her family supply on the FAFSA and CSS Profile. Amounts can fluctuate from one year to the next if financial circumstances change. The Stevens Grant has no specific grade point average requirement other than the university's standards for satisfactory academic progress. Students must complete a FAFSA each year by April 15th to confirm their eligibility.

▸ Federal Financial Aid Programs

The federal government offers grant, loan, and work opportunity programs to assist students and their families in meeting the cost of higher education. Eligibility consideration is determined by information from the FAFSA, a student's enrollment status and satisfactory progress toward completion of their degree program.

Undergraduate students who are admitted to graduate degree programs are reclassified as graduate students when they are within six (6) credits of completing their undergraduate degree and are enrolled in at least one graduate level course. Students reclassified as graduate students are no longer eligible for undergraduate federal aid.

Federal aid programs include:

Federal Pell Grant: The Federal Pell grant program is designed to assist the neediest of undergraduate students who are earning their first baccalaureate or four-year professional degree. For 2019-2020 awards range from $657 to $6195 per academic year.

Federal Supplemental Education Opportunity Grant: is designed to assist undergraduate students with exceptional financial need and gives priority to students who receive Federal Pell Grants. Eligible students must be enrolled at least half time and awards range from $500 up to $4,000 annually.

Federal Work Study: provides an opportunity to earn money while in school to help pay educational expenses. Students may work on campus or off campus at non-profit community service agencies. Awards range from $1,000 to $2,000 per academic year.

Federal Perkins Loan: A subsidized loan with a 5% fixed interest rate offered to students demonstrating exceptional financial need. No interest accrues on the loan while enrolled at least half time; there is a nine (9) month grace period after a student graduates, withdraws or drops below half-time, prior to repayment. Awards range from $750 to $4,000. The Federal Perkins Loan Program expired on September 30, 2017.

Federal Direct Loan: Eligibility for a Direct Federal Subsidized or Unsubsidized loan is based upon 'need' as determined by the information submitted on the FAFSA. Undergraduate borrower limits for Federal Direct Loans are as follows:

   ▸ $3,500.00 Subsidized + $2,000.00 Unsubsidized for Dependent Freshmen

   ▸ $3,500.00 Subsidized + $6,000.00 Unsubsidized for Independent Freshman

   ▸ $4,500.00 Subsidized + $2,000.00 for Unsubsidized for Dependent Sophomores

   ▸ $4,500.00 Subsidized +$6,000.00 for Unsubsidized for Independent Sophomores

   ▸ $5,500.00 Subsidized + $2,000.00 for Unsubsidized for Dependent Juniors & Seniors

   ▸ $5,500.00 Subsidized +$7,000.00 for Unsubsidized for Independent Juniors & Seniors

The cumulative aggregate Federal Direct Loan debt an undergraduate dependent student may incur is $31,000.00 — no more than $23,000 may be from the Direct Subsidized Loan program. The cumulative aggregate Federal Direct Loan debt an independent student may incur is $57,500 — no more than $23,000 from the Direct Subsidized Loan program.

Students must complete Loan Entrance Counseling and a Master Promissory Note (MPN) prior to borrowing at www.studentloans.gov. The Loan Entrance Counseling provides required information about a borrower's rights and responsibilities.

Subsidized Federal Direct Loans

"Interest free' while the student is enrolled at least half-time (6 credits). Students are required to begin repayment six months after leaving school or dropping below six credits. The interest rate is fixed each award year and there is a loan fee taken at the time of disbursement. Interest rates are set by Congress and are tied to financial markets. Interest rates for loans made on/afer July 1, 2018 and before July 1, 2019 are 5.05%. There is a 1.062% loan fee. New borrowers as of July 1, 2013 may not receive Direct Subsidized Loans for more than 150 percent of the published length of their program (measured in academic years).

Unsubsidized Federal Direct Loans

Available to students who do not qualify for a Subsidized Direct loan or are eligible for loan funds in addition to their subsidized eligibility. However, students are responsible for the interest on the loan while enrolled in school. Students may choose to have the interest capitalized. The interest rate for loans made on/after July 1, 2018 and before July 1, 2019 is fixed at 5.05% and there is a 1.062% loan fee taken at the time of disbursement.

Federal PLUS Loan Program

The Federal Direct PLUS Loan is a credit-based loan program for the parent (adoptive or biological) or step-parent of dependent undergraduate students. Parents of matriculated students enrolled at least halftime (6 credits) may borrow up to the cost of education less any other financial aid received by the student per academic year. Repayment of the PLUS Loan begins 60 days after disbursement of the funds to the University. Parents have up to 10 years to repay the loan with a minimum payment of $50 per month.

To be eligible for a Federal Direct PLUS loan, the student must file the FAFSA and the parent (as well as the student) may not be in default on his/her federal student loans. Prequalification can be determined when parent applies via www.studentloans.gov. Credit decisions will expire after 180 days. In the event a parent is denied a PLUS loan, they may elect to apply with an endorser or the student may receive additional unsubsidized loan proceeds.

For Federal Direct PLUS Loans made on/after July 1, 2018 and befor July 1, 2019, there is a fixed interest rate of 7.6% and a loan fee of 4.248% that is taken at the time of disbursement.

▶ State of New Jersey Financial Aid Programs

New Jersey residents attending Stevens may qualify for a variety of grants and scholarships offered by the State, mostly through the New Jersey Higher Education Student Assistance Authority (NJHESAA). To be considered for state aid, a student must file the FAFSA no later than June 1 of each year (note that Stevens recommends new students file the FAFSA by February 15 and the deadline for current students is April 15). No late applications are considered for state awards, and state awards cannot be used at out-of-state colleges or universities. In addition, they are only available if the student has resided in New Jersey for at least 12 months as of September 15 of the academic year. If one is considered a dependent student, his/her parent(s) must also meet the same residency requirement. These are estimated awards set by the state and awards will be finalized by the state.

Undergraduate students who are admitted to graduate degree programs are reclassified as graduate students when they are within six (6) credits of completing their undergraduate degree and are enrolled in at least one graduate level course. Students reclassified as graduate students are no longer eligible for undergraduate state aid.

Tuition Aid Grant (TAG): TAG is a need-based grant, available to assist low and middle income students. Annual award amounts range amounts range between $2074 and $12,938. Eligibility is based on the data supplied on the FAFSA and may fluctuate with the student's or family's financial circumstances from one year to the next. TAG is available for a maximum of nine semesters of undergraduate study. Students must be enrolled full-time in a degree-granting program. However, students in their final semester who need fewer than 12 credits to fulfill their degree requirements may qualify for TAG during that term with as few as 6 credits. Students must meet the April 15 yearly TAG deadline in order to be re-awarded for the next academic year.

Educational Opportunity Fund (EOF): New Jersey residents admitted into The Stevens Technical Enrichment Program (STEP) upon entry into Stevens may also qualify for an Educational Opportunity Fund, or EOF, Grant. This need-based award is in the amount of $2,600. In order to qualify for this grant and admission into the EOF program, a student (and/or family) must meet income guidelines established by the State of New Jersey, and the student must also be from an educationally disadvantaged background.

NJS Governor's Urban Scholars Program: provides a merit award to high-achieving students who reside in New Jersey's 14 designated high-need communities. Annual awards of up to $1,000 are available for qualified students. Students must rank within the top five (5%) percent of their class and have a minimum 3.0 GPA at the end of their junior year of high school and meet other basic eligibility and renewal criteria.

New Jersey Student Tuition Assistance Reward Scholarship II (STARS II): allows successful NJ STARS scholars to transfer to a New Jersey four-year public or non-public college or university and earn a bachelor's degree. The NJ STARS II Scholarship is valued at $1,250 per semester ($2,500 per academic year – traditional fall and spring semesters only). Students must be NJ STARS recipients or non-funded during the semester of county college graduation and graduate with an Associate's degree and GPA of 3.25 or higher. While there is no consideration of financial need, the maximum family income (taxable and non-taxable) must be less than $250,000. In addition, the student must be enrolled full-time, apply for all forms of state and federal need-based grants and merit scholarships and begin NJ STARS II program participation no later than the second semester immediately following county college graduation. To be considered for NJ STARS II, students must file a FAFSA each year within established New Jersey State deadlines.

▸ Satisfactory Academic Progress (SAP)

The following guidelines apply to all undergraduate students at Stevens, including those seeking financial aid awards from federal, state, institutional, or other sources administered through Stevens, except in cases where the donor or donors establish specific requirements.

The student is subject to federal, state, and university limits on the total number of semesters of aid he/she may receive. To be eligible to receive aid for which he/she qualifies financially, a student must make satisfactory progress toward a degree as follows:

> ▸ Progress is routinely monitored at the end of the spring semester after spring semester grades are submitted to the Office of the Registrar.

Undergraduate Program Guidelines

There are three distinct measurements to the SAP standards:

A. Grade Point Average (Qualitative Measure)

B. Credit Completion Ratio/Pace (Quantitative Measure)

C. Maximum Time Frame measurement

These standards also include an opportunity to appeal the denial of financial aid if the student has faced special circumstances, which prevented the student from attaining the minimum standards described in this policy. The Satisfactory Academic Appeals Committee will not automatically reinstate a student's aid even after a student has been readmitted to the University. Federal financial aid eligibility does not allow for reinstatement based on academic renewal policies.

A. Grade Point Average (GPA) / (Qualitative Measure)

Undergraduate students must maintain at least a 2.0 cumulative GPA after attempting 23 credits. A 1.7 GPA is required for students who have earned less than 23 credits. The GPA calculated for the purposes of SAP determination calculates all grades earned, including initial grades received for repeated coursework. This may result in a GPA calculation that differs from that which is reported on your transcript. Stevens Institute of Technology requires at least a 2.0 GPA for conferral of the bachelor's degree. Specific federal, state and institutional scholarships and grants may require a different GPA for renewal; this is a separate requirement for continued eligibility for these funds.

B. Credit Completion Ratio or Calculating Pace (Quantitative Measure)

Each year, a student's progress will be measured by comparing the number of attempted credit hours with the earned credit hours. This includes any course for which the student has remained enrolled past the add/drop period. After a student has attempted 12 credits, s/he must earn sixty seven percent (67%) of the cumulative attempted credits to maintain satisfactory academic progress.

C. Maximum Time Frame Measure

A student is eligible to receive funding up to 150% attempted credit hours toward their degree. Some programs limit funding on a semester basis. Students that attempt and earn only the minimum amount of credit hours required may run out of eligibility for certain federal and state financial aid programs prior to completing their degree.

Example of Satisfactory Academic Progress review requirements:

Attempted Credits	Required Percentage	# of Credits To Be Earned	Required Cumulative
24	67%	16.75	2.0
49	67%	32.38	2.0
73	67%	48.91	2.0
97	67%	64.99	2.0

General Information

A. Withdrawal from courses /WD (Withdrawn officially)

Credits remain in the total number of attempted hours but are not added to the earned credits. This may have a negative effect on the total number of earned credits needed per year. The GPA is not affected by these grades.

B. Incomplete courses/ INC (Incomplete)

These courses will be counted when determining the number of credits attempted. When a passing grade is received, the grade will be added to the number of credits earned.

C. Repeated courses

These courses are counted each time the course is taken and will be included in the total number of attempted credit hours. When a course is completed, the credits are added to the total number of earned credits hours.

D. Transfer credits

Transfer credits, accepted by Stevens, will be added to the attempted/earned credit hours in order to determine the number of credits a student should attempt and earn.

E. Failing Grades

These grades may have a serious negative impact on the student's academic record: F (Failing), and M (Missing, no grade submitted)

F. Expunged Grades

Expunged Grades are included in the financial aid SAP calculation. Federal regulations do not allow for Academic Amnesty; therefore Expunged grades cannot be excluded from evaluation. This means that the GPA that appears on a student's academic transcript will be different than the GPA used in the financial aid SAP calculation.

Students identified as not making SAP will receive notification via their campus email address. Students have the right to appeal the decision by submitting a SAP Appeal Form by the established deadline. Generally, the SAP Appeals Committee will consider appeals that involve circumstances beyond the student's control that have had an impact upon the student's academic performance.

The appeal must include a narrative of the extenuating circumstances (e.g., the student or an immediate family member suffered a serious illness or injury, death of a close relative, separation or divorce) that prevented the student from meeting the minimum requirements, and reasonable explanation of the expectation that the event/circumstances will not re-occur. Students are required to attach pertinent documentation supporting their appeal including their Appeal Letter and at least one piece of objective documentation. Furthermore, students who do not meet SAP after their financial aid probation semester are required to submit their academic plan to succeed in their program of study as well as carefully review their academic history.

SAP Appeal Deadlines:

Fall Semester	July 15
Spring Semester	January 15

Students may submit their appeals by the deadline to the Office of Financial Aid.

SAP Appeals Committee and Decision:

The appeal will be reviewed by a committee and a response will be provided within fifteen (15) business days of the established deadline. All committee decisions are final. Students will be notified of the committee's decision in writing (personal email announcement at their Stevens Email account). The committee reserves the right to request additional information, including an academic plan, for consideration in the review.

Appeal Approvals and Academic Plan:

Students who successfully appeal are approved for one payment period are considered to be on probation. To gain eligibility in the subsequent semester, a student must meet the standards of SAP or meet the requirements of his or her academic plan described at the time of the appeal submission. It is highly recommended that students meet with their academic advisor or Dean before creating their academic plan to ensure it is attainable.

SAP Academic Suspension:

If the student fails to meet SAP standards or the requirements set forth in the SAP Academic Plan, the student will be placed on SAP suspension. The student is ineligible for financial aid with this status. A student with SAP suspension status will remain ineligible for financial aid until the student meets the minimum SAP Policy requirements.

Graduate Student Financial Information

▸ Financial Aid Sources

Many sources of financial aid are available to graduate students. These include fellowships, assistantships, on-campus employment, employer tuition assistance plans, loan funds, and deferred payment plans. Fellowships and assistantships are granted on a competitive basis to outstanding full-time graduate students. Applicants should consult their department for more information regarding assistantships. Continuing students may become eligible for additional sources of aid as they progress through the program and should consult with their department at regular intervals.

Click here for more information.

Graduate Assistantships

Graduate Assistantships (teaching, research, or other) are available in every academic department and in some non-academic departments. Graduate Assistants are appointed based on recommendation by the appropriate department director or principal investigator of a grant or contract. Graduate Assistants may carry a reduced course load but still complete the master's degree in two years or less.

Stevens Institute of Technology is able to offer a select group of students funding in the form of teaching or research assistantships. The material provided and discussed in this section is for information purposes only, and is offered as a guide.

Assistantships are graduate funding opportunities that can take many forms. A student awarded a research or teaching assistantship may receive tuition and fees for up to three courses per semester during the Fall and Spring semester plus a stipend; or some combination of tuition, fees, and stipend. In exchange for the predetermined funding, the student must work up to a maximum of 20 hours per week during the semester, and maintain a satisfactory academic performance. Stevens does not provide what is commonly known as "tuition waivers"; for example, the tuition and fee costs cannot be waived. Additional support may also be available for the summer sessions.

The number of assistantships awarded each year is limited. If you do not receive an assistantship for your first year at Stevens you can pursue an assistantship within your department after you arrive. It is important to note that each department identifies and awards assistantships to students, and the Office of Graduate Academics administers the process.

Provost Masters Fellowship Awards

The Provost Masters Fellowships are offered each year during the fall and spring semesters to exceptional students interested in pursuing a master's degree on a full-time basis. These one-time fellowships are awarded to qualified students at the time of their admission to any one of the Master's degree programs offered at Stevens. Students who are placed approximately in the top 5% of the applicant pool are considered for this award. Selection criteria for the Provost Masters Fellowship includes GRE/GMAT scores in addition to exceptional undergraduate academic performance. TOEFL/IELTS scores are also considered as a criterion for international applicants. There is no separate application for the fellowship awards as students are automatically considered when they initially apply.

Research Assistantships

Research Assistantships generally provide graduate tuition and fee support and a monthly stipend (see above) for services on sponsored research contracts. Appointments are reviewed and made by the Office of Graduate Admissions after recommendation by the academic department director or principal investigator.

Teaching Assistantships

Teaching Assistantships generally provide graduate tuition and fee support and a monthly stipend (see above) for teaching assistant services in the academic departments. Appointments are reviewed and made by the Dean of Academic Administration after recommendation by the academic department director.

Robert Crooks Stanley Graduate Fellowships

Robert Crooks Stanley Graduate Fellowships provide tuition plus living allowance for graduate students pursuing a Ph.D. degree. The fellowships are endowed through the generosity of the late Mrs. Robert C. Stanley and her children as a memorial to Dr. Stanley, Class of 1899 and former chairman of the Board of Trustees. A committee appointed by the Board of Trustees makes the selections.

Graduate Grant

Students who are reclassified from undergraduate to graduate level may receive a Graduate Grant for completion of the graduate degree. Eligibility determination is performed by the Office of Graduate Academics and processed by the Office of Financial Aid.

Loans and Work-Study

Graduate students enrolled in a degree-granting program on at least a half-time basis (a minimum of six credits per semester) may apply for federal student loans and/or Federal Work-Study by submitting the Free Application for Federal Student Aid (FAFSA). The results of this standardized application will allow the Office of Financial Aid to determine eligibility for federal aid. Only U.S. citizens or permanent residents may file the FAFSA; international students do not qualify for federal assistance.

FAFSA

The FAFSA should be completed and submitted to the processing center at least eight weeks prior to the beginning of the semester in which the student plans to enroll. The FAFSA may be submitted online atwww.fafsa.ed.gov. Additional information about graduate financial aid, including free, online scholarship search services, as well as alternative financing sources, may also be accessed through the Office of Financial aid's home page (www.stevens.edu/finaid/).

Federal Loans

There are a number of loan opportunities for eligible graduate students. Federal Direct Unsubsidized Loans as well as Federal Direct Graduate PLUS loans may be available to qualified borrowers. The maximum amount that can be borrowed from the Federal Direct Unsubsidized Loan program for the academic year is $20,500. The graduate student aggregate loan limit is $138,500. Interest accrues on the loan beginning at disbursement (the interest rate is fixed and is 6.6% for the 2018-2019 year and a 1.062% loan fee taken at the time of disbursement).

The Graduate PLUS loan is a credit-based loan that is not need based. The interest rate is fixed at 7.6% for the 2018-2019 year and a loan fee of 4.248% is taken at the time of disbursement. The Graduate PLUS Application can be completed at studentloans.gov. After submission of the PLUS Application, the student will receive a credit decision electronically. If credit approved then the student must complete their Graduate PLUS Promissory Note, on studentloans.gov. If your credit is declined by the federal government then you may appeal their credit decision, or you may wish to obtain a co-signer. A co-signer must electronically complete an Endorser Addendum on www.studentloans.gov.

Private Education Loans

Alternative Loans (Private Education Loans) are offered through private lenders and are meant to provide additional educational funding only after a student and his/her family has exhausted all other sources of funding such as federal and state aid. These loans are not guaranteed by the federal government and may carry high interest rates and origination fees. All of the loans require a credit check and most will require a cosigner if the borrower has little or negative credit history. Stevens is not permitted to recommend any specific lender/programs. Contact the lender of your choice for details about their program and application process. Make sure to understand your rights, responsibilities and benefits before you select a lender. A list of historical lenders may be found at https://www.stevens.edu/admissions/tuition-financial-aid/undergraduate-scholarships-aid/alternative-financing-options.

SCHAEFER SCHOOL OF ENGINEERING AND SCIENCE

SCHAEFER SCHOOL OF ENGINEERING AND SCIENCE

The Charles V. Schaefer, Jr. School of Engineering and Science seeks to be globally recognized as an engineering and science school that educates students to have the breadth and depth required to lead in their chosen profession, and leads in the development of important new knowledge and new technologies and their integration into the fabric of society by the various education and innovation pathways we support.

The graduates of the Charles V. Schaefer, Jr. School of Engineering and Science shall:

▸ Demonstrate technical competence in engineering design and analysis consistent with the practice of a specialist and with the broad perspective of the generalist;

▸ Develop the hallmarks of professional conduct, including a keen cognizance of ethical choices, together with the confidence and skills to lead, to follow, and to transmit ideas effectively; and

▸ Inculcate learning as a lifelong activity and as a means to the creative discovery, development, and implementation of technology.

Our graduate programs prepare students to:

▸ Expand the scope of their professional activities in academia, industry, and government and increase the diversity of their careers;

▸ Create and transfer knowledge through cutting-edge research and succeed in bringing innovations to the marketplace.

Undergraduate Programs

BACHELOR OF ENGINEERING

The Stevens engineering curriculum is rooted in a tradition that has set it apart since the founding of the Institute in 1870, yet it remains responsive to the changing demands of the workplace into which one graduates. The Stevens tradition recognizes the value of a broad core curriculum that provides significant breadth in engineering, the sciences, and the humanities, combined with the necessary depth in your chosen engineering discipline.

To meet these goals, the Charles V. Schaefer, Jr. School of Engineering and Science offers a demanding curriculum. It prepares you technically and instills a work ethic that has proven of considerable value to our graduates throughout their lives. In addition to strong technical competencies in general engineering and the specific discipline, the curriculum teaches key competencies that are highly valued by employers. These include strong problem-solving skills, effective team-participation skills, and the ability to communicate effectively, in both written and oral modes.

A major vehicle for achieving these competencies in the engineering curriculum is the Design Spine. The Design Spine is a sequence of design courses each semester; initially it is integrated with science and engineering core courses and, in future semesters, the discipline-specific program. Design is at the heart of engineering. Design activities allow you to gain confidence in applying and reinforcing the knowledge learned in the classroom.

As an engineering student, you take core courses for the first three semesters. The choice of the engineering discipline in which you will concentrate is made late in the third semester. You are provided many opportunities to explore the various engineering fields.

You may choose to specialize in biomedical, chemical, civil, computer, electrical, environmental, industrial, mechanical, or optical engineering. Programs in engineering management and software engineering are offered in the School of Systems & Enterprises. A program in engineering is also available which presently has a concentration in naval engineering.

A strength of the Stevens engineering curriculum is the requirement for a significant thread of humanities and general education courses throughout the four-year program. You may take advantage of this as a platform to pursue a minor or to pursue the double degree program, a B.A. degree in addition to the B.E. degree.

The following pages outline the structure of the engineering curriculum by semester, showing core course and technical elective requirements. Specific concentrations are described by the department, as are requirements for their minor programs.

Engineering Program

The B.E. in Engineering is founded on the strength of the extensive Stevens core curriculum in exposing students to a breadth of engineering topics while allowing for concentration in an engineering area. In this regard it allows for a somewhat more flexible program than is typically available in a specialized B.E. program. At present, concentrations are offered in Naval Engineering and Optical Engineering. Several technical electives within the program can be tailored to a student's interests under the guidance of the program faculty advisor.

Concentration in Naval Engineering

Naval Engineering is a broad-based engineering discipline that involves the design, construction, operation, and maintenance of surface and sub-surface ships, ocean structures, and shore facilities. Although these vessels and facilities are traditionally employed in the defense of the nation, many are also employed in the support of the civilian (commercial) Marine Transportation System. Because of the complexities of today's naval and civilian vessels and supporting infrastructure, the naval engineer must possess a strong background in the physical sciences, mathematics, and modeling, as well as the more specialized fields of naval architecture, marine engineering, systems engineering, and environmental engineering.

Mission and Objectives

The mission of the engineering program with a concentration in naval engineering program at Stevens is to develop innovative engineers capable of international leadership in the profession. The educational program emphasizes design innovation, trans-disciplinary study, a systems perspective on complex ship and infrastructure designs, lifelong learning and opportunities for international study and internships. As is the case for the other Stevens engineering programs, the naval engineering program includes a broad-based core engineering curriculum and a substantial experience in the humanities.

The program is conducted in concert with the Stevens leadership in the Office of Naval Research–sponsored Atlantic Center for the Innovative Design and Control of Small Ships and in collaboration with University College London.

The objectives of the engineering with a concentration in naval engineering program are provided in terms of our expectations for our graduates. Within several years of graduation, they will:

‣ Be recognized as among the most innovative designers and project managers in the world;

‣ Be thoroughly aware of, and knowledgeable in dealing with, environmental, social, ethical, and economic impacts of their projects; Augment their knowledge through professional and cultural continuing education; and

‣ Be active in leadership roles within their professional and technical societies.

Concentration in Optical Engineering

The concentration in Optical Engineering covers a broad range of technologies that involve the generation, manipulation, and measurement of light. This includes but is not limited to the following areas - optical imaging, light sources and displays, sensors and detectors, metrology, fiber optics and optical networking, integrated optics, and nonlinear optics.

Optics is essential to almost all areas of modern technology including manufacturing, defense, medicine, telecommunications, computing, and aerospace and is ubiquitous in devices that we use daily ranging from smartphones to automobiles. Optical engineers utilize physics and mathematics to design and model optical systems and devices.

<u>Mission and Objectives</u>

The mission of this concentration is to prepare a next generation of engineers with a deep background in optics and optical design. The mission of the program is to prepare students for careers in many emerging areas of technology such as machine vision and lidar for autonomous vehicles and robots, additive manufacturing, next generation laser and optics based weapons systems, quantum computing and communication, biomedical optics, renewable energy, and new lighting and display technologies. The educational program emphasizes optical physics and hands on laboratory training along with design.

The concentration-specific objectives of this program are:

▸ Graduates will demonstrate a solid foundation in the basic principles of optics, mathematics, and physics necessary to understand a broad range of optical systems.

▸ Graduates will be able to apply both independently and as part of multidisciplinary teams engineering tools and techniques to design, analyze, build, and test technological systems that employ optical physics.

▸ Graduates will be able to pursue careers that span physics, electrical and computer engineering, systems engineering, and broad application oriented careers.

Guidelines for Engineering Minor Programs

A minor represents a coherent program of study in an engineering discipline other than the student's major degree program. Successful completion of a minor program is recognized on the transcript and with a Minor Certificate at graduation. Recognition is thus provided for a significant education experience in another discipline.

General guidelines for a minor program in an engineering discipline are:

▸ Engineering minor programs will consist of a coherent sequence of a minimum of six courses. A minimum of two courses (minimum 6 credits) should be in addition to those courses required to complete a student's major degree program (which includes general education courses).

▸ The minor program must be in a discipline other than that of a student's major program of study. As such minors are distinguished from options within the major discipline or the concentration within the Engineering Program (typically referred to as the general engineering program)

▸ The Minor Advisor may allow courses awarded transfer credit to be used but these must constitute less than half of those applied to the minor program.

▸ A student may earn no more than two Engineering minors.

▸ A student wishing to pursue a minor program must complete a Minor Program Study Plan signed by a Minor Advisor from the discipline of the minor to ensure a coherent program is undertaken. In order to be awarded the minor at graduation the student must complete a Minor Candidacy Form signed by the Minor Advisor after all minor requirements are fulfilled.

Entry to an Engineering minor program requires the student to have a minimum GPA of 2.5. In order for a course to count towards a minor the grade of C or above must be achieved.

Minor in Entrepreneurship

The undergraduate minor in entrepreneurship provides the educational prerequisites needed to foster the successful birth and development of technology-driven new ventures.

The minor will provide the knowledge and the infrastructure needed to sustain and support the efforts of Stevens' undergraduate students in engineering and science to create economic value through innovation and entrepreneurship.

After completing the minor, students will be able to develop and write an effective business plan by systematically developing the following skills:

- Able to identify and recognize viable technical business opportunities
- Can critically evaluate these business opportunities
- Can assess and manage the intellectual property embodied in technological opportunities
- Can develop an effective business model addressing market, operating and financial requirements
- Knows how to launch a technologically-based business

Courses

- BT 244 Microeconomics
- BT 372 Entrepreneurship
- BT 419 Entrepreneurship Practicum
- E 355 Engineering Economy or E 356 Engineering Economy; or BT 200 Financial Accounting
- MGT 472 Assessment and Financing of Technical Business Opportunities
- MGT 103 Introduction to Entrepreneurial Thinking

Graduation Requirements

Physical Education Requirements

- All undergraduate students must complete a minimum of four semesters of Physical Education (P.E.). A large number of activities are offered in lifetime, team and wellness areas.
- All P.E. courses must be completed by the end of the sixth semester. Students can enroll in more than the minimum required P.E. for graduation and are encouraged to do so.
- Participation in varsity sports can be used to satisfy up to three semesters of the P.E. requirement.
- Participating in club sports can be used to satisfy up to two of the P.E. requirements.

Note: Student may repeat Physical Education class but the repeated course (excluding varsity and club sports) will not count toward the graduation requirement.

Humanities Requirements

All undergraduate students are required to fulfill certain Humanities requirements in order to graduate. Please see pages 599-600 for a breakdown of specific requirements by program.

Engineering Curriculum

Term I

Course #	Course Name	Lecture	Lab	Study	Credit
CH 115	General Chemistry I	3	0	6	3
CH 117	General Chemistry Laboratory I	0	3	1	1
MA 121; MA 122	Differential Calculus; Integral Calculus	4	0	8	4
E 101	Engineering Experiences I	1	0	0	1
E 121	Engineering Design I: Introduction to Systems Thinking	0	3	2	2
E 120	Engineering Graphics	0	2	1	1
E 115	Introduction to Programming	1	2	3	2
CAL 103	Writing And Communications Colloquium	3	0	6	3
PE 200	Physical Education I	0	0	0	0
	Total	**12**	**10**	**27**	**17**

Term II

Course #	Course Name	Lecture	Lab	Study	Credit
	Science Elective[1]	3	0	6	3
PEP 111	Mechanics	3	0	6	3
E 122	Engineering Design II: Field Sustainable Systems with Sensors	0	3	3	2
CAL 105	CAL Colloquium: Knowledge, Nature, Culture	3	0	6	3
MA 123; MA 124	Series, Vectors, Functions, and Surfaces; Calculus of Two Variables	4	0	8	4
PE 200	Physical Education II	0	0	0	0
MGT 103	Introduction to Entrepreneurial Thinking	1	2	0	2
	Total	**14**	**5**	**29**	**17**

Term III

Course #	Course Name	Lecture	Lab	Study	Credit
MA 221	Differential Equations	4	0	8	4
PEP 112	Electricity and Magnetism	3	0	6	3
E 126	Mechanics of Solids	4	0	8	4
E 245	Circuits and Systems	2	3	7	3
E 231	Engineering Design III: Structural Performance and Failure	0	3	2	2
Hum	Humanities	3	0	6	3
PE 200	Physical Education III	0	2	0	0
	Total	**16**	**8**	**37**	**19**

Term IV

Course #	Course Name	Lecture	Lab	Study	Credit
E 232	Engineering Design IV: Systems with Analog Circuits	2	3	7	3
E 234	Thermodynamics[2]	3	0	6	3
S.E.	Science Elective[1]	3	0	6	3
T.E.	Technical Elective[3]	3	0	6	3
Hum	Humanities	3	0	6	3
PE 200	Physical Education IV	0	2	0	0
MA 227	Multivariable Calculus	3	0	6	3
	Total	**17**	**5**	**37**	**18**

Term V

Course #	Course Name	Lecture	Lab	Study	Credit
E 342	Transport/Fluid Mechanics[2]	3	3	6	4
E 344	Materials Processing	3	0	6	3
E 321	Engineering Design V: Materials Selection and Process Optimization	0	3	2	2
E 243	Probability and Statistics for Engineers	3	0	6	3
T.E.	Technical Elective[3]	3	0	6	3
Hum	Humanities	3	0	6	3
	Total	**15**	**6**	**32**	**18**

Term VI

Course #	Course Name	Lecture	Lab	Study	Credit
E 345	Modeling and Simulation[3]	3	0	6	3
E 355	Engineering Economics	3	3	6	4
E 322	Engineering Design VI[3]	1	3	5	2
T.E.	Technical Elective[3]	3	0	6	3
T.E.	Technical Elective[3]	3	0	6	3
G.E.	General Elective[4]	3	0	6	3
IDE 400	Senior Innovation I[5]	1	0	2	1
	Total	**17**	**6**	**37**	**19**

Term VII

Course #	Course Name	Lecture	Lab	Study	Credit
T.E.	Technical Elective[3]	3	0	6	3
T.E.	Technical Elective[3]	3	0	6	3
G.E.	General Elective[4]	3	0	6	3
IDE 401	Senior Innovation II	1	0	2	1
T.E.	Technical Elective[3]	3	0	6	3
E 423	Engineering Design VII	1	7	4	3
	Total	**14**	**7**	**30**	**16**

Term VIII

Course #	Course Name	Lecture	Lab	Study	Credit
T.E.	Technical Elective[3]	3	0	6	3
T.E.	Technical Elective[3]	3	0	6	3
G.E.	General Elective[4]	3	0	6	3
IDE 402	Senior Innovation III	1	0	2	1
E 424	Engineering Design VIII[3]	1	7	4	3
Hum	Humanities	3	0	6	3
	Total	14	7	30	16

(1) Basic Science electives – note: engineering programs may have specific requirements: one elective must have a laboratory component; two electives from the same science field cannot be selected.
(2) Core option – specific course determined by engineering program
(3) Discipline specific course
(4) General Electives – chosen by the student can be used towards a minor or option can be applied to research or approved international studies
(5) IDE 400 can be taken concurrently with IDE 401 in Term VII as determined by the engineering program.

ENGINEERING PROGRAM

Science Elective I and II Requirements & Options (normally taken in second and fourth semesters)

Biomedical Engineering

▸ Science 1: CH 116 Chemistry II and CH 118 Chemistry II Lab

▸ Science 2: BIO 281 Biology and Biotechnology without BIO 282 Introductory Biology Lab

Chemical Engineering

▸ Science 1: CH 116 General Chemistry II and CH 118 General Chemistry II Lab

▸ Science 2: BIO 281 Biology and Biotechnology without BIO 282 Introductory Biology Lab

Civil Engineering

▸ Science 1: CH 116 General Chemistry II and CH 118 General Chemistry II Lab

▸ Science 2: BIO 281 Biology and Biotechnology with or without BIO 282 Biology Lab or CE 240 Introduction to Geosciences

*as long as one lab is included in the 2 courses

Computer Engineering (science elective 2 deferred to term 6)

▸ Any two of science electives listed at the end

*as long as one lab is included in the 2 courses

Electrical Engineering (science elective 2 deferred to term 6)

▸ Any two of science electives listed at the end

*as long as one lab is included in the 2 courses

Engineering - concentration in Naval Engineering

▸ Any two of science electives listed at the end

*as long as one lab is included in the 2 courses

<u>Engineering - concentration in Optical Engineering</u>

- Science 1: BIO 281 Biology, CH 116 Chemistry II, NANO 200 Intro. to Nanotechnology, EN 250 Quantitative Biology, or PEP 151 Intro. to Astronomy.

- Science 2: PEP201 Physics III for Engineers.

<u>Engineering Management</u>

- Any two of science electives listed at the end

*as long as one lab is included in the 2 courses

<u>Environmental Engineering</u>

- Science 1: CH 116 General Chemistry II and CH 118 General Chemistry II Lab

- Science 2: any of the remaining science electives listed at the end

<u>Mechanical Engineering</u>

- Science 1: CH 116 General Chemistry II (with or without CH 118 General Chemistry II Lab) or BIO 281 Biology and Biotechnology (with or without BIO 282 Introductory Biology Lab)

- Science 2: Any science elective listed at the end

*as long as at least one lab is included in the two courses

<u>Software Engineering</u>

- Any two of science electives listed at the end

*as long as one lab is included in the 2 courses

List of Science Electives

- CH 116 General Chemistry II and CH 118 General Cheistry II Lab

- BIO 281 Biology and Biotechnology and BIO 282 Introductory Biology Lab

- CE 240 Introduction to Geosciences

- EN 250 Quantitative Biology (online only)

- PEP 151 Introduction to Astronomy

- PEP 201 Physics III for Engineers (course has a built-in lab)

- PEP 242 Modern Physics

- PEP 336 Introduction to Astrophysics and Cosmology

- PEP 351 Introduction to Planetary Science

- NANO 200 Introduction to Nanotechnology

Lab Requirement

If a lab was NOT taken with the Science Elective 1 choice it will be required with the Science Elective 2 choice.

- CE 240, EN 250, PEP 151, PEP 242, PEP 336, PEP 351 and NANO 200 do not have a laboratory associated with them.

- PEP 201 has a built in lab component which fulfills the lab requirement.

When Courses are Offered:

- ▸ CH 116 and BIO 281 are offered in the Spring and Summer II
- ▸ CE 240 is offered only in the Spring
- ▸ EN 250 is offered in the Spring and Summer I (online)
- ▸ NANO 200 is offered only in the Spring
- ▸ PEP 151 is offered in the Fall and Summer II
- ▸ PEP 201 is offered in all semesters
- ▸ PEP 242 is offered only in the Spring
- ▸ PEP 336 is offered only in the Spring
- ▸ PEP 351 is offered only in the Spring

Note

Science Elective I & II cannot be in the same field.

- ▸ BIO 281 & EN 250 are considered science electives from the same field.
- ▸ PEP 201 & PEP 242 are considered science electives from the same field

BACHELOR OF SCIENCE

The science departments—Biomedical Engineering, Chemistry & Biological Sciences, Computer Science, Mathematical Sciences and Physics & Engineering Physics—provide exciting, top-quality programs for undergraduates at Stevens. The quality of our programs derives from the quality of our world-class faculty. Undergraduate students are a welcomed part of our community. They are afforded ready access to faculty and to ongoing research activities on campus and off campus, and, as they pursue their studies, undergraduates are encouraged to participate in research and innovative and entrepreneurial activities.

The science curricula at Stevens emphasize project-based learning, encourage and reward independent study and scientific initiative, offer expanded research opportunities for undergraduates, and promote the undergraduate thesis as a capstone for a student's course of study. These elements of the curriculum are intended to enhance the undergraduate experience of the student with a serious interest in studying the natural sciences or computer science.

The undergraduate programs are separated into two categories of curricula. The programs in biology & chemical biology, mathematical sciences, and physics follow a unified curriculum, the Bachelor of Science in the natural sciences. The Department of Computer Science has developed distinct curricula for each of two undergraduate programs: Bachelor of Science in Computer Science, and Bachelor of Science in Cybersecurity.

The science program at Stevens offers a remarkable opportunity for a career in today's scientific world. It prepares you to work at the frontiers of knowledge making significant contributions to science and the well-being of mankind. Careers in biology, chemistry, medicine, physics, nanotechnology, mathematics, and statistics, are accessible through the science program.

The concepts, techniques and attitudes that are common to all sciences form the core courses of the Science program. You develop an awareness of the interactions among the various scientific disciplines and their individual contributions to the advancement of knowledge - the total picture of science. Additional courses in a chosen concentration prepare you exceptionally well with both the tools and knowledge to enter a profession immediately upon graduation, or to embark on advanced study leading to a graduate degree.

Studies during your freshman year include courses in biology, chemistry, computer science, mathematics, and physics, and a sequence of courses in humanities. Studies in the humanities continue throughout the four-year program. In the next three years you may choose a concentration in the area of biology, chemistry, chemical biology, mathematics, computational science, applied physics, or engineering physics. Upon successful completion of your studies, you are awarded the Bachelor of Science degree.

The minimal formal requirements for the science program are listed in the semester-by-semester schedule, including the Notes. Courses may be taken in a different order than listed. Consult the individual department schedule for more specific details.

Bachelor of Science (Computer Science)

The computer science degree emphasizes the principles of computer science and prepares students for careers in industry and/or graduate school. Course materials focus on how to design, implement, deploy, and manage sophisticated software systems.

Bachelor of Science (Cybersecurity)

As the need for security and privacy increases in all industries (including medicine, banking, and homeland security) and many aspects of our daily lives, the demand for professionals with a comprehensive education in cybersecurity continues to grow.

Guidelines for Science Minor Programs

A minor represents a coherent program of study in a science discipline other than the student's major degree program. Successful completion of a minor program is recognized on the transcript and with a Minor Certificate at graduation. Recognition is thus provided for a significant education experience in another discipline.

General guidelines for a minor program in a science discipline are:

- Science minor programs will consist of a coherent sequence of a minimum of six courses. A minimum of two courses (minimum 6 credits) should be in addition to those courses required to complete a student's major degree program (which includes general education courses).

- The minor program must be in a discipline other than that of a student's major program of study. As such minors are distinguished from options or concentrations within the major discipline.

- The Minor Advisor may allow courses awarded transfer credit to be used but these must constitute less than half of those applied to the minor program.

- A student may earn no more than two minors.

- A student wishing to pursue a minor program must complete a Minor Program Study Plan signed by a Minor Advisor from the discipline of the minor to ensure a coherent program is undertaken. In order to be awarded the minor at graduation the student must complete a Minor Candidacy Form signed by the Minor Advisor after all minor requirements are fulfilled.

Entry to a Science minor program requires the student to have a minimum GPA of 2.5. In order for a course to count towards a minor the grade of C or above must be achieved.

Minor in Entrepreneurship

The undergraduate minor in entrepreneurship provides the educational prerequisites needed to foster the successful birth and development of technology-driven new ventures.

The minor will provide the knowledge and the infrastructure needed to sustain and support the efforts of Stevens' undergraduate students in engineering and science to create economic value through innovation and entrepreneurship.

After completing the minor, students will be able to develop and write an effective business plan by systematically developing the following skills:

▸ Able to identify and recognize viable technical business opportunities

▸ Can critically evaluate these business opportunities

▸ Can assess and manage the intellectual property embodied in technological opportunities

▸ Can develop an effective business model addressing market, operating and financial requirements

▸ Knows how to launch a technologically-based business

Courses

▸ BT 244 Microeconomics

▸ BT 372 Entrepreneurship

▸ BT 419 Entrepreneurship Practicum

▸ E 355 Engineering Economy or E 356 Engineering Economy; or BT 200 Financial Accounting

▸ MGT 472 Assessment and Financing of Technical Business Opportunities

▸ MGT 103 Introduction to Entrepreneurial Thinking

Graduation Requirements

Physical Education Requirements

▸ All undergraduate students must complete a minimum of four semesters of Physical Education (P.E.). A large number of activities are offered in lifetime, team and wellness areas.

▸ All P.E. courses must be completed by the end of the sixth semester. Students can enroll in more than the minimum required P.E. for graduation and are encouraged to do so.

▸ Participation in varsity sports can be used to satisfy up to three semesters of the P.E. requirement.

▸ Participating in club sports can be used to satisfy up to two of the P.E. requirements.

Note: Student may repeat Physical Education class but the repeated course (excluding varsity and club sports) will not count toward the graduation requirement.

Humanities Requirements

All undergraduate students are required to fulfill certain Humanities requirements in order to graduate. Please see pages 599-600 for a breakdown of specific requirements by program.

Science Curriculum

Term I

Course #	Course Name	Lecture	Lab	Study	Credit
PEP 111	Mechanics	3	0	6	3
CS 105 Or CS 115	Introduction to Scientific Computing Or Introduction to Computer Science	2	2	6	3
CH 115	General Chemistry I	3	0	6	3
CH 117	General Chemistry Laboratory I	0	3	1	1
MA 121; MA 122	Differential Calculus; Integral Calculus	4	0	8	4
CAL 103	Writing And Communications Colloquium	3	0	6	3
PE 200	Physical Education I	0	0	0	0
	Total	**15**	**5**	**33**	**17**

Term II

Course #	Course Name	Lecture	Lab	Study	Credit
PEP 112	Electricity and Magnetism	3	0	6	3
BIO 281	Biology and Biotechnology	3	0	6	3
CH 116	General Chemistry II	3	0	6	3
CH 118	General Chemistry Laboratory II	0	3	1	1
MA 123; MA 124	Series, Vectors, Functions, and Surfaces; Calculus of Two Variables	4	0	8	4
CAL 105	CAL Colloquium: Knowledge, Nature, Culture	3	0	6	3
PE 200	Physical Education II	0	0	0	0
	Total	**16**	**3**	**33**	**17**

Term III

Course #	Course Name	Lecture	Lab	Study	Credit
MA 221	Differential Equations	4	0	8	4
PEP 221	Physics Lab I for Scientists	0	3	1	1
BT 244 Or BT 243	Microeconomics Or Macroeconomics	3	0	6	3
T.E.	Technical Elective	3	0	6	3
	Humanities	3	0	6	3
PE 200	Physical Education III	0	2	0	0
	Total	**13**	**5**	**27**	**14**

Term IV

Course #	Course Name	Lecture	Lab	Study	Credit
	Science Elective[1]	3	0	6	3
PEP 222	Physics Lab II for Scientists	0	3	1	1
	Thermodynamics[2]	3	0	6	3
T.E.	Technical Elective	3	0	6	3
	Humanities	3	0	6	3
PE 200	Physical Education IV	0	2	0	0
	Total	**12**	**5**	**25**	**13**

Term V

Course #	Course Name	Lecture	Lab	Study	Credit
Hum	Humanities	3	0	6	3
T.E.	Technical Elective	3	0	6	3
T.E.	Technical Elective	3	0	6	3
T.E.	Technical Elective III	3	0	6	3
	Total	**12**	**0**	**24**	**12**

Term VI

Course #	Course Name	Lecture	Lab	Study	Credit
Hum	Humanities	3	0	6	3
MA 222	Probability and Statistics	3	0	6	3
PEP 242	Modern Physics	3	0	6	3
T.E.	Technical Elective	3	0	6	3
	Total	**12**	**0**	**24**	**12**

Term VII

Course #	Course Name	Lecture	Lab	Study	Credit
Hum	Humanities	3	0	6	3
T.E.	Technical Elective	3	0	6	3
T.E.	Technical Elective	3	0	6	3
T.E.	Technical Elective III	3	0	6	3
GE	Elective 2	3	0	6	3
	Total	**15**	**0**	**30**	**15**

Term VIII

Course #	Course Name	Lecture	Lab	Study	Credit
Hum	Humanities	3	0	6	3
T.E.	Technical Elective	3	0	6	3
T.E.	Technical Elective	3	0	6	3
T.E.	Technical Elective III	3	0	6	3
GE	Elective 2	3	0	6	3
	Total	**15**	**0**	**30**	**15**

(1) The Science Elective must be chosen from: MA 227 Multivariable Calculus (3-0-3) or CH 382 Biological Systems (3-3-4)
(2) Thermodynamics can be either CH 321 or E 234.

87

CORE CURRICULUM COURSES

E 101 Engineering Experiences I

This course consists of a set of engineering experiences such as lectures, small group sessions, on-line modules and visits. Students are required to complete a specified number of experiences during the semester. The goal is to introduce students to the engineering profession, engineering disciplines, college success strategies, Stevens research and other engaging activities. Course is pass/fail.

E 115 Introduction to Programming

An introduction to the use of an advanced programming language for use in engineering applications, using C++ as the basic programming language and Microsoft Visual C++ as the program development environment. Topics covered include basic syntax (data types and structures, input/output instructions, arithmetic instructions, loop constructs, functions, subroutines, etc.) needed to solve basic engineering problems as well as an introduction to advanced topics (use of files, principles of objects and classes, libraries, etc.). Algorithmic thinking for development of computational programs and control programs from mathematical and other representations of the problems will be developed. Basic concepts of computer architectures impacting the understanding of a high-level programming language will be covered.

E 120 Engineering Graphics

Engineering graphics: principles of orthographic and auxiliary projections, pictorial presentation of engineering designs, dimensioning and tolerance, sectional and detail views, assembly drawings. Descriptive geometry. Engineering figures and graphs. Solid modeling introduction to computer-aided design and manufacturing (CAD/CAM) using numerically-controlled (NC) machines.

E 121 Engineering Design I: Introduction to Systems Thinking

This course introduces students to the process of design and seeks to engage their enthusiasm for engineering from the very beginning of the program. The engineering method is used in the design and manufacture of a product. Product dissection is exploited to evaluate how others have solved design problems. Development is started of competencies in professional practice topics, primarily: effective group participation, project management, cost estimation, communication skills and ethics. Engineering Design I is linked to and taught concurrently with the Engineering Graphics course.

Corequisites: E 115, E 120

E 122 Engineering Design II: Field Sustainable Systems with Sensors

This course will continue the freshman year experience in design. The engineering method introduced in Engineering Design I will be reinforced. Further introduction of professional practice topics will be linked to their application and testing in case studies and project work.

Prerequisite: E 121

E 126 Mechanics of Solids

Fundamental concepts of particle statics, equivalent force systems, equilibrium of rigid bodies, analysis of trusses and frames, forces in beam and machine parts, stress and strain, tension, shear and bending moment, flexure, combined loading, energy methods, statically indeterminate structures.

Prerequisites: PEP 111, MA 115 or MA 122

E 231 Engineering Design III: Structural Performance and Failure

This course continues the experiential sequence in design. Design projects are linked with Mechanics of Solids topics taught concurrently. Core design themes are further developed.

Prerequisite: E 122

Corequisite: E 126

E 232 Engineering Design IV: Systems with Analog Circuits

This course continues the experiential sequence in design. Design projects and lectures address the area of electronics and instrumentation. Core design themes are further developed.

Prerequisites: E 231, E 245

E 234 Thermodynamics

This course introduces students to concepts of energy, energy transfer and analysis. Major thermodynamic devices such as heat exchangers, turbines and compressors will be discussed in the context of the first and second laws of thermodynamics along with the required property relationships and equations necessary to analyze these systems. The fundamental mechanisms of heat transfer will also be presented before the course culminates with a discussion of integrated thermodynamic systems and cycles such as refrigeration and air conditioning units.

Prerequisites: CH 115, MA 115 or MA 122, PEP 111

E 243 Probability and Statistics for Engineers

Descriptive statistics, pictorial and tabular methods, measures of location and of variability, sample space and events, probability and independence, Bayes' formula, discrete random variables, densities and moments, normal, gamma, exponential and Weibull distributions, distribution of the sum and average of random samples, the central limit theorem, confidence intervals for the mean and the variance, hypothesis testing and p-values, applications for prediction in a regression model. A statistical computer package is used throughout the course for teaching and for project assignments.

Prerequisite: MA 116 or MA 124

E 245 Circuits and Systems

Ideal circuit elements; Kirchoff laws and nodal analysis; source transformations; Thevenin/Norton theorems; operational amplifiers; response of RL, RC and RLC circuits; sinusoidal sources and steady state analysis; analysis in frequency domain; average and RMS power; linear and ideal transformers; linear models for transistors and diodes; analysis in the s-domain; Laplace transforms; transfer functions.

Corequisites: PEP 112, MA 221

E 301 International Educational Experiences I

This course designation provides a vehicle to award general elective academic credit to approved international educational experiences that meet School of Engineering and Science/engineering program educational outcomes, but would not otherwise be transferable as equivalent to a Stevens course or courses. Multiple activities can be combined for approval if they present a coherent whole that addresses school/program outcomes. The program or activities must be approved for credit by the School of Engineering and Science Education and Assessment Committee.

E 302 International Educational Experiences II

This course designation provides a vehicle to award general elective academic credit to approved international educational experiences that meet School of Engineering and Science/engineering program educational outcomes, but would not otherwise be transferable as equivalent to a Stevens course or courses. Multiple activities can be combined for approval if they present a coherent whole that addresses school/program outcomes. The program or activities must be approved for credit by the School of Engineering and Science Education and Assessment Committee.

E 321 Engineering Design V: Materials Selection and Process Optimization

This course includes both experimentation and open-ended design problems that are integrated with the Materials Processing course taught concurrently. Core design themes are further developed.

Corequisite: E 344

E 322 Engineering Design VI

This course allows each discipline to address design topics specific to their discipline. Offered as a discipline specific course (e.g.: CE322, CHE322, CPE322, EE322, EM322, EN322, ME322, NE322, SSW322).

Prerequisite: E 321

Corequisites: E 345, E 355

E 342 Transport/Fluid Mechanics

Offered as a specific departmental course; see departmental listing.

E 344 Materials Processing

An introduction is provided to the important engineering properties of materials, to the scientific understanding of those properties and to the methods of controlling them. This is provided in the context of the processing of materials to produce products.

Prerequisite: CH 115

E 345 Modeling and Simulation

Development of deterministic and non-deterministic models for physical systems; engineering applications; simulation tools for deterministic and non deterministic systems; case studies and projects. Offered as a discipline specific course (e.g.: CE345, CHE345, CPE345, EE345, EM345, EN345, ME345, NE 345, SSW345).

E 355 Engineering Economics

Students learn a set of Engineering Economic techniques that serve as powerful tools to aid in the design, implementation and continued improvement of any engineering project or process. The primary goal of this course is to help students develop an ability to make sound economic decisions, thereby facilitating effective evaluation and selection of alternative technical, design, and engineering solutions. In this course students will be exposed to the analysis of financial data, the concept of interest rates, the time value of money, economic analysis using the three worths, internal rate of return and benefit cost analysis. Furthermore, the student will gain a comprehensive knowledge about advanced engineering economy topics such as depreciation, capital cost and recovery, after tax analysis, inflation, sensitivity analysis, risk analysis and simulation. Laboratory exercises include the use of spreadsheets to solve engineering economy problems and a series of labs that parallel the lecture portion of the course.

Prerequisites: E 121, and E 122, and E 231, and E 232

E 385 Special Topics in Sustainable Engineering

This is a multidisciplinary course addressing contemporary issues in sustainable engineering. The course is primarily project-based with relevant lectures and seminars from the instructor and guest speakers. Each student or group of students will develop a plan of project activities appropriate for the assigned credits under the supervision of an advisor and may include a co-advisor from outside Stevens. The scope of the project must not duplicate any activity for which credit has been or is being obtained in another course. This course is open to engineering undergraduate students from any discipline with at least sophomore standing. This course can be used as an elective in the Green Engineering Minor.

E 400 Research in Engineering

Individual research investigation under the guidance of a faculty advisor. Hours/credits to be arranged. A final report/thesis and a formal presentation in a seminar/conference is required.

E 423 Engineering Design VII

Senior design capstone courses. A capstone project spanning two semesters is required. While the focus is on the capstone disciplinary design experience the two-semester capstone is coupled to a sequence of three 1-credit workshops on project management, innovation and entrepreneurial considerations related to the project, IDE 400, IDE 401 & IDE 402.

Co-requisites: IDE 400 & 401

E 424 Engineering Design VIII

Senior design capstone courses include a capstone project spanning two semesters.

Prerequisites: E 423, IDE 400 & 401; Corequisite: IDE 402

E 580 Sustainable Energy

Assessment of current and potential energy systems, covering extraction, conversion and end use, with emphasis on meeting regional and global energy needs in the 21st century in a sustainable manner; systems engineering and economic analysis tools for sustainable energy systems; climate change; energy technologies in each fuel cycle stage for fossil (oil, gas, synthetic), nuclear (fission and fusion) and renewable (solar, biomass, wind, hydro, and geothermal) energy types; storage, transmission, and conservation; evaluation and analysis of energy technology systems in the context of engineering, economic, environmental, political and social aspects.

IDE 314 Entrepreneurship Experience Part-I

This is the first part of a two-part course that actively educates and incubates investment viable start-ups with technology at their core, and service-to-mankind as their purpose. IDE 314's educational goals are to teach the pedagogical principles behind the lean launchpad (LLP) movement, along with it's toolkits such as the business model canvas (BMC), customer discovery, customer interviews, customer development, agile programming, rapid prototyping, and the formulation of a minimum viable product (MVP). IDE 314's incubation goals are to actively nurture an early stage experiment in successful start-up building. This includes creation of real prototypes/products that lead towards a value proposition that is significantly better than the competition. This is the first step in creating a Sequioa style investment thesis. In its current offering, our domain of technology will be limited to computer hardware, software, and/or allied technologies.

Prerequisites: E115. Attendance to, and successful completion of, the Launchpad *retreat*. This retreat is normally held in March semester prior to this course in Fall).

IDE 315 Entrepreneurship Experience Part II

This is the second part of a two-part course that actively educates and incubates investment viable start-ups. Startups with technology at their core, and service-to-mankind as their purpose. IDE 315's educational goals are more experiential compared to IDE 314. Topics covered include principles behind customer acquisition, customer lifetime value (CLV), revenue streams, product pricing, market segmentation and growth (journey from beach-head to SAM and TAM), as well as the legal mechanics of patents, LLCs and incorporations. IDE 315's incubation goals are in the creation and nurturing of real enterprises in partnership with the Stevens Venture Center (SVC). Such enterprises are able to establish a unique value proposition, a scalable-repeatable business model, and a sound investment thesis with students in a leadership role.

Prerequisite: IDE 314

IDE 400 Senior Innovation I: Project Planning

This course enables students to effectively identify senior design project topics, form and build teams and create a project charter. IDE 400 Project Planning focuses on techniques required to identify the customer segments, interview potential stakeholders and develop a set of requirements for their capstone design project.

Prerequisite: MGT 103

IDE 401 Senior Innovation II: Value Proposition

This course focuses on the Identification and articulation of the entrepreneurial, societal and humanitarian values of the products and processes developed during the senior design project.

Corequisite: IDE 400

IDE 402 Senior Innovation III: Venture Planning and Pitch

This course focuses on preparing a business idea based on the senior design project and creating a business model for that idea. This course also will help students articulate and pitch their business opportunity to various stakeholders. IDE 402 should be taken concurrent with Design VIII (XE 424).

Prerequisite: IDE 401

Department of Biomedical Engineering

FACULTY

HONGJUN WANG
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Industry Professor
Program Director, Biomedical Engineering

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UNDERGRADUATE PROGRAM

Biomedical Engineering

A Biomedical Engineer works at the interface between physical and biological systems. A distinguishing feature of biomedical engineers is that they design instruments and devices that interact with or make measurements on living systems. These systems can be as small as a protein, gene, or cell, as complex as an organ such as the heart and lungs or as integrated as the heart lungs and muscles during exercise. The ultimate goal is to help improve medical diagnosis and treatment and to improve the quality of life for people who are incapacitated.

The biomedical engineering field is truly multidisciplinary. Biomedical engineers must understand not only basic engineering principles but also the biology and physiology of cells, organs and systems that work together to create a functioning human being. In addition, the biomedical engineer must have some in-depth experience in applying engineering concepts to living systems. Biomedical Engineers are engaged in designing and manufacturing prostheses (replacement hips, knees, tendons, arms, legs, etc.), total artificial hearts as well as left ventricular assist devices, pacemakers and defibrillators, Imaging devices such as CAT scans, MRI, f-MRI, ultrasound, and nuclear medicine imaging (PET,SPECT), replacement organs (artificial pancreas, ears, retina, etc.), in-patient monitoring devices (blood pressure, sleep apnea, EKG, etc.), in addition to more standard medical devices such as portable EKG and pulmonary function machines for use in physicians' offices. Biomedical Engineers also engage in cutting edge research on living systems and contribute important new knowledge to the field.

The Biomedical Engineering program at Stevens is based on a solid foundation in basic science, math, biology and engineering fundamentals. Within Biomedical Engineering, there is depth in these two areas:

Biomechanics & Biomaterials

- E344 Materials Processing
- BME 505 Biomaterials
- BME 506 Biomechanics
- BME 556 Advanced Biomechanics

Bioinstrumentation

- E232 Engineering Design IV: Systems with Analog Circuits
- E322 Engineering Design VI
- BME 460: Biomedical Digital Signal Processing Laboratory
- BME 504: Medical Instrumentation & Imaging

In addition, courses in Transport in Biosystems, Engineering Physiology, Biosystems Simulation and Control, and Bioethics are included to provide the multidisciplinary background for a modern biomedical engineer. The transport, physiology, biomaterials, imaging and simulation courses contain laboratories to provide extensive hands-on experience. Since tomorrow's biomedical devices will have to be smarter, smaller and, in many cases wireless, a course in bioinstrumentation design is included in the design sequence (Design VI). The program is design oriented and culminates in a group capstone senior design project that spans the 7th and 8th semesters. The group carries out a comprehensive design of a biomedical device which includes an economic analysis, engineering computations and drawings, a plan for manufacture and the delivery of a working prototype of the device or a major component of the device. The emphasis in the design sequence is on teamwork, presentation skills and an entrepreneurial approach to design and manufacture. The program also provides for the flexibility of applying to medical school. The courses required to take the MCAT exam are normally completed by the end of the junior year.

Biomedical Engineering Program Mission and Objectives

The Stevens biomedical engineering program produces graduates who possess a broad foundation in engineering and liberal arts, combined with a depth of disciplinary knowledge at the interface of engineering and biology. This knowledge is mandatory for success in a biomedical engineering career. Biomedical engineering is also an enabling step for a career in medicine, dentistry, business or law.

The objectives of the biomedical engineering program are to prepare students such that within several years after graduation:

‣ Graduates will identify biomedical engineering challenges and lead solution concepts using their knowledge of fundamental engineering principles, work experience and state-of-the-art tools and techniques.

‣ Graduates will be among the leaders of the fields in development of biomedical devices, implants, tissues, and systems to meet the needs of society.

‣ Graduates will establish themselves as leaders in their chosen career path by applying their skills in problem solving, teamwork, ethics, management, communication, and their awareness of professional and social issues.

Biomedical Engineering offers alternative Red and Gray sequences in which courses may be taken. Both sequences are listed below.

Biomedical Engineering Curriculum - Red Sequence

Term I

Course #	Course Name	Lecture	Lab	Study	Credit
CH 115	General Chemistry I	3	0	6	3
CH 117	General Chemistry Laboratory I	0	3	1	1
E 101	Engineering Experience I	1	0	0	1
E 115	Introduction to Programming	1	2	3	2
E 120	Engineering Graphics	0	2	1	1
E 121	Engineering Design I: Introduction to Systems Thinking	0	3	2	2
MA 121; MA 122	Differential Calculus; Integral Calculus	4	0	8	4
CAL 103	Writing And Communications Colloquium	3	0	6	3
	Total	**12**	**10**	**27**	**17**

Term II

Course #	Course Name	Lecture	Lab	Study	Credit
CH 116	General Chemistry II	3	0	6	3
CH 118	General Chemistry Laboratory II[1]	0	3	1	1
E 122	Engineering Design II: Field Sustainable Systems with Sensors	0	3	3	2
MA 123; MA 124	Series, Vectors, Functions, and Surfaces; Calculus of Two Variables	4	0	8	4
PEP 111	Mechanics	3	0	6	3
MGT 103	Introduction to Entrepreneurial Thinking	1	2	0	2
CAL 105	CAL Colloquium: Knowledge, Nature, Culture	3	0	6	3
	Total	**14**	**8**	**30**	**18**

Term III

Course #	Course Name	Lecture	Lab	Study	Credit
E 126	Mechanics of Solids	4	0	8	4
E 231	Engineering Design III: Structural Performance and Failure	0	3	2	2
E 245	Circuits and Systems	2	3	7	3
MA 221	Differential Equations	4	0	8	4
PEP 112	Electricity and Magnetism	3	0	6	3
Hum	Humanities[1]	3	0	6	3
	Total	**16**	**6**	**37**	**19**

Term IV

Course #	Course Name	Lecture	Lab	Study	Credit
BME 306	Introduction to Biomedical Engineering	3	0	6	3
BIO 281	Biology and Biotechnology (no Lab)	3	0	6	3
E 232	Engineering Design IV: Systems with Analog Circuits	2	3	7	3
E 234	Thermodynamics	3	0	6	3
E 344	Materials Processing	3	0	6	3
MA 227	Multivariable Calculus	3	0	6	3
	Total	**17**	**3**	**37**	**18**

Term V

Course #	Course Name	Lecture	Lab	Study	Credit
BME 460	Biomedical Digital Signal Processing Laboratory	1	3	4	2
BME 505	Biomaterials	2	3	6	3
BME 506	Biomechanics	3	0	6	3
BIO 381	Cell Biology	3	3	7	4
E 243	Probability and Statistics for Engineers	3	0	6	3
E 321	Engineering Design V: Materials Selection and Process Optimization Or	0	3	2	2
Hum	Humanities[1]	3	0	6	3
	Total	**12**	**12**	**31**	**17**

Term VI

Course #	Course Name	Lecture	Lab	Study	Credit
BME 322	Engineering Design VI	1	3	2	2
BME 342	Transport in Biological Systems	3	3	6	4
BME 556	Advanced Biomechanics	3	0	6	3
E 355	Engineering Economics	3	3	6	4
E 321	Engineering Design V: Materials Selection and Process Optimization Or	0	3	2	2
Hum	Humanities[1]	3	0	6	3
G.E.	General Elective[2]	3	0	6	3
	Total	**13**	**12**	**28**	**18**

Term VII

Course #	Course Name	Lecture	Lab	Study	Credit
BME 423	Engineering Design VII	0	8	3	3
BME 482	Engineering Physiology	3	3	6	4
BME 453	Bioethics	3	0	3	3
CH 243	Organic Chemistry I	3	0	6	3
CH 245	Organic Chemistry Laboratory I	0	4	0	1
IDE 400	Senior Innovation I[4]	1	0	2	1
IDE 401	Senior Innovation II[4]	1	0	2	1
Hum	Humanities[1]	3	0	6	3
	Total	**14**	**15**	**28**	**19**

Term VIII

Course #	Course Name	Lecture	Lab	Study	Credit
BME 424	Engineering Design VIII	0	8	3	3
BME 445	Biosystems Simulation and Control	3	3	4	4
BME 504	Medical Instrumentation and Imaging	3	0	6	3
IDE 402	Senior Innovation III	1	0	2	1
G.E.	General Elective[2]	3	0	6	3
Hum	Humanities[1]	3	0	6	3
	Total	**13**	**11**	**27**	**17**

(1) The four humanities beyond CAL 103 and 105 must cover at least two disciplines in CAL, with at least one course at the 100 or 200 level and at least one course at the 300 or 400 level.
(2) General electives are courses chosen by the student. General electives can be applied toward a minor, research or approved international studies.
(3) Four PE course are required for graduation.
(4) BME students should take IDE 400 concurrently with IDE 401, in Term VII.

Biomedical Engineering Curriculum - Gray Sequence

Term I

Course #	Course Name	Lecture	Lab	Study	Credit
CH 115	General Chemistry I	3	0	6	3
CH 117	General Chemistry Laboratory I	0	3	1	1
E 101	Engineering Experiences I	1	0	0	1
E 121	Engineering Design I: Introduction to Systems Thinking	0	3	2	2
E 120	Engineering Graphics	0	2	1	1
E 115	Introduction to Programming	1	2	3	2
MA 121; MA 122	Differential Calculus; Integral Calculus	4	0	8	4
CAL 103	Writing And Communications Colloquium	3	0	6	3
	Total	**12**	**10**	**27**	**17**

Term II

Course #	Course Name	Lecture	Lab	Study	Credit
CH 116	General Chemistry II	3	0	6	3
CH 118	General Chemistry Laboratory II[1]	0	3	1	1
E 122	Engineering Design II: Field Sustainable Systems with Sensors	0	3	3	2
MA 123; MA 124	Series, Vectors, Functions, and Surfaces; Calculus of Two Variables	4	0	8	4
PEP 111	Mechanics	3	0	6	3
CAL 105	CAL Colloquium: Knowledge, Nature, Culture	3	0	6	3
MGT 103	Introduction to Entrepreneurial Thinking	1	2	0	2
	Total	**14**	**8**	**30**	**18**

Term III

Course #	Course Name	Lecture	Lab	Study	Credit
MA 221	Differential Equations	4	0	8	4
PEP 112	Electricity and Magnetism	3	0	6	3
E 126	Mechanics of Solids	4	0	8	4
E 245	Circuits and Systems	2	3	7	3
E 231	Engineering Design III: Structural Performance and Failure	0	3	2	2
Hum	Humanities[1]	3	0	6	3
PE 200	Physical Education I[3]	0	2	0	0
	Total	**16**	**8**	**37**	**19**

Term IV

Course #	Course Name	Lecture	Lab	Study	Credit
MA 227	Multivariable Calculus	3	0	6	3
E 232	Engineering Design IV: Systems with Analog Circuits	2	3	7	3
BME 306	Introduction to Biomedical Engineering	3	0	6	3
BIO 281	Biology and Biotechnology (no lab)	3	0	6	3
E 344	Materials Processing	3	0	6	3
E 234	Thermodynamics	3	0	6	3
PE 200	Physical Education II[3]	0	2	0	0
	Total	**17**	**5**	**37**	**18**

Term V

Course #	Course Name	Lecture	Lab	Study	Credit
BME 342	Transport in Biological Systems	3	3	6	4
E 321	Engineering Design VI	0	3	2	2
CH 243	Organic Chemistry I	3	0	6	3
CH 245	Organic Chemistry Laboratory I	0	4	0	1
BIO 381	Cell Biology	3	3	7	4
E 243	Probability and Statistics for Engineers	3	0	6	3
Hum	Humanities[1]	3	0	6	3
	Total	**15**	**13**	**33**	**20**

Term VI

Course #	Course Name	Lecture	Lab	Study	Credit
E 355	Engineering Economics	3	3	6	4
BME 322	Engineering Design V	1	3	2	2
BME 505	Biomaterials	2	3	6	3
BME 460	Biomedical Digital Signal Processing Laboratory	1	3	4	2
BME 506	Biomechanics	3	0	6	3
G.E.	General Elective[2]	3	0	6	3
PE 200	Physical Education III[3]	0	2	0	0
	Total	**13**	**14**	**30**	**17**

Term VII

Course #	Course Name	Lecture	Lab	Study	Credit
BME 482	Engineering Physiology	3	3	6	4
BME 504	Medical Instrumentation and Imaging	3	0	6	3
BME 423	Engineering Design VII	0	8	3	3
IDE 400	Senior Innovation I[4]	1	0	2	1
IDE 401	Senior Innovation II[4]	1	0	2	1
Hum	Humanities[1]	3	0	6	3
BME 556	Advanced Biomechanics	3	0	6	3
PE 200	Physical Education IV[3]	0	2	0	0
	Total	**14**	**13**	**31**	**18**

Term VIII

Course #	Course Name	Lecture	Lab	Study	Credit
BME 445	Biosystems Simulation and Control	3	3	4	4
BME 453	Bioethics	3	0	3	3
G.E.	General Elective II[2]	3	0	6	3
BME 424	Engineering Design VIII	0	8	3	3
IDE 402	Senior Innovation III	1	0	2	1
Hum	Humanities[1]	3	0	6	3
	Total	**12**	**11**	**22**	**17**

(1) The four humanities beyond CAL 103 and 105 must cover at least two disciplines in CAL, with at least one course at the 100 or 200 level and at least one course at the 300 or 400 level.

(2) General electives are courses chosen by the student. General electives can be applied toward a minor, research or approved international studies.

(3) Four PE course are required for graduation.

(4) IDE 400 can be taken concurrently with IDE 401 in Term VII as determined by the engineering program. BME students should take IDE 400 concurrently with IDE 401, in Term VII.

Graduation Requirements

Physical Education Requirements

▸ All undergraduate students must complete a minimum of four semesters of Physical Education (P.E.). A large number of activities are offered in lifetime, team and wellness areas.

▸ All P.E. courses must be completed by the end of the sixth semester. Students can enroll in more than the minimum required P.E. for graduation and are encouraged to do so.

▸ Participation in varsity sports can be used to satisfy up to three semesters of the P.E. requirement.

▸ Participating in club sports can be used to satisfy up to two of the PE requirements.

Note: Student may repeat Physical Education class but the repeated course (excluding varsity and club sports) will not count toward the graduation requirement.

Humanities Requirement

▸ All undergraduate students are required to fulfill certain Humanities requirements in order to graduate. Please see pages 599-600 for a breakdown of specific requirements by program.

Minor

Biomedical Engineering (for students in Engineering Curriculum)

The following are required courses:

▸ BIO 381 Cell Biology

▸ BME 306 Introduction to Biomedical Engineering

▸ BME 482 Engineering Physiology

▸ BME 504 Medical Instrumentation and Imaging

▸ BME 505 Biomaterials

▸ BME 506 Biomechanics

The following prerequisite is needed to undertake the minor program:

▸ BIO 281 Biology and Biotechnology

GRADUATE PROGRAMS

The Master of Engineering and Doctor of Philosophy degrees are offered in biomedical engineering. Admission to these programs requires a bachelor's degree in engineering. Students without a bachelor's degree in biomedical engineering may be required to complete prerequisites during their enrollment in the program.

Our department offers one additional Master of Science program in bioengineering. This program is for students interested in obtaining a fundamental knowledge of bioengineering with a focus on tissue engineering, regenerative medicine, and biomaterials. For admission to the M.S. program in bioengineering, students must have earned a B.A. or B.S. in a strong science program such as biology, chemical biology, biochemistry, biotechnology, or equivalent. Students should also have taken basic Calculus and Physics courses as part of their undergraduate degree.

Master of Science - Bioengineering

The M.S. in Bioengineering is tailored for students with a strong science background who would like the skills needed to develop materials and devices at the intersect ion of life science and engineering. This interdisciplinary program focuses on tissue engineering and regenerative medicine methods to improve healthcare. Our program builds on a foundation of molecular biology and chemistry while also adding elements of bioengineering design. For the Master of Science degree, students must successfully complete thirty graduate credits including 15 credits of core courses listed below. Students may elect to choose thesis (6-9 credits} or non-thesis options, depending on their professional goals. Students pursuing a thesis should make arrangements with an advisor within the first year at Stevens. Graduates of this program will be well positioned to obtain careers in pharmaceutical, biotechnology, and medical device companies in addition to biomedical research and regulatory institutions.

Core Courses in Bioengineering -15 credits

- BIO 687: Molecular Biology
- BIO 684: Molecular Biology Laboratory
- BME 505: Biomaterials
- BME 602: Principles of Tissue Engineering
- BME/BIO 690: Cellular Signal Transduction

Technical Elective Courses - 9 credits for non-thesis option, 6-9 credits for thesis option

- BIO 583: Physiology
- BIO 668: Computational Biology
- BIO 686: Immunology
- BIO 689: Cellular Biology Lab Techniques
- BIO 691: Introduction to Systems Biology
- BIO 695: Organelles
- BME 502: Physiology for Engineers I
- BME 503: Physiology for Engineers II
- BME 650: Advanced Biomaterials
- BME 665: Pathophysiology
- CH 601: Professional Ethics in Science & Chemistry
- PME 530: Introduction to Pharmaceutical Manufacturing
- CAL 557: Bioethics
- CH/BME 800: Special Problems

Unrestricted Electives - 6 credits for non-thesis option only

Additional courses are chosen with an advisor's guidance and will depend on the student's interests and background. The Program Director must approve all elective courses.

Master of Engineering - Biomedical Engineering

Stevens is a leader in the field of biomedical engineering, engaging in visionary research and collaboration with researchers in medical centers, the biotech industry and government. Our graduates are leaders in academia, industries related to medicine, biotechnology and in newly emerging fields based on biological technology.

The Biomedical Engineering graduate program is designed to foster independent scholarly work while providing flexibility to accommodate each student's interests and career goals. Each full time M. Eng. student is required to complete 30 credits of graduate work that includes 6 required credits of core course work. The additional 24 graduate credits of course work can be tailored to aid the students' research project or their professional development goals and may include a 9 credit thesis.

In lieu of the 9-credit thesis, students can elect to do a 6-credit research or design project, plus 3 credits of additional graduate course work. The project must be approved by the BME program director and have the official support of the students company. Wherever possible, research and design projects will include an outside member of the thesis committee from the medical or biotech industry.

Core Courses in Biomedical Engineering - Common Requirements for Students with BME/other Engineering background. (Prerequisites may be required)

Students may be admitted to the M.Eng. program in BME with undergraduate engineering degrees other than BME. For students admitted with a non-BME degree, prerequisite courses may be required that may not carry graduate credit. The prerequisite courses will be determined on an individual basis in consultation with the BME graduate program advisor. In any case, all graduate BME students are required to complete the following core courses:

- BME 600 Strategies and Principles of Biomedical Design
- BME 701 Selected Topics in Biomedical Engineering

Doctoral Program in Biomedical Engineering

The purpose of the doctoral program is to educate scientists and engineers who are prepared to carry out independent investigations. While courses provide the tools for independent work, a large part of the doctoral work is done through independent study. This includes preparation for the qualifying examination, the preparation of research proposals and seminars and familiarity with the current scientific literature in the area of specialization.

The master's degree is not a prerequisite for admission to the doctoral program. Admission to the doctoral program is based on 1) GRE score, and 2) reasonable evidence that the student will prove capable of specialization on a broad intellectual foundation. 84 credits of graduate work in an approved program of study are required beyond the bachelor's degree. This may include up to 30 credits obtained in a master's degree program, if the area of the master's degree is relevant to the doctoral program. Those with a master's degree who wish to transfer credits towards the Ph.D. must be aware that only one master's degree can be used toward the Ph.D. A doctoral dissertation based on the results of original research, carried out under the guidance of a faculty member and defended in public examination, is a major component of the doctoral program, and is included in the 84-credit requirement. For more details about program requirements, see our Graduate Student Handbook.

In the BME program, at least 30 credits must be earned for the Ph.D. dissertation.

Graduate Certificate Programs

In addition to the degree programs, the department currently offers a "mini-graduate" program leading to the Certificate of Special Study Biomedical Engineering. Students in this certificate program must meet the same admission and performance standards as regular degree graduate students. The certificate program requires twelve credits (four courses), all of which are transferable to the appropriate master's degree program.

Biomedical Engineering

‣ BME 502 Physiology for Engineers I

‣ BME 504 Medical Instrumentation and Imaging

‣ BME 505 Biomaterials

‣ BME 506 Biomechanics

(Requires an undergraduate Engineering Degree)

Computational Chemistry

‣ CH 520 Advanced Physical Chemistry

‣ CH 550 Spectra and Structure

‣ CH 664 Computer Method in Chemistry

‣ CH 669 Applied Quantum Chemistry

COURSE OFFERINGS

Biomedical Engineering

BME 181   Seminar in Biomedical Engineering   (1 - 1 - 0)

Introduction to current research topics in Biomedical Engineering. The applications are chosen to demonstrate the depth, breadth, impact and future directions of the BME field. Typical topics include Biomechanics, Biomaterials and Tissue Engineering, Cardio-Respiratory Mechanics, Gait Analysis, Markerless motion capture, Bio-Robotics and Robotic Surgery, Brain-Computer Interfaces and nano-medicine. Students will learn how to critically review current research publications.

BME 306   Introduction to Biomedical Engineering   (3 - 3 - 0)

Overview of the biomedical engineering field with applications relevant to the healthcare industry such as medical instrumentation and devices. Introduction to the nervous system, propagation of the action potential, muscle contraction and introduction to the cardiovascular system. Discussion of ethical issues in biomedicine. Prerequisite: Sophomore Standing.

BME 322   Engineering Design VI   (2 - 1 - 3)

Introduction to the principles of wireless transmission and the design of biomedical devices and instrumentation with wireless capabilities.(e.g. pacemakers, defibrilators. EKG). Electrical safety (isolation, shielding), and equipment validation standards for FDA compliance are introduced. Use of LabView to provide virtual bioinstrumentation. The course culminates in group projects to design a biomedical device that runs on wireless technology. Prerequisite: E 232

BME 342   Transport in Biological Systems   (4 - 3 - 3)

A study of momentum, mass and heat transport in living systems. Rheology of blood. Basic hemodynamics. Use of the equations of continuity and motion to set up complex flow problems. Flow within distensible tubes. Shear stress and endothelial cell function. Mass transfer and metabolism in organs and tissues. Microscopic and macroscopic mass balances. Diffusion. Blood-tissue transport of solutes in the microcirculation. Compartmental models for pharmacokinetic analyses. Analysis of blood oxygenators, hemodialysis, tissue growth in porous support materials. Artificial organs. Energy balances and the use of heat to treat tumor growth (radio frequency ablation, cryogenic ablation). Laboratory exercises accompany major topics discussed in class and are conducted at the same time. Prerequisite: MA 227 Corequisite: BME 306

BME 423   Engineering Design VII   (3 - 0 - 8)

Senior design courses. Senior design provides, over the course of two semesters, a collaborative design experience with a significant biomedical problem related to human health. The project will often originate with an industrial sponsor or a medical practitioner at a nearby medical facility and will contain a clear implementation objective (i.e. for a medical device). It is a capstone experience that draws extensively on the student's engineering and scientific background and requires independent judgments and actions. The project generally involves a determination of the medical need, a detailed economic analysis of

the market potential, physiological considerations, biocompatibility issues, ease of patient use, an engineering analysis of the design, manufacturing considerations and experimentation and/or prototype construction of the device. The faculty advisor, industrial sponsor or biomedical practitioner works closely with the group to insure that the project meets its goals in a timely way. Leadership and entrepreneurship are nourished throughout all phases of the project. The project goals are met in a stepwise fashion, with each milestone forming a part of a final report with a common structure. Oral and written progress reports are presented to a panel of faculty at specified intervals and at the end of each semester. Prerequisites: BME 322, BME 342, BME 505, and BME 506 Corequisite: BME 482

BME 424   Engineering Design VIII   (3 - 0 - 8)

Senior design courses. Senior design provides, over the course of two semesters, a collaborative design experience with a significant biomedical problem related to human health. The project will often originate with an industrial sponsor or a medical practitioner at a nearby medical facility and will contain a clear implementation objective (i.e. for a medical device). It is a capstone experience that draws extensively on the student's engineering and scientific background and requires independent judgments and actions. The project generally involves a determination of the medical need, a detailed economic analysis of the market potential, physiological considerations, biocompatibility issues, ease of patient use, an engineering analysis of the design, manufacturing considerations and experimentation and/or prototype construction of the device. The faculty advisor, industrial sponsor or biomedical practitioner works closely with the group to insure that the project meets its goals in a timely way. Leadership and entrepreneurship are nourished throughout all phases of the project. The project goals are met in a stepwise fashion, with each milestone forming a part of a final report with a common structure. Oral and written progress reports are presented to a panel of faculty at specified intervals and at the end of each semester. Prerequisite: BME 423

BME 445   Biosystems Simulation and Control   (4 - 3 - 3)

Time and frequency domain analysis of linear control systems. Proportional, derivative and integral control actions. Stability. Applications of control theory to physiological control systems: biosensors, information processors and bioactuators. Mathematical modeling and analysis of heart and blood pressure regulation, body temperature regulation, regulation of intracellular ionic concentrations, eye movement and pupil dilation controls. Use of Matlab and Simulink to model blood pressure regulation, auto regulation of blood flow, force development by muscle contraction, and integrated response of cardiac output, blood pressure and respiration to exercise. Prerequisite: BME 482

BME 453   Bioethics   (3 - 3 - 0)

This course focuses on professional ethical conduct in the biomedical field. It will enable students to understand the ethical challenges they may encounter as biomedical engineers, allow them to practice biomedical engineering in an ethical manner and conduct themselves ethically as contributing members of society. Case discussions and presentations by practitioners in the field illustrate ethical norms and dilemmas. Corequisite: BME 306

BME 460   Biomedical Digital Signal Processing Laboratory   (2 - 1 - 3)

Biomedical Digital Signal Processing is an introductory course into the fascinating world of Digital Signal Processing as it applies to the clinic. Since modern medical systems employ DSP concepts to analyze biomedical signals, such as the ECG, there is a need for Biomedical Engineers to gain a more in-depth understanding of the subject. This class is designed to break the complex subject down into three fundamental areas, hardware systems, mathematical concepts, and software algorithms. Essential Signal Processing concepts are introduced and then reinforced with multiple biomedical examples and MatLab simulations, all serving to clarify the subject. Topics include: The Hardware building blocks, Signals and Systems, Euler's Equation, Nyquist's Sampling Theorem as Applied to Biomedical Applications, Convolution, Filters, Adaptive Filters, the Power Spectrum, and Discrete Fourier Transformations. Prerequisites: E 232, E 245

BME 482   Engineering Physiology   (4 - 3 - 3)

Introduction to mammalian physiology from an engineering point of view. The quantitative aspects of normal cellular and organ functions and the regulatory processes required maintaining organ viability and homeostasis. Laboratory exercises using exercise physiology as an integration of function at the cellular, organ and systems level will be conducted at the same time. Measurements of heart activity (EKG), cardiac output (partial CO_2 rebreathing), blood pressure, oxygen consumption, carbon dioxide production, muscle strength (EMG), fluid shifts and respiratory function in response to exercise stress will be measured and analyzed from an engineering point of view. Prerequisites: BME 342, CH 381 or BIO 381

BME 498   Research in Biomedical Engineering I   (- -)

Individual investigation of a substantive character undertaken at an undergraduate level under the guidance of a member of the departmental faculty. A written report is required. Hours to be arranged with the faculty advisor. Prior approval required. These courses can be used as general electives for degree requirements. Cross-listed with: CM 502

BME 499   Research in Biomedical Engineering II   (1 - 0 - 2)

An individual research project of a substantive nature and relevant to the field of biomedical engineering.

BME 502   Physiology for Engineers I   (3 - 3 - 0)

The objectives of this course is to provide an engineering approach to human physiology for engineering students that have a limited background in Biology as a prerequisite for pursuing a graduate course of study in Biomedical Engineering. Part I will cover homeostasis and the two master controllers of the body, the nervous system and the endocrine system and their complementary mechanisms for maintaining homeostasis from a *systems engineering point of view*. Functional anatomy and physiology will be covered as well as quantitative methods for the analysis of cell signaling. Cross-listed with: ME 528

BME 503   Physiology for Engineers II   (3 - 3 - 0)

A study of the physiological functions of major organ systems (Neural, Blood, Muscle, Heart, Vascular System Renal, Respiratory and Lymphatics) and how they interact to maintain homeostasis from a systems engineering point of view. Functional anatomy and physiology will be covered as well as quantitative methods for the analysis of organ function and their interactions. An analysis of changes in the major physiological variables with exercise will be used as an example of the integration of the major organs to compensate for stress. Prerequisite: BME 502

BME 504   Medical Instrumentation and Imaging   (3 - 3 - 0)

Imaging plays an important role in both clinical and research environments. This course presents both the basic physics together with the practical technology associated with such methods as X-ray computed tomography (CT), magnetic resonance imaging (MRI), functional MRI (f-MRI) and spectroscopy, ultrasonics (echocardiography, Doppler flow), nuclear medicine (Gallium, PET and SPECT scans) as well as optical methods such as bioluminescence, optical tomography, fluorescent confocal microscopy, two-photon microscopy and atomic force microscopy. Cross-listed with: CPE 585 Prerequisites: BME 306 and BME 322

BME 505   Biomaterials   (3 - 2 - 3)

Intended as an introduction to materials science for biomedical engineers, this course first reviews the materials properties relevant to the application to the human body. It goes on to discuss proteins, cells, tissues, and their reactions and interactions with foreign materials, as well as the degradation of these materials in the human body. The course then treats various implants, burn dressings, drug delivery systems, biosensors, artificial organs, and elements of tissue engineering. Laboratory exercises accompany the major topics discussed in class and are conducted at the same time. Cross-listed with: MT 505 Prerequisite: E 344 Corequisite: BME 306

BME 506   Biomechanics   (3 - 3 - 0)

This course reviews basic engineering principles governing materials and structures such as mechanics, rigid body dynamics, fluid mechanics and solid mechanics and applies these to the study of biological systems such as ligaments, tendons, bone, muscles, joints, etc. The influence of material properties on the structure and function of organisms provides an appreciation for the mechanical complexity of biological systems. Methods for both rigid body and deformational mechanics are developed in the context of bone, muscle, and connective tissue. Multiple applications of Newton's Laws of mechanical are made to human motion. Corequisite: BME 505

BME 515   Natural Polymers in Medicine   (3 - 0 - 3)

Natural polymers have shown tremendous potential in biomedical engineering applications over the past decades. With their exceptional properties, unique versatility, and biocompatibility, these polymers have been extensively used in tissue engineering, cardiovascular grafts, orthopedic grafts, dermatological dressing and grafts and drug delivery. In this course, we will introduce various types of natural polymers used in medicine, which will include: polysaccharides, polyesters, proteins/polypeptides, DNA, and RNA. In each category, we will explore the synthesis/extraction, chemical composition, properties, characterization techniques, processing methods and current medical applications. Limitations such as sustainability, FDA regulations, cost and performance will also be discussed. Students will be exposed to the future potential of these materials through extensive literature reviews, databases and assignments using simulation software. The semester will conclude with project at the end of the semester.

BME 520   Cardiopulmonary Mechancis   (3 - 3 - 0)

The heart and lungs are mechanically dynamic organs. This course will survey the principal mechanisms of mechanical cardiopulmonary function. In the lungs, topics will include pressure-volume curve analysis, surface tension effects, hypoxic pulmonary vasoconstriction and lung diseases such as neonatal respiratory distress, pulmonary edema, pulmonary hypertension and emphysema. In the cardiovascular system, topics will include the Frank-Starling mechanism, the myogenic response, the end-systolic pressure-volume response, cardiac oxygen consumption, ventricular-arterial coupling, shear stress effects on the vascular endothelium, and ventricular assist devices for Fontan and adult circulations. Prerequisites: BME 482 or BME 503, BME 506, and CH 381 or BIO 381

BME 556   Advanced Biomechanics   (3 - 3 - 0)

This course will provide students with a practical approach to current computational and experimental methods used in the field of biomechanics. The goal of the course will be to bridge the gap between the theoretical computations and the practical application of experimental techniques. Topics covered will include cartilage and muscle mechanics as well as the response of bone tissue to loading. The analysis of implants will also be covered. The course will conclude with analysis of human motion. Experiments will be associated with various topics to demonstrate practical applications of the theoretical concepts introduced. Students will be required to use statistical analysis software. Prerequisites: BME 505, BME 506, and knowledge of or courses in Differential Equations, Multivariable Calculus and Statistics.

BME 557   Sensory Systems I   (3 - 3 - 0)

The Sensory Systems I course will focus on speech, audition, and vision systems. Students will begin with a review of system principles including sampling, filtering, analog to digital conversion (ADC), spectral (Fourier) analysis and transfer functions. The second topic will cover the audio spectrum and properties of sound as they relate to both speech and hearing. The course will then cover basic anatomy and physiology of the larynx, ear, and eye. Students will participate in two types of Labs for each of the three topics. Sensory Labs are designed to enhance the student's knowledge of sound production, auditory response and image processing. Reverse Engineering (RE) Labs utilizing existing speech, hearing, and vision enhancement products will be conducted as well. Prerequisites: E 245, BME 306, and BME 482

BME 558   Introduction to Brain-Machine Interfaces   (3 - 3 - 0)

This course aims for understanding the emerging field of Brain Machine Interfaces (BMI). After the completion of this course the students will have working knowledge of what BMIs are, how they are designed, implemented and tested. The core modules of BMI are data acquisition, decoding and application. Each of these modules will be expanded in detail. A common midterm project will be assigned to all the students. Then the students are expected to select a specialized topic, do a final project and write a term paper towards the final week. This course serves as an introduction to this emerging field of BMIs. This can serve both undergraduate seniors and graduate students.

BME 560   Movement Control Rehabilitation   (3 - 3 - 0)

Effective strategies for movement rehabilitation must consider several underlying factors for each unique clinical case. These factors include: (1) the sensorimotor mechanisms causing movement dysfunction, (2) the residual capabilities of each person, and (3) the technological platform available to execute clinical objectives. In this course, the clinical movement disorders that will be discussed include spinal cord injury, orthopaedic trauma (from soft tissue tears to limb amputations), stroke, and Parkinson's disease. The modes of rehabilitation to be evaluated fall across the spectrum from surgical intervention, strength and coordination training, use of assistive devices, and feedback control principles for advanced human-machine interfaces such as neuro-prostheses and powered exoskeletons. Students will be exposed to advanced concepts of neuromuscular physiology and biomechanical assessment. Learning materials will include lecture presentations, literature reviews, building experimental databases, and assignments using simulation software. The course will conclude with a final project that includes a research proposal and executing a related pilot experiment primarily through simulation. Prerequisites: BME 506 or equivalent.

BME 580   Biomedical Instrumentation and Measurements   (3 - 3 - 0)

This course introduces biomedical engineering principles, techniques, design & application of medical instrumentation. This course deals with the sensors, electrodes and analog integrated circuits to process physiological signals in a way that it can be used further for various diagnostic, therapeutic and surgical applications. It also introduces matrix laboratory and LabVIEW software to measure, record and monitor physiological signals. The course includes a bioinstrumentation lab where students gain hands on experience with the use of sensors, electrodes, filters, microcontrollers and circuits to acquire, modify and display various physiological signals. Students are graded based on the performance in homework assignments, lab assignments and midterm & final exams. Prerequisites: BME 460, BME 423

BME 600   Strategies and Principles of Biomedical Design   (3 - 3 - 0)

A successful approach to product development and design in the field of medical technologies requires a highly interdisciplinary approach. This course reviews the regulations, protocols, and guidelines which must be met in each discipline, and describes how these issues are inter-related and how the affect design and product development. Marketing, Regulatory, IP and Clinical aspects are all considered in the technical aspects of design.

BME 601   Advanced Biomedical Engineering Lab   (3 - 3 - 6)

One of the distinguishing features of biomedical engineers is the ability to make and interpret measurements on living systems. One of the major objectives of advanced laboratory training is to provide experience in selecting appropriate measurement and analysis tools that will advance hypothesis driven and translational research and development. This laboratory serves these dual purposes. Students are introduced to techniques for measurements at the cellular, organ and systems levels. Students will then use these techniques to: a) formulate hypotheses, design experiments using the tools provided, make appropriate measurements, analyze the data an determine if the data do or do not support their hypotheses; b) make measurements that facilitate the design and manufacture of devices in terms of materials properties, fatigue and failure modes. Each student will keep a laboratory notebook. Prerequisites: BME 505, BME 503

BME 602   Principles of Tissue Engineering   (3 - 3 - 0)

This course is an introduction to the field of Tissue Engineering. It is rapidly emerging as a therapeutic approach to treating damaged or diseased tissues in the biotechnology industry. In essence, new and functional living tissue can be fabricated using living cells combined with a scaffolding material to guide tissue development. Such scaffolds can be synthetic, natural, or a combination of both. This course will cover the advances in the field of cell biology, molecular biology, material science and their relationship towards developing novel 'tissue engineered' materials. Cross-listed with: NANO 602

BME 603   Topics in Biological Transport   (3 - 3 - 0)

The engineering applications of biological transport phenomena are important considerations in basic research related to molecules, organelles, cell and organ function; the design and operation of devices such as filtration units for kidney dialysis, high density cell culture and biosensors; and applications including drug and gene delivery, biological signal transduction and tissue engineering. This course develops the fundamental principles of transport processes, the mathematical expression of these principles and the solution of transport equations, along with characterization of composition, and function of living systems to which they are applied.

BME 640   Intro to Clinical Research   (3 - 3 - 0)

This course will introduce students to various aspects of clinical research, i.e. research with human subjects, including clinical research methods, protocols, governance, study designs, as well as subject management and protection, bioethics, and biostatics. It is anticipated that students are familiar with biomedical design, biomaterials and biomechanics.

BME 650   Advanced Biomaterials   (3 - 3 - 0)

Upon completion of this course, students will be able to demonstrate an understanding of the major classes of engineering materials, their principle properties and design requirements that serve as both the basis for materials selection as well as for the ongoing development of new materials. This course is substantially differentiated from introductory materials courses by its very specific focus on material whose use puts them in direct contact with physiological systems. Thus the course begins with brief sections on inflammatory response, thrombosis, infection and device failure. It then concentrates on developing the fundamental material science and engineering concepts underlying the structure-property relationships in both synthetic and natural polymers, metals and alloys, and ceramics relevant to in vivo medial-device technology. Cross-listed with: NANO 650

BME 655   Principles of Multiscale Biosystems Development and Integration   (3 - 3 - 0)

This course extends concepts present in tissue engineering, biotransport and biomaterial to develop design principles for generating tissue and organs in-vitro. The processes which cells integrate proteins and extracellular matrix to form functioning organ systems are developed. The principles of bioreactor design are sued to analyze and design in-vitro systems for growing functioning tissue and organs for use as prostheses. Principles of Scale-up to organs of different size are discussed. Design issues and limitations for extension of these principles to multi-organ systems are illustrated.

BME 665   Pathophysiology   (3 - 3 - 0)

Pathophysiology describes changes in physiology resulting in disease or injury. A solid understanding of normal physiology is necessary before attempting the study of abnormal situations. The course emphasizes the "mechanistic" approach to pathophysiology, i.e., A-B-C, rather that the symptom-diagnosis-treatment approach. Multiple examples, case studies and procedural videos are presented with a discussion of what they do well and where improvements can be made. Prerequisites: CH 583 or BME 482 or BME 503 or BIO 583

BME 675   Nanomedicine   (3 - 3 - 0)

This course will provide a comprehensive introduction to the rapidly developing field of nanomedicine, and discuss the application of nanoscience and nanotechnology in medicine such as in diagnosis, imaging and therapy, surgery and drug delivery. Cross-listed with: NANO 675 Prerequisite: NANO 600

BME 685   Nanobiotechnology   (3 - 3 - 0)

This course describes the application of nano- and micro-fabrication methods to build tools for exploring the mysteries of biological systems. It is a graduate-level course that will cover the basics of biology and the principles and practice of nano- and micro-fabrication techniques with a focus on applications in biomedical and biological research. Cross-listed with: NANO 685 Prerequisite: NANO 600

BME 690   Cellular Signal Transduction   (3 - 3 - 0)

This advanced course coves the mechanism and biological role of signal transduction in mammalian cells. Topics included are exracellular regulatory signals, intercellular signal transduction pathways, role of tissue context in the function of cellular regulation, and example of biological processes controlled by specific cellular signal transduction pathways. Cross-listed with: BIO 690 Prerequisites: CH 381, CH 484 or CH 381, CH 484

BME 700   Seminar in Biomedical Engineering   (0 - -)

Lectures by department faculty, guest speakers, and doctoral students on recent research.

BME 701-702   Selected Topics in Biomedical Engineering I-II   (3 - 3 - 0)

Selected topics of current interest in the field of biomedical engineering will be treated from an advanced point of view.

BME 702   Curriculum Practical Training   (1 - 0 - 0)

International graduate students may arrange an internship or paying position off campus and receive Curricular Practical Training (CPT) credit via this course provided that the course constitutes and integral part of their educational program. Students must maintain their full time status while receiving CPT. Prior approval of the program director is required for enrollment. To justify enrollment, the student must have a concrete commitment from a specific employer for a specific project, and must provide to the program director for his/her approval a description of the project plus a statement from the employer that he/she intends to employ the student. This information must be provided to the program director with sufficient advance notice so that the program director has time to review the materials and determine if the project is appropriate. During the semester, the student must submit written progress reports. At the end of the semester, the student must submit for grading a written report that describes his/her activities during that semester, even if the activity remains ongoing. This is a one-credit course that may be repeated up to a total of three credits.

BME 800   Special Problems in Biomedical Engineering (ME)   (1 to 3 - -)

One to three credits. Limit of three credits for the degree of Master of Engineering (Biomedical).

BME 801   Special Problems in Biomedical Engineering (PHD)   (1 to 3 - -)

One to three credits. Limit of three credits for the doctoral degree in Biomedical Engineering.

BME 810   Special Topics in Biomedical Engineering   (1 to 3 - -)
One to three credits. Limit of three credits. Must arrange with instructor.

BME 900   Masters Thesis in Biomedical Engineering   (9 - 0 - 0)
For the degree of Master of Engineering (Biomedical). Nine credits with departmental approval

BME 901   Biomedical Engineering Project (ME)   (1 to 9 - -)
For the degree of Master of Engineering (Biomedical). One to nine credits with departmental approval.

BME 960   Research in Biomedical Engineering   (- -)
Original research leading to the doctoral dissertation. Hours and credits to be arranged.

Department of Chemistry and Chemical Biology

FACULTY

PETER TOLIAS
DEPARTMENT CHAIR

Sesha Alluri, Ph.D.
Lecturer, Chemistry

Athula Attygalle, Ph.D.
Research Professor, Chemistry

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Senior Lecturer, Biology and Chemical Biology

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Anju Sharma, Ph.D.
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Peter Tolias, Ph.D.
Professor and Chair,
Director of the Center for Healthcare Innovation

Hongjun Wang, Ph.D.
Professor, Chemical Biology and Biomedical Engineering

Kenny Wong, Ph.D.
Teaching Associate Professor, Biology
Program Director, Biology

Yong Zhang, Ph.D.
Professor, Chemistry

UNDERGRADUATE PROGRAMS

Chemistry

Chemistry is a field of study which seeks to describe the properties, composition, structure and process of formation of all things that make up the universe. Chemistry, which is commonly known as the central science, bridges the gap between the life sciences and physical sciences.

The Stevens Chemistry program is based on a solid foundation in the major core areas of chemistry which includes organic chemistry, analytical chemistry, physical chemistry, inorganic chemistry and biochemistry. Additional courses in advanced chemistry are available in those areas in which Stevens has unique strengths, such as polymer chemistry, natural products, medicinal chemistry, computational chemistry, and instrumental analysis. Research is strongly encouraged due to its importance in preparing for a career in chemistry; it also helps develop independence in solving open-ended problems.

The Stevens program prepares students for career opportunities in diverse fields including pharmaceuticals, petroleum, polymers and plastics, paints and adhesives, electronic materials, waste treatment, agricultural chemistry, and foods and fragrances, in addition to many other industries. Chemists can be involved in research where they either create new knowledge or synthesize new chemicals. They can also choose fields in quality control where testing and analysis are crucial. Chemists are employed in hospitals, as well as clinical, environmental control, and criminology laboratories. Chemistry also occupies a pivotal role in the high-technology areas of bioinformatics, biotechnology, materials technology, ceramics, polymers, and electronic materials. The Stevens program also prepares students for success in graduate programs in chemistry and professional schools.

The Bachelor of Science in Chemistry is certified by the American Chemical Society (ACS).

Chemistry Curriculum

Term I

Course #	Course Name	Lecture	Lab	Study	Credit
PEP 111	Mechanics	3	0	6	3
CS 105	Introduction to Scientific Computing[1]	2	2	6	3
CH 115	General Chemistry I	3	0	6	3
CH 117	General Chemistry Laboratory I	0	3	1	1
MA 121; MA 122	Differential Calculus; Integral Calculus	4	0	8	4
CAL 103	Writing And Communications Colloquium	3	0	6	3
	Total	**15**	**5**	**33**	**17**

Term II

Course #	Course Name	Lecture	Lab	Study	Credit
PEP 112	Electricity and Magnetism	3	0	6	3
CH 116	General Chemistry II	3	0	6	3
CH 118	General Chemistry Laboratory II	0	3	1	1
BIO 281	Biology and Biotechnology	3	0	6	3
MA 123; MA 124	Series, Vectors, Functions, and Surfaces; Calculus of Two Variables	4	0	8	4
CAL 105	CAL Colloquium: Knowledge, Nature, Culture	3	0	6	3
	Total	**17**	**3**	**33**	**17**

Term III

Course #	Course Name	Lecture	Lab	Study	Credit
Hum	Humanities[3]	3	0	6	3
MA 221	Differential Equations	4	0	8	4
BIO 381	Cell Biology	3	3	7	4
PEP 221	Physics Lab I for Scientists	0	3	1	1
CH 243	Organic Chemistry I	3	0	6	3
CH 245	Organic Chemistry Laboratory I	0	4	0	1
PE 200	Physical Education I	0	2	0	0
	Total	**13**	**12**	**28**	**16**

Term IV

Course #	Course Name	Lecture	Lab	Study	Credit
Hum	Humanities[3]	3	0	6	3
MA 227	Multivariable Calculus	3	0	6	3
CH 321	Thermodynamics	3	0	6	3
CH 244	Organic Chemistry II	3	0	6	3
PEP 222	Physics Lab II for Scientists	0	3	1	1
CH 246	Organic Chemistry Laboratory II	0	4	0	1
CH 301	Professional Ethics in Chemical & Scientific Research	1	0	1	1
PE 200	Physical Education II	0	2	0	0
	Total	**15**	**9**	**31**	**15**

Term V

Course #	Course Name	Lecture	Lab	Study	Credit
Hum	Humanities[3]	3	0	6	3
CH 580	Biochemistry I – Cellular Metabolism and Regulation	3	0	6	3
CH 362	Instrumental Analysis I - Spectroscopy and Chromatography	3	4	8	4
CH 550	Spectra and Structure	3	0	6	3
BT 244	Microeconomics[2]	3	0	6	3
PE 200	Physical Education III	0	2	0	0
	Total	**15**	**6**	**32**	**16**

Term VI

Course #	Course Name	Lecture	Lab	Study	Credit
Hum	Humanities[3]	3	0	6	3
PEP 242	Modern Physics	3	0	6	3
MA 222	Probability and Statistics	3	0	6	3
CH 461	Instrumental Analysis II - Electrochemistry	3	4	8	4
CH 581	Biochemistry II – Biomolecular Structure and Function	3	0	6	3
PE 200	Physical Education IV	0	2	0	0
	Total	**15**	**6**	**32**	**16**

Term VII

Course #	Course Name	Lecture	Lab	Study	Credit
Hum	Humanities[3]	3	0	6	3
G.E.	General Elective[4]	3	0	6	3
T.E.	Technical Elective[5]	3	0	6	3
CH 496 Or CH 498	Chemistry Project I Or Chemical Research I	0	8	4	3
CH 421	Chemical Dynamics	3	4	6	4
	Total	**12**	**12**	**28**	**16**

Term VIII

Course #	Course Name	Lecture	Lab	Study	Credit
Hum	Humanities[3]	3	0	6	3
CH 412	Inorganic Chemistry I	3	4	8	4
CH 582	Biophysical Chemistry	3	0	6	3
CH 497 Or CH 499	Chemistry Project II Or Chemical Research II	0	8	4	3
CH 322	Theoretical Chemistry	3	0	6	3
	Total	**12**	**12**	**30**	**16**

(1) Students may choose CS 115, Intro. to Computer Science, in place of CS 105.

(2) Students may choose BT 243, Macroeconomics, in place of BT 244.

(3) Humanities requirements can be found on pages 599-600.

(4) General Education Electives: Chosen by the student, can be any approved 3 or 4 credit course needed towards a minor, major concentration, research, independent study, language course or a course taken during an international experience.

(5) Technical elective: can be selected from available CH and BIO 4XX and 5XX.

Chemical Biology

Chemical Biology is the application of chemistry to the understanding and utilization of biological phenomena. Chemical biology represents an approach to understanding biology through the underlying chemical interactions of biological macromolecules and provides students with the essential tools to reveal the logic of how biological systems operate as well as engineering changes in those systems. Stevens pioneered this field with establishing the first undergraduate program in chemical biology in the late 1970s.

By developing a chemical understanding of biological systems, chemical biologists can develop quantitative descriptions of complex biological phenomena, predict outcomes of biological systems, and contribute to the new field of synthetic biology wherein the chemistry of life is expanded using existing scientific principles that nature has not yet employed.

The Stevens Program in Chemical Biology combines a complete education in chemistry with additional mathematics and physics training to ensure a solid foundation in quantitative physical sciences and a set of biology courses that introduce the key elements of cellular, molecular, and physiological biology. Thus, the chemical biology program is effective in launching students onto careers in chemistry, biochemistry, biotechnology, forensic science or biology. This program also allows students to prepare for further training at the Masters or PhD level in a wide array of programs in chemical or biological sciences as well as gain the training necessary for admission in professional schools in medicine, dentistry, veterinary medicine or other health professions.

The Bachelor of Science in Chemical Biology is certified by the American Chemical Society if the students choose to take two additional courses in the degree program which includes courses in Inorganic Chemistry, which serves a general elective, and Professional Ethics.

Beyond the traditional chemical biology curriculum, two specialized tracks have been identified within the chemical biology program: Bioanalytical Chemistry and Bioinformatics.

Chemical Biology Curriculum

Term I

Course #	Course Name	Lecture	Lab	Study	Credit
CH 115	General Chemistry I	3	0	6	3
CH 117	General Chemistry Laboratory I	0	3	1	1
CS 105	Introduction to Scientific Computing[1]	2	2	6	3
MA 121; MA 122	Differential Calculus; Integral Calculus	4	0	8	4
PEP 111	Mechanics	3	0	6	3
CAL 103	Writing And Communications Colloquium	3	0	6	3
	Total	**15**	**5**	**33**	**17**

Term II

Course #	Course Name	Lecture	Lab	Study	Credit
CH 116	General Chemistry II	3	0	6	3
CH 118	General Chemistry Laboratory II	0	3	1	1
BIO 281	Biology and Biotechnology	3	0	6	3
MA 123; MA 124	Series, Vectors, Functions, and Surfaces; Calculus of Two Variables	4	0	8	4
PEP 112	Electricity and Magnetism	3	0	6	3
CAL 105	CAL Colloquium: Knowledge, Nature, Culture	3	0	6	3
	Total	**16**	**3**	**33**	**17**

Term III

Course #	Course Name	Lecture	Lab	Study	Credit
Hum	Humanities[5]	3	0	6	3
MA 221	Differential Equations	4	0	8	4
BIO 381	Cell Biology	3	3	7	4
CH 243	Organic Chemistry I	3	0	6	3
CH 245	Organic Chemistry Laboratory I	0	4	0	1
PEP 221	Physics Lab I for Scientists	0	3	1	1
PE 200	Physical Education I	0	2	0	0
	Total	**13**	**12**	**28**	**16**

Term IV

Course #	Course Name	Lecture	Lab	Study	Credit
Hum	Humanities[5]	3	0	6	3
BIO 382	Biological Systems	3	3	7	4
CH 321	Thermodynamics	3	0	6	3
CH 244	Organic Chemistry II	3	0	6	3
CH 246	Organic Chemistry Laboratory II	0	4	0	1
PEP 222	Physics Lab II for Scientists	0	3	1	1
CH 301	Professional Ethics in Chemical & Scientific Research	1	0	1	1
PE 200	Physical Education II	0	2	0	0
	Total	**12**	**12**	**26**	**16**

Term V

Course #	Course Name	Lecture	Lab	Study	Credit
Hum	Humanities[5]	3	0	6	3
BIO 484	Introduction to Molecular Genetics	3	3	7	4
CH 580	Biochemistry I – Cellular Metabolism and Regulation	3	0	6	3
CH 362	Instrumental Analysis I - Spectroscopy and Chromatography	3	4	8	4
BT 244	Microeconomics[2]	3	0	6	3
PE 200	Physical Education III	0	2	0	0
	Total	**15**	**9**	**33**	**17**

Term VI

Course #	Course Name	Lecture	Lab	Study	Credit
Hum	Humanities[5]	3	0	6	3
PEP 242	Modern Physics	3	0	6	3
E 243	Probability and Statistics for Engineers	3	0	6	3
CH 461	Instrumental Analysis II - Electrochemistry	3	4	8	4
CH 581	Biochemistry II – Biomolecular Structure and Function	3	0	6	3
PE 200	Physical Education IV	0	2	0	0
	Total	**15**	**6**	**32**	**16**

Term VII

Course #	Course Name	Lecture	Lab	Study	Credit
Hum	Humanities[5]	3	0	6	3
BIO 583	Physiology	3	0	6	3
CH 421	Chemical Dynamics[6]	3	4	6	4
CH 496 Or CH 498	Chemistry Project I Or Chemical Research I	0	8	4	3
G.E.	General Elective	3	0	6	3
	Total	**12**	**12**	**28**	**16**

Term VIII

Course #	Course Name	Lecture	Lab	Study	Credit
Hum	Humanities[5]	3	0	6	3
CH 582	Biophysical Chemistry	3	0	6	3
T.E.	Technical Elective[4]	3	0	6	3
CH 497 Or CH 499	Chemistry Project II Or Chemical Research II	0	8	4	3
G.E.	General Elective[3]	3	0	6	3
	Total	**12**	**8**	**28**	**15**

(1) Students may choose CS 115, Intro. to Computer Science, in place of CS 105. The Bioinformatics Concentration requires CS 115 in place of CS 105.
(2) Students may choose BT 243, Macroeconomics, in place of BT 244.
(3) CH 412 required for ACS certification and only offerred in Spring semester
(4) BIO 486 Immunology is suggested but available elective courses can be selected from CH or BIO 3XX, 4XX, and 5XX courses.
(5) Humanities requirements can be found on pages 599-600.
(6) CH 421 can be taken in term V instead of term VII.

Bioinformatics Concentration

New and powerful techniques have been developed for determining the structures of biological molecules and manipulating biomolecular sequences which results in large amounts of data. Bioinformatics makes use of mathematical and computer science techniques to process this data so it can be used for further scientific advances. The Stevens Bioinformatics track is built on the foundations of chemical biology. Students elect CS115 as an introduction to computing in the freshman year in place of CS105. After the first two years in the Chemical Biology Program, the Bioinformatics student begins replacing certain electives with mathematics and computer science courses. The Stevens Bioinformatics track concentrates on giving students the ability to contribute to building the software and analytical infrastructure of the field.

Bioinformatics Curriculum

Term V

Course #	Course Name	Lecture	Lab	Study	Credit
CS 135	Discrete Structures	3	2	8	4
CS 284	Data Structures[1]	2	2	8	4
Hum	Humanities[3]	3	0	6	3
CH 580	Biochemistry I – Cellular Metabolism and Regulation	3	0	6	3
CH 362	Instrumental Analysis I - Spectroscopy and Chromatography	3	4	8	4
	Total	**14**	**8**	**36**	**18**

Term VI

Course #	Course Name	Lecture	Lab	Study	Credit
Hum	Humanities[3]	3	0	6	3
PEP 242	Modern Physics	3	0	6	3
MA 222	Probability and Statistics	3	0	6	3
CH 461	Instrumental Analysis II - Electrochemistry	3	4	8	4
CH 581	Biochemistry II – Biomolecular Structure and Function	3	0	6	3
	Total	**15**	**4**	**32**	**16**

Term VII

Course #	Course Name	Lecture	Lab	Study	Credit
Hum	Humanities[3]	3	0	6	3
BT 244	Microeconomics	3	0	0	3
CS 385	Algorithms	4	0	8	4
BIO 484	Introduction to Molecular Genetics	3	3	7	4
BIO 583	Physiology	3	0	6	3
CH 421	Chemical Dynamics[4]	3	4	6	4
	Total	**19**	**7**	**33**	**21**

Term VIII

Course #	Course Name	Lecture	Lab	Study	Credit
Hum	Humanities[3]	3	0	6	3
CS 442	Database Management Systems	3	0	6	3
CH 582	Biophysical Chemistry	3	0	6	3
BIO 368	Fundamentals of Computational Biology[3]	3	0	6	3
BIO 486	Immunology	3	0	6	3
CH 497	Chemistry Project II[2]	0	8	4	3
	Total	**15**	**8**	**34**	**18**

(1) CS 115 must have been chosen in Freshman year
(2) Project/Research can either be a project (CH 496/497) or thesis (CH 498/499) and can be done either in the junior/senior or senior year.
(3) Humanities requirements can be found on pages 599-600.
(4) CH 421 can be taken in term V instead of term VII.

Bioanalytical Chemistry Concentration

Biological systems are characterized by presence of large, complex biological molecules arrayed as collections of genes, transcripts, proteins, carbohydrates, lipids, and associated metabolites. Whereas a comprehensive chemical definition of biological systems was once beyond the realm of possibility, we can now envision the treatment of biological cells, tissues, and even complete organisms in terms of their chemical composition and interactions. Bioanalytical chemistry comprises the techniques and instrumentation necessary to separate and analyze the chemical composition of biological systems. Bioanalytical chemists have already made tremendous contributions in the areas of genomics, gene expression analysis, and disease gene/protein identification, as well as drug discovery and forensic science. In addition to further contributions in these fields, bioanalytical chemists will be increasingly needed to improve the practice of medicine through chemically-defined diseases states, and to protect our general public through surveillance for illicit drugs, explosives, and pathogens. The track in bioanalytical chemistry is built on the foundations of chemical biology. After the first two years in the regular chemical biology program, the bioanalytical chemistry student begins concentrating on analytical techniques relevant to biological macromolecules such as mass spectrometry, magnetic resonance imaging, flow cytometry, and genome and transcriptome array analysis.

Bioanalytical Chemistry Curriculum

Term V

Course #	Course Name	Lecture	Lab	Study	Credit
Hum	Humanities	3	0	6	3
CH 560	Spectra and Structure	3	0	6	3
CH 362	Instrumental Analysis I - Spectroscopy and Chromatography	3	4	8	4
CH 580	Biochemistry I – Cellular Metabolism and Regulation	3	0	6	3
CH 421	Chemical Dynamics[4]	3	4	6	4
BIO 484	Introduction to Molecular Genetics	3	3	7	4
	Total	**18**	**11**	**39**	**21**

Term VI

Course #	Course Name	Lecture	Lab	Study	Credit
Hum	Humanities[5]	3	0	6	3
MA 222	Probability and Statistics[3]	3	0	6	3
PEP 242	Modern Physics	3	0	6	3
CH 461	Instrumental Analysis II - Electrochemistry	3	4	8	4
CH 581	Biochemistry II – Biomolecular Structure and Function	3	0	6	3
	Total	**15**	**4**	**32**	**16**

Term VII

Course #	Course Name	Lecture	Lab	Study	Credit
Hum	Humanities	3	0	6	3
BT 244	Microeconomics	3	0	0	3
CH 662	Separation Methods in Analytical and Organic Chemistry[1]	3	0	6	3
CH 666	Modern Mass Spectrometry[1]	3	4	6	4
CH 496 Or CH 498	Chemistry Project I[2] Or Chemical Research I	0	8	4	3
	Total	**12**	**12**	**22**	**16**

Term VIII

Course #	Course Name	Lecture	Lab	Study	Credit
Hum	Humanities[5]	3	0	6	3
CH 660	Advanced Instrumental Analysis[1]	3	0	0	3
CH 412	Inorganic Chemistry I	3	4	8	4
CH 582	Biophysical Chemistry	3	0	6	3
CH 497 Or CH 499	Chemistry Project II[2] Or Chemical Research II	0	8	4	3
	Total	**12**	**12**	**24**	**16**

(1) Requires advisor' approval.
(2) Project/Research can be either a project (CH 496/497) or thesis (CH 498/499) and can be done either in the junior/senior year or senior year.
(3) E243 Engineering Statistics may be substituted.
(4) CH 421 can be taken in term VII instead of term V.
(5) Humanities requirements can be found on pages 599-600.

Biology

Stevens instituted a major in biology in Fall of 2015. The biology program reflects Stevens' philosophy that life sciences are best approached with a strong foundation in chemical and physical sciences. As a result, the Biology and Chemical Biology Programs share the same curriculum through three semesters. The principle difference between the programs relates to the amount of chemistry required in the advance undergraduate curriculum. In the biology major, additional upper level courses are dedicated to expanding the breadth and depth of exposure to biology topics and additional technical and general electives encourage pairing of the biology curriculum with the pursuit of minor fields of study, graduate certificates, double majors or master's degrees in other disciplines. Like the chemical biology curriculum, the biology curriculum will provide students with a strong background in chemistry, physics and mathematics that will ensure that students will have the ability to understand and engineer life science systems.

Graduates of the biology program at Stevens will be well prepared to pursue employment in biomedical science, biotechnology, or clinical research laboratories, to continue their education at the master's or doctoral level in a wide array of programs in biological sciences, to gain admission to professional training in medicine, dentistry, veterinary medicine, physician assistant, physical therapy, or other health professions, or to combine their knowledge of life sciences with employment in other areas of employment such as scientific publishing, law, business, or healthcare.

Biology Curriculum

Term I

Course #	Course Name	Lecture	Lab	Study	Credit
CH 115	General Chemistry I	3	0	6	3
CH 117	General Chemistry Laboratory I	0	3	1	1
MA 121 and	Differential Calculus	4	0	8	2
MA 122	Integral Calculus				2
PEP 111	Mechanics	3	0	6	3
CS 105	Introduction to Scientific Computing	2	2	6	3
CAL 103	Writing And Communications Colloquium	3	0	6	3
	Total	**15**	**5**	**33**	**17**

Term II

Course #	Course Name	Lecture	Lab	Study	Credit
CH 116	General Chemistry II	3	0	6	3
CH 118	General Chemistry Laboratory II	0	3	1	1
MA 123 and	Series, Vectors, Functions, and Surfaces	4	0	8	2
MA 124	Calculus of Two Variables				2
PEP 112	Electricity and Magnetism	3	0	6	3
BIO 281	Biology and Biotechnology	3	0	6	3
CAL 105	CAL Colloquium: Knowledge, Nature, Culture	3	0	6	3
	Total	**16**	**3**	**33**	**17**

Term III

Course #	Course Name	Lecture	Lab	Study	Credit
CH 243	Organic Chemistry I	3	0	6	3
CH 245	Organic Chemistry Laboratory I	0	4	0	1
MA 221	Differential Equations	4	0	8	4
BIO 381	Cell Biology	3	3	7	4
PEP 221	Physics Lab I for Scientists	0	3	1	1
Hum	Humanities[2]	3	0	6	3
PE 200	Physical Education I	0	2	0	0
	Total	**13**	**12**	**28**	**16**

Term IV

Course #	Course Name	Lecture	Lab	Study	Credit
CH 244	Organic Chemistry II	3	0	6	3
CH 246	Organic Chemistry Laboratory II	0	4	0	1
E 243	Probability and Statistics for Engineers[1]	3	0	6	3
BIO 382	Biological Systems	3	3	7	4
PEP 222	Physics Lab II for Scientists	0	3	1	1
Hum	Humanities[2]	3	0	6	3
CH 301	Professional Ethics in Chemical and Scientific Research	1	0	0	1
PE 200	Physical Education II	0	2	0	0
	Total	**13**	**12**	**26**	**16**

Term V

Course #	Course Name	Lecture	Lab	Study	Credit
CH 362	Instrumental Analysis I - Spectroscopy and Chromatography	3	4	8	4
BIO 484	Introduction to Molecular Genetics	3	3	7	4
BT 243 Or BT 244	Macroeconomics Or Microeconomics	3	0	6	3
CH 580	Biochemistry I - Cellular Metabolism and Regulation	3	0	6	3
Hum	Humanities[2]	3	0	6	3
PE 200	Physical Education III	0	2	0	0
	Total	**15**	**9**	**33**	**17**

Term VI

Course #	Course Name	Lecture	Lab	Study	Credit
CH 461 Or CH 321	Instrumental Analysis II - Electrochemistry Or Thermodynamics	3	4	8	4
CH 581	Biochemistry II - Biomolecular Structure and Function	3	0	6	3
T.E.	Technical Elective[3]	3	0	6	3
G.E.	General Elective[4]	3	0	6	3
Hum	Humanities[2]	3	0	6	3
PE 200	Physical Education IV	0	2	0	0
	Total	**15**	**6**	**32**	**16**

Term VII

Course #	Course Name	Lecture	Lab	Study	Credit
T.E.	Technical Elective[3]	3	0	6	3
CH 496 Or CH 498	Chemistry Project I Or Chemical Research I	0	8	4	3
T.E.	Technical Elective[3]	3	0	6	3
G.E.	General Elective[4]	3	0	6	3
Hum	Humanities[2]	3	0	6	3
	Total	**12**	**8**	**28**	**15**

Term VIII

Course #	Course Name	Lecture	Lab	Study	Credit
T.E.	Technical Elective[3]	3	0	6	3
CH 497 Or CH 499	Chemistry Project II Or Chemical Research II	0	8	4	3
PEP 242	Modern Physics	3	0	6	3
G.E.	General Elective[4]	3	0	6	3
Hum	Humanities[2]	3	0	6	3
	Total	**12**	**8**	**28**	**15**

(1) MA 222 can be taken in place of E243.

(2) Humanities requirements can be found on pages 599-600.

(3) Biology Technical Electrive can be selected from available CH. Technical electives can be selected from CH and BIO.

(4) General Education Electives - Chosen by the student can be any approved 3 or 4 credit course used towards a minor, major concentration, research, independent study, language courses, or a course taken during international experience.

Accelerated Program in Medicine

Enrolling in the Accelerated Program in Medicine requires admission to both Stevens and the professional school at the time of the initial undergraduate application. Please contact Undergraduate Admissions for more information. If you are pursuing the special combined degree program in medicine, your undergraduate curriculum will include core courses common to both the Chemical Biology and Biology Programs. The completion of this core within three years at Stevens requires adoption of a heavy course load, and a minimum GPA and score on the Medical College Admissions Test (MCAT) to ensure matriculation to the professional training program. The first year of the medical program transfers as credit for completion of the B.S. degree, so the undergraduate degree is awarded after four years.

Accelerated Program in Medicine Curriculum

Term I

Course #	Course Name	Lecture	Lab	Study	Credit
CH 115	General Chemistry I	3	0	6	3
CH 117	General Chemistry Laboratory I	0	3	1	1
CS 105	Introduction to Scientific Computing	2	2	6	3
MA 121 and MA 122	Differential Calculus Integral Calculus	4	0	8	2 2
PEP 111	Mechanics	3	0	6	3
CAL 103	Writing And Communications Colloquium	3	0	6	3
	Total	**15**	**5**	**33**	**17**

Term II

Course #	Course Name	Lecture	Lab	Study	Credit
CH 116	General Chemistry II	3	0	6	3
CH 118	General Chemistry Laboratory II	0	3	1	1
BIO 281	Biology and Biotechnology	3	0	6	3
MA 123 and MA 124	Series, Vectors, Functions, and Surfaces Calculus of Two Variables	4	0	8	2 2
PEP 112	Electricity and Magnetism	3	0	6	3
CAL 105	CAL Colloquium: Knowledge, Nature, Culture	3	0	6	3
	Total	**16**	**3**	**33**	**17**

Term III

Course #	Course Name	Lecture	Lab	Study	Credit
HUM	Humanities[4]	3	0	6	3
MA 221	Differential Equations	4	0	8	4
BIO 381	Cell Biology	3	3	7	4
CH 243	Organic Chemistry I	3	0	6	3
CH 245	Organic Chemistry Laboratory I	0	4	0	1
PEP 221	Physics Lab I for Scientists	0	3	1	1
BT	Economics[2]	3	0	6	3
PE 200	Physical Education I	0	2	0	0
	Total	**16**	**12**	**34**	**19**

Term IV

Course #	Course Name	Lecture	Lab	Study	Credit
Hum	Humanities[4]	3	0	6	3
BIO 382	Biological Systems	3	3	7	4
CH 321	Thermodynamics	3	0	6	3
CH 244	Organic Chemistry II	3	0	6	3
CH 246	Organic Chemistry Laboratory II	0	4	0	1
PEP 222	Physics Lab II for Scientists	0	3	1	1
PE 200	Physical Education II	0	2	0	0
	Total	**12**	**12**	**26**	**15**

Term V

Course #	Course Name	Lecture	Lab	Study	Credit
Hum	Humanities[4]	3	0	6	3
Hum	Humanities[4]	3	0	3	3
CH 362	Instrumental Analysis I - Spectroscopy and Chromatography	3	4	8	4
CH 580	Biochemistry I – Cellular Metabolism and Regulation	3	0	6	4
BIO 484	Introduction to Molecular Genetics	3	3	7	4
PE 200	Physical Education III	0	2	0	0
	Total	**15**	**9**	**30**	**18**

Term VI

Course #	Course Name	Lecture	Lab	Study	Credit
Hum	Humanities[4]	3	0	6	3
Hum	Humanities[4]	3	0	3	3
PEP 242	Modern Physics	3	0	6	3
CH 461	Instrumental Analysis II - Electrochemistry	3	4	8	4
CH 581	Biochemistry II – Biomolecular Structure and Function	3	0	6	3
T.E.	Technical Elective[3]	3	0	6	3
PE 200	Physical Education IV	0	2	0	0
	Total	**18**	**6**	**35**	**19**

(1) Students may choose CS 115, Intro. to Computer Science, in place of CS 105.
(2) Economics can be either BT 243 (Macro) or BT 244 (Micro).
(3) CH 486 Immunology is suggested. Requires Instructor approval.
(4) Humanities requirements can be found on pages 599-600.

Minors

Chemistry

A minor in chemistry must include the following courses:

▸ CH 243, CH 245 Organic Chemistry I + Lab;

▸ CH 244, CH 246 Organic Chemistry II + Lab.;

▸ CH 421 Chemical Dynamics,

▸ CH 362 Instrumental Analysis I;

▸ CH 412 Inorganic Chemistry

▸ CH 580 Biochemistry I

The following are prerequisites needed to undertake the minor program:

▸ CH 115, CH 117 General Chemistry I + Lab;

▸ CH 116, CH 118 General Chemistry II + Lab;

▸ CH 321

Or

▸ E 234

This sequence meets the American Chemical Society guidelines for a Minor in Chemistry. NOTE: The minor in Chemistry is not available to majors in Chemical Biology.

For more information regarding the School of Engineering and Science requirements for minor programs, please see the Guidelines for Science Minor Programs on page 82.

Chemical Biology

A minor in chemical biology includes at least the following courses:

▸ CH 243, CH 245 Organic Chemistry I + Lab.;

▸ CH 244, CH 246 Organic Chemistry II + Lab.;

▸ CH 421 Chemical Dynamics;

▸ BIO 381 Cell Biology;

▸ BIO 382 Biological Systems;

▸ BIO 484 Introduction to Molecular Genetics;

▸ CH 580 Biochemistry I.

The following are prerequisites needed to undertake the minor program:

▸ CH 115, CH 117 General Chemistry I + Lab;

▸ CH 116, CH 118 General Chemistry II + Lab;

▸ BIO 281 Biology and Biotechnology;

▸ CH 321

Or

▸ E 234

NOTE: The minor in Chemical Biology is not available to majors in Chemistry or Biology.

For more information regarding the School of Engineering and Science requirements for minor programs, please see the Guidelines for Science Minor Programs on page 82.

Biology

A minor in biology includes at least the following courses:

▸ BIO 281 Biology and Biotechnology

▸ BIO 381 Cell Biology;

▸ BIO 382 Biological Systems;

▸ BIO 484 Introduction to Molecular Genetics;

▸ Two other Biology Courses at the 300 level or higher

NOTE: The minor in Biology is not available to majors in Chemical Biology.

For more information regarding the School of Engineering and Science requirements for minor programs, please see the Guidelines for Science Minor Programs on page 82.

GRADUATE PROGRAMS

The Master of Science and Doctor of Philosophy degrees are offered in both chemistry and chemical biology. For admission to the graduate program in chemistry, applicants must have earned a B.A. or B.S. degree in Chemistry. Applicants with other degrees will be considered on a case by case basis. Admission to the chemical biology program requires either an undergraduate degree in chemistry with strong biology background or an undergraduate degree in biology with strong chemistry background.

For admission to the M.S. program in computational and medicinal chemistry for drug discovery, students must have completed a B.A. or B.S. in chemistry, chemical biology, biochemistry, or equivalent. Students should also have taken basic calculus and physics courses as part of their undergraduate degree and have a familiarity with computer programming. This program is for students interested in obtaining a fundamental knowledge of drug discovery and specifically computational and medicinal chemistry.

Awareness of recent developments in one's field is an important component of professional development. The department hosts seminars by visiting faculty in each of the disciplines. Finally, a measure of the success of a student's education is the ability to carry out original research. Either a thesis or a special research problem can be part of the master's program. Furthermore, students completing a Masters' or PhD thesis are required to present their results in a departmental seminar.

Throughout both the master's and doctoral degree program, the students are exposed to various methods and techniques for research. The department maintains instrumentation enabling atomic, molecular, cellular, and small animal studies. Instrumentation includes but is not limited to confocal and wide field fluorescence microscopy, PCR, fluorometry, double-beam spectrophotometry, polarimetry, circular dichroism, Fourier-transform infrared spectroscopy, nuclear magnetic resonance spectroscopy, mass spectrometry, gas and high performance liquid chromatography, motion capture, mechanical testing, 3D printing, and nanofiber synthesis. Other facilities at Stevens enable access to scanning and electron microscopy, atomic force microscopy, microfluidics, and a Class 100 clean room for nanofabrication.

Master of Science - Bioengineering

The M.S. in Bioengineering is tailored for students with a strong science background who would like the skills needed to develop materials and devices at the intersect ion of life science and engineering. This interdisciplinary program focuses on tissue engineering and regenerative medicine methods to improve healthcare. Our program builds on a foundation of molecular biology and chemistry while also adding elements of bioengineering design. For the Master of Science degree, students must successfully complete thirty graduate credits including 15 credits of core courses listed below. Students may elect to choose thesis (6-9 credits} or non-thesis options, depending on their professional goals. Students pursuing a thesis should make arrangements with an advisor within the first year at Stevens. Graduates of this program will be well positioned to obtain careers in pharmaceutical, biotechnology, and medical device companies in addition to biomedical research and regulatory institutions.

Core Courses in Bioengineering -15 credits

- ▸ BIO 687 Molecular Biology
- ▸ BIO 684 Molecular Biology Laboratory
- ▸ BME 504 Biomaterials
- ▸ BME 602 Principles of Tissue Engineering
- ▸ BME/BIO 690 Cellular Signal Transduction

Technical Elective Courses - 9 credits for non-thesis option, 6-9 credits for thesis option

- ▸ BIO 583 Physiology
- ▸ BIO 668 Computational Biology
- ▸ BIO 686 Immunology
- ▸ BIO 689 Cellular Biology Lab Techniques
- ▸ BIO 691 Introduction to Systems Biology
- ▸ BIO 695 Organelles
- ▸ BME 502 Physiology for Engineers I
- ▸ BME 503 Physiology for Engineers II
- ▸ BME 650 Advanced Biomaterials
- ▸ BME 665 Pathophysiology
- ▸ CH 601 Professional Ethics in Science & Chemistry
- ▸ PME 530 Introduction to Pharmaceutical Manufacturing
- ▸ CAL 557 Bioethics
- ▸ BIOE 700 Seminar in Bioengineering
- ▸ BIOE 701 Selected Topics in Bioengineering
- ▸ BIOE 702 Curriculum Practical Training
- ▸ BIOE 800 Special Problems in Bioengineering (MS)
- ▸ BIOE 900 Masters Thesis in Bioengineering
- ▸ BIOE 901 Bioengineering Project

Unrestricted Electives - 6 credits for non-thesis option only

Additional courses are chosen with an advisor's guidance and will depend on the student's interests and background. The Program Director must approve all elective courses.

Master of Science - Chemistry; Master of Science - Chemical Biology

For the Master of Science degree thirty graduate credits in an approved plan of student that includes core courses are required. The core courses required for the chemistry and chemical biology degree are specified below. Areas of concentration available for both degrees include analytical chemistry, chemical biology, organic chemistry, physical chemistry and polymer chemistry, and others can be designed. Please refer to the elective options section below for suggested courses in each concentration area. Research may be included in master's degree programs, either as a Special Research Problem (CH 800) or a Master's Thesis (CH 900), and is counted towards the 30 credits required for the degree. All fellows and teaching or research assistants are expected to complete a thesis.

Core Courses in Chemistry

- CH 520 Advanced Physical Chemistry
- CH 561 Instrumental Methods of Analysis
- CH 610 Advanced Inorganic Chemistry
- CH 620 Kinetics & Thermodynamics
- CH 640 Advanced Organic Chemistry
- CH 660 Advanced Instrumental Analysis

Core Courses in Chemical Biology
(Prerequisites may be required)

- CH 581 Biochemistry II
- BIO 687 Molecular Genetics
- BIO 690 Cellular Signal Transduction
- One Advanced Chemistry Course (with recommendation of research advisor)

Elective Courses

See the elective options section below for a list of courses. Additional courses are chosen depending on the student's interests and background. The Program Director must approve all elective courses.

Master of Science - Computational and Medicinal Chemistry for Drug Discovery

The M.S. in Computational and Medicinal Chemistry for Drug Discovery Program is tailored for students with a strong science background who are interested in drug discovery and need the skills and knowledge in computational and medicinal chemistry. This program focuses on key areas in computational chemistry, medicinal chemistry including protein structure and property interaction, ligand and receptor interactions and modification of ligands and compounds to better-fit receptors and other targets. The program builds on a foundation of chemistry and biology and provides a complement of skills and knowledge essential for drug early preclinical discovery. For the Master of Science degree, students must successfully complete thirty graduate credits including 15 credits of core courses listed below. Students may elect to choose thesis (6-9 credits) or non-thesis options, depending on their professional goals. Students pursuing a thesis should make arrangements with an advisor within the first year at Stevens. Graduates of this program will be well positioned to obtain careers in drug

discovery focusing on silico structure-based drug design and medicinal chemistry research within academic, government and national labs, pharmaceutical and biotechnology companies, as well as legal and patent offices.

Core Courses in Computational and Medicinal Chemistry for Drug Discovery - 15 credits

- CH 685 Medicinal Chemistry
- CH 664 Computational Chemistry
- CH 581 Biochemistry II - Bio-molecular Structure and Function
- CH 782 Special Topics in Bioorganic Chemistry
- CH 640 Advanced Organic Chemistry

Technical Elective Courses - 9 credits for non-thesis option, 6-9 credits for thesis option

- BIO 682 Biochemical Laboratory Techniques
- BIO 684 Molecular Biology Laboratory Techniques
- CH 642 Synthetic Organic Chemistry
- CH 582 Bio-Physical Chemistry
- CH 610 Advanced Inorganic and Bioinorganic
- CH 646 Chemistry of Natural Products
- CH 666 Modern Mass Spectroscopy
- CH 550 Spectra and Structure Determination
- CH 661 Advanced Analysis Laboratory
- CH 662 Separation Methods in Analytical and Organic Chemistry
- CH 669 Applied Quantum Chemistry

Unrestricted Electives - 6 credits for non-thesis option only

Additional courses are chosen with an advisor's guidance and will depend on the student's interests and background. The Program Director must approve all elective courses.

Doctoral Programs in Chemistry and in Chemical Biology

There are two different doctoral programs, a Doctorate in Philosophy in Chemistry and a Doctorate in Philosophy in Chemical Biology. The master's degree is not a prerequisite for admission to the doctoral program. Admission to either doctoral program is based on official transcripts showing strong performance in chemistry or chemistry and biology coursework, GRE scores, letters of recommendation from at least three of more people who know the student's academic and research background and for applicants whose native language is not English, a minimum score as specified by the Office of Graduate Academics on the TOEFL. The admissions committee is looking for reasonable evidence that the student will be successful and prove capable of specialization with a broad intellectual foundation. Specifically, students will be admitted to the doctoral program only if the Admissions Committee feels that he/she is reasonably well prepared for the Qualifying Examinations in Chemistry or Chemical Biology, which must be passed within a 15-month period after admission. Students who enter the PhD Program after a master's degree in the field should be prepared to take the Qualifying Exam within 10 months. Applicants with good academic records who lack this level of preparation may be admitted initially to the M.S. program.

Eighty four credits are required for the doctoral degree. The Master's degree is not a prerequisite for admission to the doctoral program but may be included in the 84 credits. The 84 credits should include a minimum of 30 credits of dissertation hours. Continuation in the doctoral program is contingent on passing the Qualifying Examination, Preliminary Examination, and meeting all other requirements as dictated by the Stevens Office of Graduate Academics. A student enrolled in the master's program in Chemistry or Chemical Biology who is interested in a doctorate degree must apply formally for admission to the Doctoral program. For the Ph.D. degree, a prior Masters' degree may be transferred for up to 30 credits. Up to one-third of additional course credits may be transferred with the approval of the Program Director and the Dean of the Graduate School provided they have not been used to obtain another degree.

Elective Options

The following are typical examples of specialization areas:

Analytical Chemistry

- CH 650 Spectra and Structure Determination
- CH 660 Advanced Instrumental Analysis
- CH 661 Advanced Instrumental Analysis Laboratory
- CH 662 Separation Methods in Analytical & Organic Chemistry
- CH 666 Modern Mass Spectrometry

Chemical Biology

- CH 580 Biochemistry I
- CH 581 Biochemistry II
- CH 582 Biophysical Chemistry
- BIO 583 Physiology
- BIO 668 Computational Biology
- BIO 678 Experimental Microbiology
- BIO 682 Biochemical Laboratory Techniques
- BIO 684 Molecular Biology Laboratory Techniques
- CH 685 Medicinal Chemistry
- BIO 686 Immunology
- BIO 687 Molecular Genetics
- BIO 688 Methods in Chemical Biology
- BIO 689 Cell Biology Lab Techniques
- BIO 690 Cellular Signal Transduction
- BIO 691 Introduction to Systems Biology
- BIO 692 Epigenetics
- BIO 693 Gene Therapy
- BIO 694 Advanced Computational Modeling in Biology and Biomaterials Science
- BIO 695 Organelles
- CH 780 Selected Topics in Biochemistry I

▸ CH 781 Selected Topics in Biochemistry II

▸ CH 782 Selected Topics in Bioorganic Chemistry

Organic Chemistry

▸ CH 640 Advanced Organic and Heterocyclic Chemistry I

▸ CH 641 Advanced Organic and Heterocyclic Chemistry II

▸ CH 642 Synthetic Organic Chemistry

▸ CH 646 Chemistry of Natural Products

▸ CH 650 Spectra and Structure Determination

▸ CH 685 Medicinal Chemistry

▸ CH 782 Selected Topics in Bio-organic Chemistry

Physical Chemistry

▸ CH 620 Chemical Thermodynamics and Kinetics

▸ CH 621 Quantum Chemistry

▸ CH 622 Molecular Spectroscopy

▸ CH 623 Chemical Kinetics

▸ CH 624 Statistical Mechanics

▸ CH 650 Spectra and Structure Determination

▸ CH 720 Current Topics in Chemical Physics I

▸ CH 721 Current Topics in Chemical Physics II

▸ CH 722 Selected Topics in Physical Chemistry

▸ CH 669 Applied Quantum Chemistry

Polymer Science

▸ CH 670 Polymer Synthesis

▸ CH 671 Physical Chemistry of Polymers

▸ CH 672 Macromolecules in Modern Technology

▸ CH 674 Polymer Functionality

Electives

To complete the course requirements for the degree, a student may choose additional courses with the approval of the advisor. Special courses are frequently offered under the title of Special (or Selected) Topics, which can be included with the permission of the advisor. Some courses are offered as reading courses, with no designated lecture schedule.

Degree Requirements

Eighty four credits are required for the doctoral degree. The 84 credits should include a minimum of 30 credits of dissertation hours. All doctoral students in Chemistry and Chemical Biology must pass a Qualifying Examination. After successful completion of the qualifying examination, the next milestone is a preliminary examination. The preliminary examination is based on an original research proposal in an area of the student's own choice, preferably an area related to the pending dissertation area but with a topic significantly different from his or her thesis. It is submitted in written form and defended orally before the Thesis Committee. The final milestone is the doctoral dissertation and defense. Specifics on these degree requirements can be found in the Chemistry and Chemical Biology Program Graduate Student Handbook.

<u>Language Proficiency</u>

Students must fulfill the English proficiency requirements on page 44.

<u>Doctoral Dissertation</u>

The policies and regulations governing the doctoral dissertation are described in detail in the Chemistry and Chemical Biology Program Graduate Student Handbook.

Graduate Certificate Programs

In addition to the degree programs, the department currently offers "mini-graduate" programs leading to the Certificate of Special Study in one of seven areas: Analytical Chemistry, Biomedical Chemistry, Chemical Biology, Chemical Physiology, Laboratory Methods in Chemical Biology and Polymer Chemistry. Students in these certificate programs must meet the same admission and performance standards as regular degree graduate students. Each of the certificate programs requires twelve credits (four courses), all of which are transferable to the appropriate master's degree program.

Analytical Chemistry

- ‣ CH 561 Instrumental Methods of Analysis
- ‣ CH 660 Advanced Instrumental Analysis
- ‣ CH 662 Separation Methods in Analytical and Organic Chemistry
- ‣ CH 666 Modern Mass Spectrometry

Biomedical Chemistry

- ‣ CH 642 Synthetic Organic Chemistry
- ‣ CH 646 Chemistry of Natural Products

and two of the following courses (with advisor approval):

- ‣ CH 647 Chemistry and Pharmacology of Drugs
- ‣ CH 685 Selected Topics in Medicinal Chemistry
- ‣ CH 800 Special Research Problems in Chemistry

Chemical Biology

- ‣ CH 580 Biochemistry I
- ‣ CH 681 Biochemistry II
- ‣ BIO 686 Immunology
- ‣ BIO 687 Molecular Genetics

Chemical Physiology

- ‣ CH 580 Biochemistry I
- ‣ BIO 583 Physiology
- ‣ BIO 684 Molecular Biology Laboratory Techniques

and one of the following courses with the approval of your program advisor:

- ‣ BIO 686 Immunology

▶ BIO 690 Cellular Signal Transduction

▶ CH 800 Special Research Problems in Chemistry

Laboratory Methods in Chemical Biology

▶ CH 561 Instrumental Methods of Analysis

▶ CH 682 Biochemical Lab. Techniques

▶ BIO 684 Molecular Biology Lab Techniques

▶ BIO 689 Cell Biology Lab. Techniques

Polymer Chemistry

▶ CH 670 Synthetic Polymer Chemistry

▶ CH 671 Physical Chemistry of Polymers

▶ CH 672 Macromolecules in Modern Technology

▶ CH 673 Special Topics in Polymer Chemistry

▶ CH 674 Polymer Functionality

The above graduate certificate programs are regular graduate courses and can be part of the Master of Science program in chemistry or chemical biology.

COURSE OFFERINGS

Biology

BIO 201   Introduction to Biology for Non-Majors   (3 - 3 - 0)

This course is an introduction to important concepts and principles of biology with a focus on the following topics: basic chemistry of life, important biological molecules, cellular structure and function, basic energy concepts, enzymes, cellular respiration, cellular reproduction, inheritance, DNA structure and function, DNA replication, RNA transcription, protein translation, viruses, gene control and DNA technology. This course is not intended to satisfy the science elective requirement for engineering and/or science majors.

BIO 281   Biology and Biotechnology   (3 - 3 - 0)

Biological principles and their physical and chemical aspects are explored at the cellular and molecular level. Major emphasis is placed on cell structure, the process of energy conversion by plant and animal cells, genetics and evolution, and applications to biotechnology.

BIO 282   Introductory Biology Laboratory   (1 - 0 - 3)

An introductory laboratory illustrating basic techniques and principles of modern biology by means of laboratory experiments and simulated experiments. This laboratory does not satisfy medical school admission requirements. Prerequisite: BIO 281 or CH 281 Corequisite: BIO 281

BIO 341   Biological Chemistry   (4 - 3 - 4)

Survey of biologically important classes of compounds including fats and lipids, terepenes, steroids, acetogenins, sugars, carbohydrates, peptides, proteins, alkaloids, and other natural products. Prerequisite: CH 244

BIO 368   Fundamentals of Computational Biology   (3 - 3 - 0)

A course focusing on bioinformatics and functional genomics. Students will be introduced to bioinformatics and discover the impotance of computational methods to address problems in Biology. Various sequencing techniques including genome sequencing will be presented and discussed. Gene predictions, sequence based property prediction, homology modeling and protein structure prediction as well as expression analysis will be explored. Students will learn relevant topics of comparative genomics, whole genome analysis, functional genomics and genetically modified organisms. Prerequisite: BIO281 or CH 281 Recommended: CS115 or background in computer programming

BIO 381   Cell Biology   (4 - 3 - 3)

The structure and function of the cell and its subcellular organelles is studied. Biological macromolecules, enzymes, biomembranes, biological transport, bioenergetics, DNA replication, protein synthesis and secretion, motility, and cancer are covered. Cell biology experiments and interactive computer simulation exercises are conducted in the laboratory. Prerequisite: BIO 281 or CH 281

BIO 382   Biological Systems   (4 - 3 - 3)

Physiochemical principles underlying the coordinated function in multicellular organisms are studied. Electrical properties of biological membranes, characteristics of tissues, nerve-muscle electrophysiology, circulatory, respiratory, endocrine, digestive, and excretory systems are covered. Computer simulation experiments and data acquisition methods to evaluate and monitor human physiological systems are conducted in the laboratory. Prerequisite: BIO 281 or CH 281

BIO 392   Microbiology   (3 - 3 - 0)

Microbes are important classes of organisms that are both necessary for life on earth and causative agents of some of the deadliest diseases known to man. The course focuses on the eubacteria domain of life and will cover the topics related to the biochemistry and cell biology of eubacteria, their important metabolic pathways, the molecular biology and genetics of eubacteria, their pathogenicity as well as the recent development in the benefits of the human gut microbiome. The contribution of microbes to the environment and to the biotechnology sectors will also be discussed. Prerequisites: BIO281, BIO381 or CH 281, CH 381

BIO 397   Fundamentals in Plant Biology   (3 - 3 - 0)

Fundamentals in Plant Biology focuses on the cell biology and physiology of plants. The students will learn the chemical and biological strategies plants use to make nutrients, complex biological molecules many of which are important to human health. Plant assimilation of carbon and nitrogen, important to the earth ecosystem, will also be discussed. Plant structures are emphasized to appreciate their biological functions. Key concepts and relationships include the importance of water, nutrient transport, solar energy and photoassimilates, plant growth and development, time, plant movement and phytochemicals. At the end of the course students will gain a broad knowledge in plant biology at a molecular level. Prerequisite: CH381 or BIO381

BIO 484   Introduction to Molecular Genetics   (4 - 3 - 3)

Introduction to the study of molecular basis of inheritance. Starts with classical Mendelian genetics and proceeds to the study and function of DNA, gene expression and regulation in prokaryotes and eukaryotes, genome dynamics and the role of genes in development, and cancer. All topics include discussions of current research advances. Accompanied by laboratory section that explores the lecture topics in standard wet laboratory experiments and in computer simulations. Prerequisites: BIO 281, BIO 381 or CH 281, CH 381

BIO 485   Developmental Biology   (3 - 3 - 0)

Introduction to developmental biology. Using concepts from cell and molecular biology, this course surveys the major concepts and mechanisms of development leading from a fertilized egg to a fully differentiated, multicellular organism based on three primary tissue layers. Key concepts include pattern formation, cell commitment, generation of anatomical axes, organogenesis, stem cells and progenitor cells, regeneration, and human diseases of development and aging. The course incorporates lectures, recitations/discussions, reading of the primary literature, and student presentations. Prerequisites: BIO 381, BIO 484 or CH 381, CH 484

BIO 486   Fundamental Immunology   (3 - 3 - 0)

This course is an introduction to the biology and physiology of the immune system. The development and evolution of immune responses as well as the mechanisms of host-pathogen interactions will be discussed. The widespread applications of immunology in biological research, modern medicine and therapeutics will be emphasized. Students will expected to search current research literature, read, interpret and evaluate scientific data and present current topics in immunology. Prerequisities: BIO 381, BIO 382 or CH 381, CH 382

BIO 487   Nutritional Sciences   (3 - 3 - 0)

This course presents an overview of the science of human nutrition, including the basics of protein, carbohydrate, lipid, vitamin, mineral and water pharmacodynamics along with an indepth understanding of nutrient metabolism as it relate to the microbiome. An analysis of the relationship of diet to various health issues, including but not limited to metabolic, auto-immune, neurological diseases and cancer will be covered. Students will learn the elements of nutritional analysis by evaluating their personal diets. Prerequisites: BIO281, BIO381, or CH 281, CH 381

BIO 583   Physiology   (3 - 3 - 0)

Fundamentals of control processes governing physiological systems analyzed at the cellular and molecular level. Biological signal transduction and negative feedback control of metabolic processes. Examples from sensory, nervous, cardiovascular, and endocrine systems. Deviations that give rise to abnormal states; their detection, and the theory behind the imaging and diagnostic techniques such as MRI, PET, SPECT; and the design and development of therapeutic drugs. The principles, uses, and applications of biomaterials and tissue engineering techniques; and problems associated with biocompatibility. Students (or groups of students) are expected to write and present a term project. Prerequisite: BIO 382 or CH 382

BIO 668   Computational Biology   (3 - 3 - 0)

Topics at the interface of biology and computer technology will be discussed, including molecular sequence analysis, phylogeny generation, biomolecular structure simulation, and modeling of site-directed mutagenesis. Prerequisite: CH 580

BIO 678   Experimental Microbiology   (3 - 3 - 0)

Discussions in medical, industrial, and environmental microbiology will include bacteriology, virology, mycology, parasitology, and infectious diseases. Includes experimental laboratory instruction. Prerequisite: BIO 382 or CH 382

BIO 682   Biochemical Laboratory Techniques   (3 - 3 - 0)

Students will work actively in small collaborative groups to solve a unique research project that encompasses the purification, analysis of purity, kinetics, and structure-function analysis of a novel recombinant protein. Techniques in protein purification, gel electrophoresis, peptide digest separation, ligand binding, steady-state and stopped-flow kinetics, and molecular simulation will be explored.

BIO 684   Molecular Biology Laboratory Techniques   (3 - 3 - 0)

This laboratory course introduces essential techniques in molecular biology and genetic engineering in a project format. The course includes aseptic technique and the handling of microbes; isolation and purification of nucleic acids; construction, selection and analysis of recombinant DNA molecules; restriction mapping; immobilization and hybridization of nucleic acids; and labeling methods of nucleic acid probes. Prerequisite: BIO 484 or CH 484

BIO 686   Immunology   (3 - 3 - 0)

The cells and molecules of the immune system and their interaction and regulation; the cellular and genetic components of the immune response, the biochemistry of antigens and antibodies, the generation of antibody diversity, cytokines, hypersensitivities, and immunodeficiencies (i.e. AIDS); and transplants and tumors. Use of antibodies in currently emerging immunodiagnostic techniques such as ELISA, disposable kits, molecular targets, and development of vaccines utilizing molecular biological techniques, such as recombinant and subunit vaccines. Students (or groups of students) are expected to write and present a term project. Prerequisite: BIO 381 or CH 381

BIO 687   Molecular Genetics   (3 - 3 - 0)

This course is a modern approach to the study of heredity through molecular biology. Primary emphasis is on nucleic acids, the molecular biology of gene expression, molecular recognition and signal transduction, and bacterial and viral molecular biology. The course will also discuss recombinant DNA technology and its impact on science and medicine. Prerequisite: BIO 484 or CH 484

BIO 688   Methods in Chemical Biology   (3 - 3 - 0)

A discussion of the theories underlying various techniques of molecular biology which are used in the biotechnology industry. Topics include all recombinant DNA techniques; DNA isolation and analysis; library construction and screening; cloning; DNA sequencing; hybridization and other detection methods; RNA isolation and analysis; protein isolation and analysis (immunoassay, ELISA, etc.); transgenic and ES cell methods; electrophoresis (agarose, acrylamide, two dimensional, and SDS-PAGE); column chromatography; and basic cell culture including transfection and expression systems. Prerequisite: BIO 381 or CH 381

BIO 689   Cell Biology Laboratory Techniques   (3 - 3 - 0)

Laboratory practice in modern biological research will be explored. Techniques involving gene and protein cellular probes, ELISA, mammalian cell culturing, cell cycle determination, differential centrifugation, electron microscopy, and fluorescent cellular markets will be addressed. Laboratory fee $60. Prerequisite: BIO 381 or CH 381

BIO 690   Cellular Signal Transduction   (3 - 3 - 0)

This advanced course covers the mechanism and biological role of signal transduction in mammalian cells. Topics included are extracellular regulatory signals, intracellular signal transduction pathways, role of tissue context in the function of cellular regulation, and examples of biological processes controlled by specific cellular signal transduction pathways. Cross-listed with: BME 690, NANO 690 Prerequisites: BIO 381, BIO 484 or CH 381, CH 484

BIO 691   Introduction to Systems Biology   (3 - 3 - 0)

Systems biology is a new approach to complex biological problems. It uses a combination of the most modern techniques for comprehensive measurements of cells and molecules, combined with complex computer and mathematical modeling, to build up inclusive depictions of how living systems function. This course is an integrative approach to help comprehend dynamic biological systems. True understanding of systems biology requires a cross-disciplinary approach. Topics will include both a biological and computer science perspective taught by experts in each individual discipline. The course will cover introduction to advance biological subjects in cell biology and genetics followed by introduction to computer science methods including modeling and "bio-machine" features of systems biology. In class, we will also explore critical reading of current research. Cross-listed with: CS 691

BIO 692   Epigenetics   (3 - 3 - 0)

Epigenetics describes the inheritance of different functional states, which may have divergent phenotypic consequences, without any change in the sequence of DNA. This course will examine the molecular mechanisms and biological processes in which epigenetic modifications play an elemental role in inheritance. It will cover different biological mechanisms of the epigenetic machinery including: DNA methylation, histone tails, chromatin structure, nucleosome occupancy, heterochromatin assembly, gene silencing, siRNAs and miRNAs. The epigenetic profile of embryonic stem cells, cell differentiation, gene imprinting and X-chromosome inactivation will be examined as well as the relationship of epigenetics to cancers and ageing. Prerequisites: Undergraduate Genetics and Undergraduate Cell Biology.

BIO 694   Advanced Computational Modeling in Biology and Biomaterials Science   (3 - 3 - 0)

This course combines computational modeling with lab experience. The course is project based. Students will be able to choose from a pool of problems being actively researched at Stevens, understand how to obtain experimental data, design and implement a computational model, predict the behavior of the system being modeled, and use a second set of experimental results to validate the model. Cross-listed with: CS 694

BIO 695   Organelles   (3 - 0 - 0)

This course is designed for beginning graduate students and advanced undergraduate students with a particular enthusiasm for advanced cell biology. Overall, the course will present organelle biogenesis by first presenting past scientific strategies, theories, and findings in the field of cell biology and then relating these foundations to current investigations. Reviews of protein and lipid mediators important for organelle biogenesis are then presented followed by summaries focused on the nucleus, endoplasmic reticulum, Golgi apparatus, lysosome, mitochondria, and peroxisome. Each organelle will be extensively covered for sub-compartment biochemistry, isolation, and current research. Intensive classroom discussions focus on the experimental methods used, results obtained, interpretation of these results in the context of cell structure and function, and implications for further directions of studies in the field. Prerequisite: BIO 381 or CH 381

BIO 800   Special Problems in Chemical Biology   (1 to 6 - -)

One to six credits. Limit of six credits for the degree of Master of Science.

BIO 900   Masters Thesis in Chemical Biology   (1 - 1 - 0)

For the degree of Master of Science, five to ten credits with departmental approval.

Bioengineering

BIOE 700   Seminar in Bioengineering   (0 - -)

Lectures by department faculty, guest speakers, and doctoral students on recent research.

BIOE 701   Selected Topics in Bioengineering   (3 - 3 - 0)

Selected topics of current interest in the field of bioengineering will be treated from an advanced point of view.

BIOE 702   Curriculum Practical Training   (1 - 0 - 0)

International graduate students may arrange an internship or paying position off campus and receive Curricular Practical Training (CPT) credit via this course provided that the course constitutes and integral part of their educational program. Students must maintain their full time status while receiving CPT. Prior approval of the program director is required for enrollment. To justify enrollment, the student must have a concrete commitment from a specific employer for a specific project, and must provide to the program director for his/her approval a description of the project plus a statement from the employer that he/she intends to employ the student. This information must be provided to the program director with sufficient advance notice so that the program director has time to review the materials and determine if the project is appropriate. During the semester, the student must submit written progress reports. At the end of the semester, the student must submit for grading a written report that describes his/her activities during that semester, even if the activity remains ongoing. This is a one-credit course that may be repeated up to a total of three credits.

BIOE 800   Special Problems in Bioengineering (MS)   (1 to 3 - -)

One to three credits. Limit of three credits for the degree of Master of Engineering (Bioengineering).

BIOE 900   Masters Thesis in Bioengineering   (9 - 0 - 0)

For the degree of Master of Engineering (Bioengineering). Nine credits with departmental approval.

BIOE 901   Bioengineering Project   (1 to 9 - -)

For the degree of Master of Engineering (Bioengineering). One to nine credits with departmental approval.

Chemistry and Chemical Biology

CH 115   General Chemistry I   (3 - 3 - 0)

This course is an introduction to important concepts and principles of chemistry with a focus on the following topics: atomic structure and periodic properties, stoichiometry, properties of gases, thermochemistry, chemical bond types, intermolecular forces, liquids and solids and a brief introduction to chemical kinetics, organic chemistry and materials chemistry. Corequisite: CH 117

CH 116   General Chemistry II   (3 - 3 - 0)

This course is an introduction to important concepts and principles of chemistry with a focus on the following topics: chemical kinetics; properties of solutions; chemical equilibrium; acids and bases; acid base equilibrium, polyprotic acids, buffers, titrations, indicators, salts; solubility and complex ion equilibria; chemical thermodynamics: entropy, free energy and spontaneity; electrochemistry: balancing oxidation reduction reactions, galvanic cells, electrolysis; nuclear chemistry, nuclear energetics and radioactivity; the representative elements; transition metals and coordination chemistry. Prerequisite: CH 115

CH 117   General Chemistry Laboratory I   (1 - 0 - 3)

Laboratory work to accompany CH 115: experiments of atomic spectra, stoichiometric analysis, qualitative analysis, and organic and inorganic syntheses. Corequisite: CH 115

CH 118   General Chemistry Laboratory II   (1 - 0 - 3)

Laboratory work to accompany CH 116: analytical techniques properties of solutions, kinetics, chemical and phase equilibria, acid-base titrations, thermodynamic properties, electrochemical cells, and properties of chemical elements. Prerequisite: CH 117 Corequisite: CH 116

CH 189   Seminar in Chemistry and Biology   (1 - 1 - 0)

Introduction to chemistry as the "central science" and its impact on other fields, particularly biology. Areas to be explored include the interaction of radiation with matter, the effect of symmetry on chemical and physical properties of molecules, hyphenated methods of analysis, the chemistry of biological signals, biochemical cycles, the physiology of exercise, and chaotic reactions. Corequisite: CH 115

CH 243   Organic Chemistry I   (3 - 3 - 0)

Principles of descriptive organic chemistry; structural theory; reactions of aliphatic compounds; and stereochemistry. Prerequisites: CH 116, CH 118

CH 244   Organic Chemistry II   (3 - 3 - 0)

Continuation of CH 243. Includes examination of functional groups and functional group interconversions, aromatic compounds, infrared and nuclear magnetic resonance spectroscopy. Corequisite: CH 243

CH 245   Organic Chemistry Laboratory I   (1 - 0 - 4)

Laboratory includes introduction to organic reaction and separation techniques, reactions of functional groups, and synthesis. Corequisite: CH 243

CH 246   Organic Chemistry Laboratory II   (1 - 0 - 4)

Laboratory work in synthesis, spectroscopy and chromatographic separation techniques. Corequisite: CH 244

CH 301   Professional Ethics   (1 - 1 - 0)

A course for advanced undergraduate and beginning graduate students in the sciences, especially chemistry and chemical biology, focusing on the ethical problems unique to the chemical profession. Special emphasis will be given to situations in which there is not a simple correct answer but only a number of imperfect alternatives. There will be class discussions of various case studies. This course is recommended by the Committee on Professional Training of the American Chemical Society as a component of ACS Certification. It is not a course in general theories of ethics, but a course on problems encountered in the chemical profession.

CH 321   Thermodynamics   (3 - 3 - 0)

Thermodynamics is the science of the transformations of energy and provides a powerful way to discuss equilibria and the direction of natural changes in chemistry. Its concepts apply to both physical change, such as fusion and vaporization, and chemical change, including electrochemistry. This course will cover the laws of thermodynamics, thermodynamic functions (including energy, enthalpy, entropy, Gibbs energy and the chemical potential) and the application to phase equilibria, chemical reaction equilibria and solution theory for both ideal and real systems. Applications of thermodynamic principles to current scientific problems will be explored. Prerequisites: CH 116, MA 124

CH 322   Theoretical Chemistry   (3 - 3 - 0)

Quantum mechanics of molecular systems are developed. The techniques of approximation methods are employed for molecular binding and spectroscopic transitions. Examples are taken from infrared, visible, ultraviolet, microwave, and nuclear magnetic resonance spectroscopy. Prerequisites: MA 221, CH 243

CH 362   Instrumental Analysis I - Spectroscopy and Chromatography   (4 - 3 - 4)

Theoretical and experimental approach to spectroscopy and chromatography. Includes ultraviolet, visible and infrared absorption by molecules, emission spectroscopy, nuclear magnetic resonance, mass spectroscopy and gas-liquid and high-performance chromatography. Prerequisites: CH 116, CH 118

CH 412   Inorganic Chemistry I   (4 - 3 - 4)

Lecture and laboratory; ionic solids, lattice energy, and factors determining solubility; thermodynamics in inorganic synthesis and analysis; acid-base equilibria; and systematic chemistry of the halogens and other non-metals. Prerequisites: CH 362, CH 322

CH 421   Chemical Dynamics   (4 - 3 - 4)

Chemical kinetics, solution theories with applications to separation processes, electrolytes, polyelectrolytes, regular solutions and phase equilibria, and laboratory practice in the measurements of physical properties and rate processes. Prerequisites: CH 321, MA 221, E 234

CH 461   Instrumental Analysis II - Electrochemistry   (4 - 3 - 4)

Theory and practice of electrochemical methods in analytical chemistry. Includes potentiometry, coulometry, amperometry, polarography, voltammetry, conductivity, etc. Prerequisites: CH 116, CH 118

CH 496   Chemistry Project I   (3 - 0 - 8)

Participation in a small group project, under the guidance of a faculty member, whose prior approval is required. Experimentation, application of chemical knowledge and developmental research leading to the implementation of a working chemical process. Individual or group written report required.

CH 497   Chemistry Project II   (3 - 0 - 8)

Participation in a small group project, under the guidance of a faculty member, whose prior approval is required. Experimentation, application of chemical knowledge and developmental research leading to the implementation of a working chemical process. Individual or group written report required.

CH 498   Chemical Research I   (3 - 0 - 8)

Individual research project under the guidance of a chemistry faculty member, whose prior approval is required. A written report in acceptable journal format and an oral presentation are required at the end of the project.

CH 499   Chemical Research II   (3 - 0 - 8)

Individual research project under the guidance of a chemistry faculty member, whose prior approval is required. A written report in acceptable journal format and an oral presentation are required at the end of the project.

CH 500   Physical Chemistry Review   (3 - 0 - 0)

Review of undergraduate physical chemistry by means of problem solving; atomic spectra; structure of atoms and molecules; thermodynamics; changes of state; solutions; chemical equilibrium; kinetic theory of gases; chemical kinetics, and electrochemistry.

CH 520   Advanced Physical Chemistry   (3 - 3 - 0)

The elements of quantum mechanics are developed and applied to chemical systems. Valence bond theory and molecular orbital theory of small molecules; introduction to group theory for molecular symmetry; fundamental aspects of chemical bonding, and molecular spectra.

CH 524   Intro to Surface Analysis   (3 - 3 - 0)

This course provides a broad introduction to common surface analysis techniques used to measure a wide range of properties of solid surfaces.

CH 525   Techniques of Surface and Nanostructure Characterization   (3 - 3 - 0)

Lectures, demonstrations and laboratory experiments, selected from among the following topics, depending on student interest: vacuum technology; thin-film preparation; scanning electron microscopy; infrared spectroscopy, ellipsometry: electron spectroscopies-Auger, photoelectron, LEED; ion spectroscopies SIMS, IBS, field emission; surface properties-area, roughness, and surface tension. Alternate years. Cross-listed with: MT 525, NANO 525, PEP 525

CH 540   Advanced Organic Laboratory I   (3 - 3 - 0)

Your needs and interests will be considered in the assignment of typical advanced preparations, small research problems and special operations. Fall and Spring semesters, by request.

CH 541   Advanced Organic Laboratory II   (3 - 3 - 0)

Your needs and interests will be considered in the assignment of typical advanced preparations, small research problems and special operations. Fall and Spring semesters, by request. Prerequisite: CH 540

CH 550   Spectra and Structure   (3 - 3 - 0)

An intensive course on the interpretation of spectroscopic data; emphasis is on the use of modern spectroscopic techniques, such as NMR (13C, D, 15N, and H), mass (including CI), laser-Raman, ESCA, ORD, CD, IR, and UV for structure elucidation. Special attention is given to the application of computer technology in spectral work. A course designed for practicing chemists in analytical, organic, physical, and biomedical areas. Extensive problem solving. No laboratory.

CH 555   Catalysis and Characterization of Nanoparticles   (3 - 3 - 0)

Most processes in petroleum and chemical industries utilize catalytic reactions. Moreover, many emerging technologies in the energy sector and in green chemistry for sustainability rely on catalysis. This course provides the fundamentals of synthesis, characterization and testing of catalytic materials with an emphasis on metal and metal oxide nanoparticles, the most widely used class of catalysts. Methodologies for development of molecular-level reaction mechanisms, material structure-activity relations and kinetic models are described. The course is essential for anyone planning a career in the chemical industry. It is recommended for all professionals working with nanoparticles and also with diverse applications where the solid-gas interface is important. Cross-listed with: CHE 555, MT 555, NANO 555, EN 555

CH 561   Instrumental Methods of Analysis   (3 - 3 - 3)

Primarily a laboratory course, with some lecture presenting the principles and applications of contemporary instrumental analytical methods, with a focus on spectroscopy and separations. Laboratory practice explores ultraviolet, visible and infrared spectrophotometry, atomic absorption spectroscopy, nuclear magnetic resonance spectrometry, gas-liquid and high-performance liquid chromatography, and capillary electrophoresis. These instrumental techniques are utilized for quantitative and qualitative analyses of organic, inorganic, biological and environmntal samples.

CH 580   Biochemistry I - Cellular Metabolism and Regulation   (3 - 3 - 0)

Discussions include metabolic pathways in biosynthesis and catabolism of biomolecules, including carbohydrates, proteins, lipids, and nucleic acids. The hormonal regulation of metabolism, as well as vitamin metabolism, is presented. Prerequisite: CH 242

CH 581   Biochemistry II - Biomolecular Structure and Function   (3 - 3 - 0)

Discusses the physical and structural chemistry of proteins and nucleotides, as well as the functional role these molecules play in biochemistry. Extensive use of known X-ray structural information will be used to visualize the three-dimensional structure of these biomolecules. This structural information will be used to relate the molecules to known functional information. Prerequisite: CH 244

CH 582   Biophysical Chemistry   (3 - 3 - 0)

The relationship of the chemical and physical structure of biological macromolecules to their biological functions as derived from osmotic pressure, viscosity, light and X-ray scatting, diffusion, ultracentrifugation, and electrophoresis. The course is subdivided into: 1) properties, functions, and interrelations of biological macromolecules, e.g., polysaccharides, proteins, and nucleic acids; 2) correlation of physical properties of macromolecules in solution; 3) conformational properties of proteins and nucleic acids; and 4) aspects of metal ions in biological systems. Prerequisite: CH 421

CH 610   Advanced Inorganic and Bioinorganic Chemistry   (3 - 3 - 0)

A systematic treatment of the bonding and reactivity of inorganic substances; molecular shape and electron charge distribution of main-group and coordination compounds, including valence-bond theory and a group theoretical approach to molecular orbital theory; organometallic chemistry; the solid state; and the role of inorganic compounds in biological processes and the environment.

CH 620   Chemical Thermodynamics and Kinetics   (3 - 3 - 0)

Applications of the laws of thermodynamics to solutions, electrolytes and polyelectrolytes, binding, and biological systems; statistical thermodynamics is developed and applied to spectroscopy and transition state theory; and chemical kinetics of simple and complex reactions, enzyme and heterogeneous catalysis, and theories of reaction rates.

CH 621   Quantum Chemistry   (3 - 3 - 0)

Theorems and postulates of quantum mechanics; operator relationships; solutions of the Schrödinger equation for model systems; variation and perturbation methods; pure spin states; Hartree-Fock self-consistent field theory; and applications to many-electron atoms and molecules. Prerequisites: CH 520, PEP 554

CH 622   Molecular Spectroscopy   (3 - 3 - 0)

Theoretical foundations of spectroscopic methods and their application to the study of atomic and molecular structure and properties; theory of absorption and emission of radiation; line spectra of complex atoms: group theory; rotational, vibrational, and electronic spectroscopy of diatomic and polyatomic molecules; infrared, Raman, uv-vis spectroscopy; laser spectroscopy and applications; photoelectron spectroscopy; multi-photon processes. Also offered as PEP 722. By request. Prerequisites: CH 520, PEP 554

CH 623   Chemical Kinetics   (3 - 3 - 0)

A detailed discussion of the kinetics and mechanism of complex reactions in the gaseous and liquid phases; topics include: stationary and nonstationary conditions; chain reactions, photo and radiation-induced reactions, and reaction rate theories. By request.

CH 624   Statistical Mechanics   (3 - 3 - 0)

Classical and quantum mechanical preliminaries; derivation of the laws of thermodynamics; applications to monoatomic and polyatomic gases and to gaseous mixtures; systems of dependent particles with applications to the crystalline solid, the imperfect gas, and the cooperative phenomena; electric and magnetic fields; and degenerate gases. By request. Prerequisite: CH 620

CH 640   Advanced Organic and Heterocyclic Chemistry I   (3 - 3 - 0)

An advanced course in the chemistry of carbon compounds, with special reference to polyfunctional compounds, heterocycles, techniques of literature survey, stereochemical concepts, and physical tools for organic chemists. Fall semester. Prerequisite: CH 244

CH 641   Advanced Organic and Heterocyclic Chemistry II   (3 - 3 - 0)

An advanced course in the chemistry of carbon compounds, with special reference to polyfunctional compounds, heterocycles, techniques of literature survey, stereochemical concepts, and physical tools for organic chemists. Spring semester.

CH 642   Synthetic Organic Chemistry   (3 - 3 - 0)

A survey of important synthetic methods with emphasis on stereochemistry and reaction mechanism. Prerequisite: CH 244

CH 646   Chemistry of Natural Products   (3 - 3 - 0)

Structure, synthesis, and biogenesis of antibiotics, alkaloids, hormones, and other natural products. Prerequisite: CH 244

CH 647   Chemistry and Pharmacology of Drugs   (3 - 3 - 0)

Discussion at the molecular level of drug receptor interaction, influence of stereochemistry and physiochemical properties on drug action, pharmacological effects of structural features, mechanism of drug action, metabolic rate of drugs in animals and man, and drug design. The application of newer physical tools and recent advances in methods for pharmacological studies will be emphasized. Prerequisite: CH 244

CH 660   Advanced Instrumental Analysis   (3 - 3 - 0)

Advanced treatment of the theory and practice of spectrometric methods (mass spectrometry, nuclear magnetic resonance, etc.) and electroanalytical methods with emphasis on Fourier Transform techniques (FTIR, FTNMR, etc.) and hyphenated methods (gc-ms, etc.), the instrument-sample interaction, and signal sampling. A survey of computational methods, such as factor analysis and other chemometric methods is also included. Prerequisite: CH 362

CH 661   Advanced Instrumental Analysis Laboratory   (3 - 3 - 0)

Your needs and interests are considered in the assignment of work on one or more of the following: NMR spectrometry, mass spectrometry, electrochemical methods, infrared, ultraviolet, and visible spectrophotometry.

CH 662   Separation Methods in Analytical and Organic Chemistry   (3 - 3 - 0)

An advanced course applying principles and theory to problems in chemical analysis. Theory of separations, including distillation, chromatography, and ultracentrifugation; heterogeneity and surface effects; and sampling and its problems.

CH 663   Design of Chemical Instrumentation   (3 - 3 - 0)

A practical treatment of the mechanical, electronic, and optical devices used in the construction of instruments for research and chemical analysis and control; motors, light sources and detectors, servomechanisms, electronic components and test equipment, vacuum and pressure measuring devices, and overall design concepts are among the topics treated.

CH 664   Computer Methods in Chemistry   (3 - 3 - 0)

Discusses computational chemistry topics, including energy minimization, molecular dynamics, solvation mechanics, and electronic structure calculations. Applications in drug design and receptors will be discussed. Prerequisite: CH 321

CH 665   Chemometrics I   (3 - 3 - 0)

Application of chemometric techniques to problems in analytical, physical and organic chemistry, with emphasis on spectroscopic measurements. Includes optimization, analysis of variance, pattern recognition, factor analysis, experimental design, etc.

CH 666   Modern Mass Spectrometry   (4 - 3 - 4)

A comprehensive hands-on course covering both fundamentals and modern aspects of mass spectrometry, with emphasis on biological and biochemical applications. Topics include: contemporary methods of gas phase ion formation [electron ionization (EI), chemical ionization (CI), inductively coupled plasma (ICP), fast atom bombardment (FAB), plasma desorption (PD), electrospray (ESI), atmospheric pressure chemical ionization (APCI), matrix assisted laser desorption ionization (MALDI), detection (electron and photomultipliers, and array detectors), and mass analysis [magnetic deflection, quadrupole, ion trap, time of flight (TOF), and Fourier-transform (FTMS)]. Detailed interpretation of organic mass spectra for structural information, with special emphasis on even-electron-ion fragmentation. Qualitative and quantitative applications in environmental, biological, pharmacological, forensic, and geochemical sciences.

CH 669   Applied Quantum Chemistry   (3 - 3 - 0)

Quantum chemistry is the foundation of modern chemistry. Modern quantum chemistry software can be used to obtain accurate information of interesting chemical and biochemical systems that are in excellent agreement with available experiments and can provide useful predictions for future experimental research. This course focuses on the applications of modern quantum chemistry to help solve real-world experimental research problems. It will provide hands-on experience to use currently state-of-the-art quantum chemistry software and modeling software to build various kinds of molecules and calculate various kinds of molecuar properties, including reaction pathways. It has both lecture and lab parts, which utilize materials from recent research publications in highly prestigious peer-reviewed journals. Students will learn about the power of modern quantum chemistry through the accuracy of predictions of experimental properties and the usefulness of information that cannot be easily obtained from experimental studies. Prerequisite: CH 520: Advanced Physical Chemistry

CH 670   Synthetic Polymer Chemistry   (3 - 3 - 0)

Mechanisms and kinetics of organic and inorganic polymerization reactions; condensation, free radical and ionic addition, and stereoregular polymerizations; copolymerizations; and the nature of chemical bonds and the resulting physical properties of high polymers.

CH 671   Physical Chemistry of Polymers   (3 - 3 - 0)

Physio-chemical aspects of polymers, molecular weight distributions, solution characterization and theories, polymer chain configuration, thermodynamics of polymer solutions, the amorphous state, and the crystalline state.

CH 672   Macromolecules in Modern Technology   (3 - 3 - 0)

The course covers recent advances in macromolecular science, including polyelectrolytes and water-soluble polymers, synthetic and biological macromolecules at surfaces, self-assembly of synthetic and biological macromolecules, and polymers for biomedical applications. Cross-listed with: NANO 672

CH 673   Special Topics in Polymer Chemistry   (3 - -)

Recent developments in polymer science will be discussed, e.g., physical measurements, polymer characterization, polymerization kinetics, and morphology. Topics will vary from year to year and specialists will participate.

CH 674   Polymer Functionality   (3 - 3 - 0)

Topics at the interface of polymer chemistry and biomedical sciences, focusing on areas where polymers have made a particularly strong contribution, such as in biomedical sciences and pharmaceuticals . Synthesis and properties of biopolymers; biomaterials; nanotechnology smart polymers; functional applications in biotechnology, tissue and cell engineering; and biosensors and drug delivery. Cross-listed with: NANO 674 Prerequisite: CH 244

CH 685   Medicinal Chemistry   (3 - 3 - 0)

A few topics of timely interest will be treated in depth,; recent chemical developments will be surveyed in fields such as antibiotics, cancer chemotherapy, CNS agents, chemical control of fertility, steroids and prostaglandins in therapy, etc. Prerequisite: CH 244

CH 700   Seminar in Chemistry   (0 - 1.5 - 0)

Lectures by department faculty, guest speakers, and doctoral students on recent research.

CH 701   Curricular Practical Training   (1 - 0 - 0)

International graduate students may arrange an educationally relevant internship or paying position off campus and receive Curricular Practical Training (CPT) credit via this course. Students must maintain their full time status while receiving CPT. Prior approval of the program director is required for enrollment. To justify enrollment, the student must have a concrete commitment from a specific employer for a specific project, and must provide to the program director for his/her approval a description of the project plus a statement from the employer that he/she intends to employ the student. This information must be provided to the program director with sufficient advance notice so that the program director has time to review the materials and determine if the project is appropriate. The project must be educationally relevant; i.e., it must help the student develop skills consistent with the goals of the educational program. During the semester, the student must submit written progress reports. At the end of the semester, the student must submit for grading a written report that describes his/her activities during that semester, even if the activity remains ongoing. The student must also present his/her activities in an accompanying oral presentation that is also graded. This is a one-credit course that may be repeated up to a total of three credits.

CH 720   Selected Topics in Chemical Physics I   (3 - 3 - 0)

Topics of current interest selected by you are to be investigated from an advanced point of view.

CH 721   Selected Topics in Chemical Physics II   (3 - 3 - 0)

Topics of current interest selected by you are to be investigated from an advanced point of view.

CH 722   Selected Topics in Physical Chemistry   (3 - 3 - 0)

Topics selected to coincide with research interests current in the department.

CH 740   Selected Topics in Organic Chemistry   (3 - 3 - 0)

Selected topics of current interest in the field of organic chemistry will be treated from an advanced point of view; recent developments will be surveyed in fields such as reaction mechanisms, physical methods in organic chemistry, natural products chemistry, biogenesis, etc.

CH 760   Chemoinformatics   (3 - 3 - 0)

This advanced course in computational chemistry builds on the methods developed in CH 664. Students will analyze and design combinatorial libraries, develop SAR models, and generate calculated molecular properties. The hands-on course will use both PC and Silicon Graphics computers. Software, such as that from Oxford Molecular, Tripos, and Oracle will be used, as will MSI software, such as INSIGHT/DISCOVER, Catalyst, and Cerius 2. Prerequisite: CH 664

CH 780   Selected Topics in Biochemistry I   (3 - 3 - 0)

Topics of current interest in biochemical research are discussed, such as: enzyme chemistry, biochemical genetics and development, cellular control mechanism, biochemistry of cell membranes, bioenergetics, and microbiology.

CH 781   Selected Topics in Biochemistry II   (3 - 3 - 0)

Topics of current interest in biochemical research are discussed, such as: enzyme chemistry, biochemical genetics and development, cellular control mechanism, biochemistry of cell membranes, bioenergetics, and microbiology.

CH 782   Selected Topics in Bioorganic Chemistry   (3 - 3 - 0)

Topics of timely interest will be treated in an interdisciplinary fashion; recent developments will be surveyed in fields such as biosynthesis, radioactive and stable isotope techniques, genesis of life chemicals, nucleic acids and replication, genetic defects, and metabolic errors.

CH 800   Special Research Problems in Chemistry   (1 to 6 - -)

One to six credits. Limit of six credits for the degree of Master of Science.

CH 801   Special Problems in Chemistry   (1 to 6 - -)

One to six credits. Limit of six credits for the degree of Doctor of Philosophy.

CH 900   Masters Thesis in Chemistry/Chemical Biology   (1 - 1 - 0)

For the degree of Master of Science, five to ten credits with departmental approval.

CH 960   Dissertation in Chemistry/Chemical Biology   (1 - 1 - 0)

Original experimental or theoretical research that may serve as the basis for the dissertation required for the degree of Doctor of Philosophy. The work will be carried out under the guidance of a faculty member. Hours and credits to be arranged.

Department of Chemical Engineering & Materials Science

FACULTY

RONALD BESSER
DEPARTMENT CHAIR

Pinar Akcora, Ph.D.
Associate Professor

Ronald Besser, Ph.D.
Professor and Department Chair

Henry Du, Ph.D.
Professor and Associate Dean for Research

Dilhan Kalyon, Ph.D.
Professor and
Director of Highly Filled Materials Institute

Jae Kim, Ph.D.
Assistant Professor

Suphan Kovenklioglu, Ph.D.
Professor and Associate Chair of Undergraduate Studies

Adeniyi Lawal, Ph.D.
Professor and Associate Chair of Graduate Studies;
Co-Director of the Center for Microchemical Systems

Stephanie Lee, Ph.D.
Assistant Professor

Woo Lee, Ph.D.
George Meade Bond Professor
Director of the Center for Microchemical Systems

Matthew Libera, Ph.D.
Professor

Simon Podkolzin, Ph.D.
Associate Professor

Keith Sheppard, Ph.D.
Professor and Senior Advisor to the Dean
of Engineering & Science

Fei Tian, Ph.D.
Research Assistant Professor

Yujun Zhao, Ph.D.
Teaching Associate Professor

EMERITUS FACULTY

Richard Griskey, Ph.D.
Professor Emeritus

Milton Ohring, Ph.D.
Professor Emeritus

UNDERGRADUATE PROGRAMS

Chemical Engineering

Chemical engineers create, design, and improve processes and products that are vital to our society. Today's high technology areas of biomedicine, electronic device processing, ceramics, plastics, and other high-performance materials offer problems that require innovative solutions provided by chemical engineers.

Considered to be one of the most diverse fields of engineering, the opportunities afforded chemical engineers are equally diverse: research and development, design, manufacturing, marketing and management. A variety of industries are served by chemical engineers, including: energy, petrochemical, pharmaceutical, food, agricultural products, polymers and plastics, materials, semiconductor processing, waste treatment, environmental monitoring and improvement, and many others. There are career opportunities in traditional chemical engineering fields like energy and petrochemicals, but also in biochemical, pharmaceutical, biomedical, electrochemical, materials, and environmental engineering.

The chemical engineering program at Stevens is based on the fundamental areas of chemical engineering science that are common to all of its branches. Courses in organic and physical chemistry, biochemical engineering and process control are offered in addition to chemical engineering core courses in thermodynamics, fluid mechanics, heat and mass transfer, separations, process analysis, reactor design, and process design. Thus, the chemical engineering graduate is equipped for the many challenges facing modern engineering professionals. Chemical engineering courses include significant use of modern computational tools and computer simulation programs. Qualified undergraduates may also work with faculty on research projects. Many of our graduates pursue advanced study in chemical engineering, bioengineering or biomedical engineering, medicine, law, and many other fields.

Mission and Objectives

The following mission statement lays out our primary goal in the education of future chemical engineers:

> *"The chemical engineering program educates technological leaders by preparing them for the conception, synthesis, design, testing, scale-up, operation, control and optimization of industrial chemical processes that impact our well-being."*

The Program Educational Objectives (PEOs) of the Chemical Engineering Program indicate expectations from our graduates a few years after graduation. The program faculty in collaboration with the School of Engineering's Education and Assessment Committee (SEAC), the CEMS department's External Advisory Board, and alumni developed these objectives. The objectives follow:

Graduates of the Stevens Bachelor of Engineering in Chemical Engineering are expected to:

- Apply mathematics, science and maturity of experience to lead in the solution of complex problems in chemical engineering.

- Demonstrate broad-based skills and understanding of problem solving, ethics, social awareness, safety, communication, teamwork and leadership to excel as recognized leaders in their profession.

In addition, a statement of the specific **Chemical Engineering Program Outcomes** that we aim to see demonstrated in the students we are preparing for the profession follow.

Graduates of the Bachelor of Engineering Chemical Engineering Program from Stevens Institute of Technology will:

▸ Be able to apply basic scientific principles in physics, mathematics, physical chemistry, organic chemistry, materials science and biological sciences as well as principles of material and energy balances, heat, mass and momentum transfer, kinetics and thermodynamics and process control to analyze and solve complex chemical engineering problems.

▸ Be able to apply the basic chemical engineering concepts, tools and methods to design chemical engineering units and systems and be able to develop and assess alternative designs for chemical engineering systems incorporating considerations such as feasibility, cost, safety, legal/regulatory issues and societal impacts.

▸ Be able to prepare professional reports and deliver effective presentations to a wide range of audiences.

▸ Be cognizant of ethical and moral issues and codes relating to chemical engineering and general engineering practice that impact engineering solutions in global, economic, environmental and societal contexts.

▸ Be able to function on teams and assume leadership roles to create a collaborative and inclusive environment to address engineering problems by establishing goals, planning tasks and meeting objectives.

▸ Be able to develop and conduct experiments in conjunction with the use of basic instrumentation for process variables measurements, process sensors, process simulators and computer software for applications in process analysis and design.

▸ Display genuine interest and participate in the activities of the chemical engineering professional societies and pursue knowledge that goes beyond the classroom experience.

▸ Be able to apply fundamental knowledge in chemical engineering to nurture new technologies from concept to commercialization.

Chemical Engineering Curriculum

Term I

Course #	Course Name	Lecture	Lab	Study	Credit
CH 115	General Chemistry I	3	0	6	3
CH 117	General Chemistry Laboratory I	0	3	1	1
E 101	Engineering Experiences I	1	0	0	1
E 121	Engineering Design I: Introduction to Systems Thinking	0	3	2	2
E 120	Engineering Graphics	0	2	1	1
E 115	Introduction to Programming	1	2	3	2
MA 121; MA 122	Differential Calculus; Integral Calculus	4	0	8	4
CAL 103	Writing And Communications Colloquium	3	0	6	3
PE 200	Physical Education I	0	2	0	0
	Total	**12**	**12**	**27**	**17**

Term II

Course #	Course Name	Lecture	Lab	Study	Credit
CH 116	General Chemistry II	3	0	6	3
CH 118	General Chemistry Laboratory II	0	3	1	1
PEP 111	Mechanics	3	0	6	3
E 122	Engineering Design II: Field Sustainable Systems with Sensors	0	3	3	2
MA 123; MA 124	Series, Vectors, Functions, and Surfaces; Calculus of Two Variables	4	0	8	4
CAL 105	CAL Colloquium: Knowledge, Nature, Culture	3	0	6	3
PE 200	Physical Education II	0	2	0	0
MGT 103	Introduction to Entrepreneurial Thinking	1	2	0	2
	Total	**14**	**10**	**30**	**18**

Term III

Course #	Course Name	Lecture	Lab	Study	Credit
MA 221	Differential Equations	4	0	8	4
PEP 112	Electricity and Magnetism	3	0	6	3
E 126	Mechanics of Solids	4	0	8	4
E 245	Circuits and Systems	2	3	7	3
E 231	Engineering Design III: Structural Performance and Failure	0	3	2	2
Hum	Humanities[1]	3	0	6	3
PE 200	Physical Education III	0	2	0	0
	Total	**16**	**8**	**37**	**19**

Term IV

Course #	Course Name	Lecture	Lab	Study	Credit
E 232	Engineering Design IV: Systems with Analog Circuits	2	3	7	3
CHE 234	Chemical Engineering Thermodynamics	4	0	8	4
CHE 210	Process Analysis	3	0	3	3
Hum	Humanities[1]	3	0	6	3
PE 200	Physical Education IV	0	2	0	0
E 344	Materials Processing	3	0	6	3
MA 227	Multivariable Calculus	3	0	6	3
	Total	**18**	**5**	**36**	**19**

Term V

Course #	Course Name	Lecture	Lab	Study	Credit
CHE 342	Heat and Mass Transfer	3	0	6	3
E 321	Engineering Design V: Materials Selection and Process Optimization	0	3	2	2
CHE 332	Separation Operations	3	0	6	3
CHE 336	Fluid Mechanics	3	0	6	3
Hum	Humanities[1]	3	0	6	3
CH 243	Organic Chemistry I	3	0	6	3
	Total	**15**	**3**	**32**	**17**

Term VI

Course #	Course Name	Lecture	Lab	Study	Credit
E 355	Engineering Economics	3	3	6	4
CHE 322	Engineering Design VI	1	4	5	3
CHE 351	Reactor Design	3	0	6	3
E 243	Probability and Statistics for Engineers	3	0	6	3
CHE 345	Process Control, Modeling and Simulation	3	0	3	3
BIO 281	Biology and Biotechnology	3	0	6	3
IDE 400	Senior Innovation I[4]	1	0	2	1
	Total	**17**	**7**	**34**	**20**

Term VII

Course #	Course Name	Lecture	Lab	Study	Credit
CH 245	Organic Chemistry Laboratory I	0	4	0	1
CHE 423	Engineering Design VII	0	8	4	3
CHE 432	Chemical Engineering Laboratory	1	4	6	2
IDE 401	Senior Innovation II	1	0	2	1
G.E.	General Elective[2]	3	0	6	3
T.E.	Chemistry Elective[3]	3	4	6	4
	Total	**8**	**20**	**24**	**14**

Term VIII

Course #	Course Name	Lecture	Lab	Study	Credit
T.E.	Chemistry Elective[3]	3	4	6	4
G.E.	General Elective[2]	3	0	6	3
CHE 424	Engineering Design VIII[1]	0	8	4	3
IDE 402	Senior Innovation III	1	0	2	1
Hum	Humanities[1]	3	0	6	3
G.E.	General Elective[2]	3	0	6	3
	Total	**13**	**12**	**30**	**17**

(1) Humanities requirements can be found on pages 599-600.
(2) General Electives – chosen by the student - can be used towards a minor or option - can be applied to research or approved
    international studies
(3) Technical Elective
(4) IDE 400 can be taken concurrently with IDE 401 in Term VII as determined by the engineering program

Graduation Requirements

Physical Education Requirements

‣ All undergraduate students must complete a minimum of four semesters of Physical Education (P.E.). A large number of activities are offered in lifetime, team and wellness areas.

‣ All P.E. courses must be completed by the end of the sixth semester. Students can enroll in more than the minimum required P.E. for graduation and are encouraged to do so.

‣ Participation in varsity sports can be used to satisfy up to three semesters of the P.E. requirement.

▸ Participating in club sports can be used to satisfy up to two of the PE requirements.

Note: Student may repeat Physical Education class but the repeated course (excluding varsity and club sports) will not count toward the graduation requirement.

<u>Humanities Requirements</u>

All undergraduate students are required to fulfill certain Humanities requirements in order to graduate. Please see pages 599-600 for a breakdown of specific requirements by program.

Minors

Students may qualify for a minor in biochemical or chemical engineering by taking the required courses indicated. Completion of a minor indicates proficiency beyond that provided by the Stevens curriculum in the basic material of the selected area. Student must meet the Institute requirements for enrolling into a minor program. At least two courses in the minor must be overload courses, beyond the credit requirements for all other programs being pursued by the student. Moreover these courses cannot be used for graduate credits. In addition, the grade in any course credited for a minor must be "C" or better.

Requirements for a Minor in Biochemical Engineering for students enrolled in the Chemical Engineering curriculum

▸ CH 243: Organic Chemistry I

▸ CH 244: Organic Chemistry II

▸ BIO 281: Biology and Biotechnology

▸ BIO 381: Cell Biology

Requirements for a Minor in Chemical Engineering for students enrolled in the Engineering curriculum

▸ CHE 210: Process Analysis

▸ CHE 234: Chemical Engineering Thermodynamics

▸ CHE 332: Separation Operations

▸ CHE 336: Fluid Mechanics

▸ CHE 342: Heat and Mass Transfer

▸ CHE 351: Reactor Design

* CHE 234 and 336 may be waived if appropriate substitutes have been taken in other programs.

GRADUATE PROGRAMS

The department offers programs of study leading to the Master of Engineering, Master of Science and the Doctor of Philosophy degrees. Courses are offered in chemical, biochemical, polymer engineering and materials science and engineering. The programs are designed to prepare graduates for a wide range of professional opportunities in manufacturing, design, research, or in development. Special emphasis is given to the relationship between basic science and its applications in modern technology. Chemical, and materials engineers create, design, and improve processes and products that are vital to our society. Our programs produce broad-based graduates who are prepared for careers in many fields and who have a solid foundation in research and development methodology. We strive to create a vibrant intellectual setting for our students and faculty anchored by pedagogical innovations and interdisciplinary research excellence. Active and well-equipped research laboratories in polymer processing, biopolymers, highly filled materials, microchemical systems, catalysis, high-performance coatings, photonic devices and systems, and nanotechnology are available for Ph.D. dissertations and master's theses.

Admission to the degree programs requires an undergraduate education in chemical engineering, materials science and, or related disciplines.

Master's Programs

The Master of Engineering or Master of Science requires 30 graduate credits in an approved plan of study. 6 to 9 credits can be obtained by performing research in the form of a master's thesis. The curriculum must include the following core courses:

Master of Engineering - Chemical Engineering

Chemical Engineering Concentration (10 Courses)

- ‣ MA 530: Applied Mathematics for Engineers and Scientists II
- ‣ CHE 620: Chemical Engineering Thermodynamics
- ‣ CHE 630: Theory of Transport Processes
- ‣ CHE 650: Reactor Design

Plus six courses or thesis work in combination with three to four courses.

Polymer Engineering Concentration (10 Courses)

- ‣ CHE 630: Theory of Transport Processes
- ‣ CHE 560: Fundamentals of Polymer Science
- ‣ CHE 671: Polymer Rheology
- ‣ CHE 672: Processing of Polymers for Biomedical Applications

Plus six courses or thesis work in combination with three to four courses.

Master of Engineering and Master of Science – Materials Science and Engineering

The degree in Master of Engineering or Master of Science requires a total of 10 courses, 4 of which must be from the core with balance in electives and research. The Master of Science typically requires enrollment in a special problem course or research credit. Candidates may choose either a special topic or thesis research with any member of the faculty in the department to satisfy the research requirement. A minimum GPA of 3.0 is required for the Master's degree.

Core Courses

Any three of the following courses:

- ‣ MT 521 Thermodynamics of Materials
- ‣ MT 601 Structure and Diffraction
- ‣ MT 602 Principles of Inorganic Materials
- ‣ MT 665 Soft Matter Physics

Plus:

- ‣ MT 650 Innovation and Entrepreneurship in Materials Science and Engineering

Microelectronics and Photonics Science and Technology - Interdisciplinary

The master's degree is also available in the concentration of Microelectronics and Photonics Science and Technology (MPST), which is an interdisciplinary area of study jointly administered with several other Departments in the School of Engineering and Science.

Core Courses

- MT 507 Introduction to Microelectronics and Photonics

- Four additional courses from the Materials core (listed above).

- Five electives are required from the courses offered below by Materials Science and Engineering, Physics and Engineering Physics, and Electrical Engineering. Three of these courses must be from Materials Science and Engineering and one must be from each of the other two departments. Ten courses are required for the degree.

Required Concentration Electives

- PEP 503 Introduction to Solid State Physics

- PEP 515 Photonics I

- PEP 516 Photonics II

- PEP 561 Solid State Electronics I

- MT 562 Solid State Electronics II

- MT 595 Reliability and Failure of Solid State Devices

- MT 596 Microfabrication Techniques

- EE 585 Physical Design of Wireless Systems

- EE 626 Optical Communication Systems

- CPE 690 Introduction to VLSI Design

Doctoral Programs

Doctoral Program in Chemical Engineering or Materials Science and Engineering

Admission to the Chemical Engineering or Materials Science and Engineering doctoral program is based on evidence that a student will prove capable of scholarly specialization in a broad intellectual foundation of a related discipline. The master's degree is strongly recommended for students entering the doctoral program. Applicants without the master's degree will normally be enrolled in the master's program.

Eighty-four credits of graduate work in an approved program of study are required beyond the bachelor's degree; this may include up to 30 credits obtained in a master's degree program, if the area of the master's degree is relevant to the doctoral program. A doctoral dissertation for a minimum of 30 credits and based on the results of the student's original research, carried out under the guidance of a faculty member and defended in a public examination, is a major component of the doctoral program. The Ph.D. qualifying exam consists of a written and an oral exam. Students are strongly encouraged to take the qualifying exam within two semesters of enrollment in the graduate program. A minimum of 3.5 GPA must be satisfied in order to take the exam. A time limit of six years is set for completion of the doctoral program.

Interdisciplinary

An interdisciplinary Ph.D. program is jointly offered with the Departments of Physics, Biomedical Engineering and Chemistry & Chemical Biology. This program aims to address the increasingly cross-cutting nature of doctoral research in these disciplines. The interdisciplinary Ph.D. program aims to take advantage of the complementary educational offerings and research opportunities in these areas. Any student who wishes to enter this interdisciplinary program needs to obtain the consent of the two departments involved and the subsequent approval of the Dean of Academic Administration. The student will follow a study plan designed by his/her faculty advisor(s). The student will be granted official candidacy in the program upon successful completion of a qualifying exam that will be administered according to the applicable guidelines of the Office

of Graduate Admissions. All policies of the Office of Graduate Admissions that govern the credit and thesis requirements apply to students enrolled in this interdisciplinary program. Interested students should follow the normal graduate application procedures through the Dean of Academic Administration.

Research

A thesis for the master's or doctoral program can be completed by participating in one of the following research programs of the department.

- Polymeric Biomaterials - Professor Matthew Libera

- Electron Microscopy of Soft Matter - Professor Matthew Libera

- Heterogeneous Catalysis: Catalyst Development, Characterization, Testing and Molecular Modeling - Professor Simon Podkolzin

- Biofuels from Renewable Feedstocks (e.g., Algae, Lignocellulosic feedstock) - Professor Adeniyi Lawal

- Microchemical Systems and Process Itensification - Professor Adeniyi Lawal

- Micro/nano Approaches for Alternative Energy Systems - Professor Ronald Besser

- Fuel Cell Materials and Architectures - Professor Ronald Besser

- Solar Energy Harvesting, Crystal Engineering, Scalable Manufacturing of Optoelectronic Devices - Professor Stephanie Lee

- Polymer nanocomposites, polymer-grafted particles for energy applications, self-assembly strategies for functional nanoparticles, dynamic heterogeneities in polymer nanocomposites - Professor Pinar Akcora

- Electrochemistry for Functional Materials, Battery Materials Design, Solid-State Chemistry - Professor Jae Chul Kim

- Human Tissues on a Chip - Professor Woo Lee

- Rheology, Simulation and Processing of Comples Fluids, including polymers, microgels, highly filled suspensions and nanosuspensions - Professor Dilhan Kalyon

- Development of Novel Processing Methods for the Fabrication of Graft Substitutes, Implants and Tissue Scaffolds and Constructs - Professor Dilhan Kalyon

- Fundamentals of Flow and Deformation Behavior and Wall Slip of Viscoplastic Fluids - Professonal Dilhan Kalyon

- Surface Modification at Multiple Length Scales, Plasmonic Nanoparticles for Sensing and Imaging, Novel Fiber Optic Sensors - Professor Henry Du

Graduate Certificate Programs

In addition to the degree programs, the department also offers graduate certificate programs. In most cases, the courses may be used toward the master's degree. Each graduate certificate program is a self-contained and highly focused collection of courses carrying nine or more graduate credits. The selection of courses is adapted to the professional interests of the student.

The Graduate Certificate in Pharmaceutical Manufacturing is an interdisciplinary School of Engineering certificate developed by the Department of Mechanical Engineering and the Department of Chemical Engineering and Materials Science. This certificate is intended to provide professionals with skills required to work in the pharmaceutical industry. The focus is on engineering aspects of manufacturing and the design of facilities for pharmaceutical manufacturing, within the framework of the regulatory requirements in the pharmaceutical industry.

The certificate is designed for technologists in primary manufacturers, including pharmaceutical, biotechnology, medical device, diagnostic, and cosmetic companies, as well as in related companies and organizations.

Pharmaceutical Manufacturing

▸ CHE 530 Introduction to Pharmaceutical Manufacturing

▸ CHE 535 Good Manufacturing Practice in Pharmaceutical Facilities Design

▸ CHE 540 Validation in Life Sciences Manufacturing

and one of the following electives:

▸ CHE 626 Manufacturing of Biopharmaceutical Products

▸ CHE 628 Manufacturing and Packaging of Pharmaceutical Oral Solid Dosage Products

▸ CHE 629 Manufacturing of Sterile Pharmaceuticals

(Full course descriptions can be found in the Interdisciplinary Programs section.)

Photonics

▸ EE/MT/PEP 507 Introduction to Microelectronics and Photonics

▸ EE/MT/PEP 515 Photonics I

▸ EE/MT/PEP 516 Photonics II

▸ EE/MT/PEP 626 Optical Communication Systems

Microelectronics

▸ EE/MT/PEP 507 Introduction to Microelectronics and Photonics

▸ EE/MT/PEP 561 Solid State Electronics I

▸ EE/MT/PEP 562 Solid State Electronics II

▸ CpE/MT/PEP 690 Introduction to VLSI Design

Microdevices and Microsystems

▸ EE/MT/PEP 507 Introduction to Microelectronics and Photonics

▸ EE/MT/PEP 595 Reliability and Failure of Solid State Devices

▸ EE/MT/PEP 596 Micro-Fabrication Techniques

▸ EE/MT/PEP 685 Physical Design of Wireless Systems

Any one elective in the three certificates above may be replaced with another within the Microelectronics and Photonics (MP) curriculum upon approval from the MP Program Director.

COURSE OFFERINGS

Chemical Engineering

CHE 210   Process Analysis   (3 - 3 - 0)
The objective of this course is to train students in the application of the basic concepts of material and energy balances in chemical process design. Equations of state for ideal and real gases, including mixtures will be covered. Multiphase systems will also be studied. Prerequisites: CH 116, MA 221

CHE 234   Chemical Engineering Thermodynamics   (4 - 4 - 0)

Thermodynamic laws and functions with particular emphasis on systems of variable composition and chemically reacting systems. Chemical potential, fugacity and activity, excess function properties, standard states, phase and reaction equilibria, reaction coordinate, chemical-to-electrical energy conversion. Prerequisites: E 115, CH 116, MA 221

CHE 322   Engineering Design VI   (3 - 1 - 4)

The objectives of this course are to learn modern systematic design strategies for steady state chemical processing systems and at the same time to gain a functional facility with a process simulator (Aspen) for design, analysis, and economic evaluation. A process is constructed stepwise, with continuing discussion of heuristics, recycle, purge streams, and other process conditions. Aspen is used for design and analysis of the process units. From the viewpoint of the process simulations, the course is divided into four categories: Component, property and data management; Unit operations; System simulation; and Process economic evaluation. The equations used by the simulator are discussed as well as convergence methods, loops and tear streams and scrutiny of default settings in the simulator. The factored cost method and profitability measures are reviewed and compared to simulator results. Work on a capstone design project is begun in the last section of the course. Prerequisites: CHE 332, E 321 Corequisite: CHE 351

CHE 332   Separation Operations   (3 - 3 - 0)

The design of industrial separation equipment using both analytical and graphical methods is studied. Equilibrium based design techniques for single and multiple stages in distillation, absorption/stripping, and liquid-liquid extraction are employed. An introduction to gas-solid and solid-liquid systems is presented as well. Mass transfer considerations are included in efficiency calculations and design procedures for packed absorption towers, membrane separations, and adsorption. Ion exchange and chromatography are discussed. The role of solution thermodynamics and the methods of estimating or calculating thermodynamic properties are also studied. Degrees of freedom analyses are threaded throughout the course as well as the appropriate use of software. Iterative rigorous solutions are discussed as bases for Aspen simulation models used in Design VI. Prerequisite: CHE 210

CHE 336   Fluid Mechanics   (3 - 3 - 0)

Fluid categories, balances of mass, energy, and momentum in the context of fluid components. Hydrostatics and the fluids in laminar, turbulent, and transitional flows. Particular attention is given to flow inside pipes including the concepts of friction and pressure drop, and the effects of changes in height and pumping energy. Fluid moving equipment and flow in porous media. Use of computational tools to solve complex and/or repetitive fluid flow problems.

CHE 342   Heat and Mass Transfer   (3 - 3 - 0)

Heat conduction, convection and radiation. General differential equations for heat transfer. Conductive and convective heat transfer. Convective heat transfer correlations. Heat exchanger design. Molecular, convective and interface mass transfer. Steady state molecular diffusion and film theory. Convective mass transfer correlations. Mass transfer equipment. Prerequisites: CHE 210, CHE 234, MA 221

CHE 345   Process Control, Modeling and Simulation   (3 - 3 - 0)

Development of deterministic and non-deterministic models for physical systems, engineering applications, and simulation tools for case studies and projects. Prerequisite: CHE 332 Corequisite: CHE 351

CHE 351   Reactor Design   (3 - 3 - 0)

Chemical equilibria and kinetics of single and multiple reactions are analyzed. Conversion, yield, selectivity, and temperature and concentration history are studied in ideal plug flow, continuous stirred tank and batch reactors. The bases of reactor selection are developed. Rate expressions for catalytic reactors are developed using L-H approach and applied to the design of fixed bed catalytic reactors. Prerequisites: CHE 210, CHE 342, CHE 336

CHE 423   Engineering Design VII   (3 - 0 - 8)

Senior Design provides, over the course of two semesters, collaborative design experiences with a problems of industrial or societal significance. Projects can originate with an industrial sponsor, from an engineering project on campus, or from other industrial or academic sources. In all cases, a project is a capstone experience that draws extensively from the student's engineering and scientific background and requires independent judgments and actions. Advice from the faculty and industrial sponsors is made readily available. The projects generally involve a number of unit operations, a detailed economic analysis, simulation, use of industrial economic and process software packages, and experimentation and/or prototype construction. The economic thread initiated in Design VI is continued in the first semester of Senior Design by close interaction on a project basis with IDE 400. Leadership and entrepreneurship are nourished throughout all phases of the project. The project goals are met stepwise, with each milestone forming a part of a final report with a common structure. Prerequisites: CHE 322, CHE 351, CHE 345

CHE 424   Engineering Design VIII   (3 - 0 - 8)

Senior Design (ChE 423, ChE 424) provides, over the course of two semesters, collaborative design experiences with problems of industrial or societal significance. Projects can originate with an industrial sponsor, from an engineering project on campus, or from other industrial or academic sources. In all cases, a project is a capstone experience that draws extensively from the student's engineering and scientific background and requires independent judgments and actions. Advice from the faculty and industrial sponsors is made readily available. The projects generally involve a number of unit operations, a detailed economic analysis, simulation, use of industrial economic and process software packages, and experimentation and/or prototype construction. The economic thread initiated in Design VI is continued in the first semester of Senior Design (ChE 423) by close interaction on a project basis with IDE 401. Leadership and entrepreneurship are nourished throughout all phases of the project. The project goals are met stepwise, with each milestone forming a part of a final report with a common structure. Prerequisite: CHE 423

CHE 432   Chemical Engineering Laboratory   (2 - 1 - 4)

A laboratory course designed to illustrate and apply chemical engineering fundamentals. The course covers a range of experiments involving mass, momentum, and energy transport processes and basic unit operations such as distillation, stripping and multi-phase catalytic reactions. Prerequisites: CHE 332, CHE 351

CHE 480   Biochemical Engineering   (3 - 3 - 0)

Integration of the principles of biochemistry and microbiology into chemical engineering processes; microbial kinetic models; transport in bioprocess systems; single & mixed culture fermentation technology; enzyme synthesis, purification & kinetics; bioreactor analysis, design and control; product recovery and downstream processing. Prerequisite: CHE 351

CHE 498   Research in CHE I   (- -)

Individual investigation of a substantive character undertaken at an undergraduate level under the guidance of a member of the Departmental faculty on a Course by Application basis. A written report is required. Hours to be arranged with the faculty advisor.

CHE 499   Research in Chemical Engineering II   (- -)

Individual investigation of a substantive character undertaken at an undergraduate level under the guidance of a member of the departmental faculty on a Course by Application basis. A written report is required. Hours to be arranged with the faculty advisor.

CHE 504   Safety of Pilot Plants and Research Operations   (3 - 3 - 0)

This course is intended to teach the basis of safety in pilot plants, laboratory and similar research operations. It will focus on the practical concerns faced in industry and highlight specifics not readily available elsewhere.

CHE 521   Chemical and Materials Thermodynamics   (3 - 3 - 0)

The principal areas of concentration include a review of the first and second laws of thermodynamics for closed and open systems; the calculus of thermodynamics; equilibrium criteria and stability criteria; properties of pure materials and unary systems; elementary applications of statistical thermodynamics to determine specific heats; chemical potentials and equilibria in heterogeneous systems, fugacity and activity functions; solution thermodynamics; vapor-liquid, liquid-liquid, vapor-liquid-liquid and solid-liquid equilibria and phase diagrams; chemical equilibria; surfaces and surface tension.

CHE 530   Introduction to Pharmaceutical Manufacturing   (3 - 3 - 0)

Pharmaceutical manufacturing is vital to the success of the technical operations of a pharmaceutical company. This course is approached from the need to balance company economic considerations with the regulatory compliance requirements of safety, effectiveness, identity, strength, quality, and purity of the products manufactured for distribution and sale by the company. Overview of chemical and biotech process technology and equipment, dosage forms and finishing systems, facility engineering, health, safety, & environment concepts, and regulatory issues.

CHE 531   Process Safety Management   (3 - 3 - 0)

This course reviews the 12 elements of the Process Safety Management (PSM) model created by the Center for Chemical Process Safety of the American Institute of Chemical Engineers. PSM systems were developed as an expectation/demand of the public, customers, in-plant personnel, stockholders and regulatory agencies because reliance on chemical process technologies were not enough to control, reduce and prevent hazardous materials incidents. PSM systems are comprehensive sets of policies, procedures and practices designed to ensure that barriers to major incidents are in place, in use and effective. The objectives of this course are to: define PSM and why it is important, describe each of the 12 elements and their applicability, identify process safety responsibilities, give real examples and practical applications to help better understand each element, share experiences and lessons learned of all participants, and assess the quality and identify enhancements to student's site PSM program. Cross-listed with: PME 531

CHE 535   Good Manufacturing Practice in Pharmaceutical Facilities Design   (3 - 3 - 0)

Current Good Manufacturing Practice compliance issues in design of pharmaceutical and biopharmaceutical facilities. Issues related to process flow, material flow, and people flow, and A&E mechanical, industrial, HVAC, automation, electrical, and computer. Bio-safety levels. Developing effective written procedures, so that proper documentation can be provided, and then documenting through validation that processes with a high degree of assurance do what they are intended to do. Levels I, II, and III policies. Clinical phases I, II, III and their effect on plant design. Defending products against contamination. Building quality into products.

CHE 540   Validation in Pharmaceutical Manufacturing   (3 - 3 - 0)

Validation of a pharmaceutical manufacturing process is an essential requirement with respect to compliance with Good Manufacturing Practices (GMP). Course covers: validation concepts for process, equipment, facility, cleaning, sterilization, filtration, analytical methods and computer systems; validation Master Plans, IQ, OQ, and PPQ protocols; and validation for medical devices. Cross-listed with: PME 540, ME 540 Prerequisites: CHE 530 or ME 530 or PME 530

CHE 541   Validation of Computerized Systems   (3 - 3 - 0)

Computers and computerized systems are ubiquitous in pharmaceutical manufacturing. Validation of these systems is essential to assure public safety and compliance with appropriate regulatory issues regarding validation: GMP, GCP, 21CFR Part 11, etc. This course covers validation concepts for various classes of computerized systems and applications used in the pharmaceutical industry; importance of requirements engineering in validation; test protocols and design; organizational maturity considerations. Prerequisite: CHE 540

CHE 555   Catalysis and Characterization of Nanoparticles   (3 - 3 - 0)

Most processes in petroleum and chemical industries utilize catalytic reactions. Moreover, many emerging technologies in the energy sector and in green chemistry for sustainability rely on catalysis. This course provides the fundamentals of synthesis, characterization and testing of catalytic materials with an emphasis on metal and metal oxide nanoparticles, the most widely used class of catalysts. Methodologies for development of molecular-level reaction mechanisms, material structure-activity relations and kinetic models are described. The course is essential for anyone planning a career in the chemical industry. It is recommended for all professionals working with nanoparticles and also with diverse applications where the solid-gas interface is important. Cross-listed with: MT 555, NANO 555, EN 555, CH 555

CHE 560   Fundamentals of Polymer Science   (3 - 3 - 0)

This course will be an introductory level graduate course in polymers. Methods in polymer formation and structural characterization of polymers will be introduced as they determine their applications in bio and nanotechnology. Polymer blends, block copolymers, networks and gelation and scattering techniques will be also covered. Examples on nanotechnology applications of self-assembled polymers and nanocomposites will be emphasized.

CHE 580   Biofuels Engineering Technology   (3 - 3 - 0)

This course is designed for both science and engineering students who want to contribute to the development and implementation of processes for production of important renewable energy sources. In this course, students will learn the fundamental concepts of important biofuels and the current state-of -the-art technology for their production along with economics, environmental impact, and policy issues. Benefiting from this course, students would be able to evaluate ways for converting feedstocks to biofuels by both biochemical and thermochemical methods and integrate conceptual design of a biofuel process. As a fundamental cross-discipline course, topics are comprehensive yet introductory and require the minimal prerequisite learning in chemistry and thermodynamics. Prerequisite: CH 321 or CHE 234

CHE 612   Stagewise Operations   (3 - 3 - 0)

The ultimate goal of this course is to prepare students to undertake the analysis of the most difficult problems in equilibrium stage operations. The problems typically involve one or more process columns with components exhibiting highly non-ideal behavior. This class of problems includes azeotropic distillation, extractive distillation, columns with more than one liquid phase, and a variety of other anomalies. Lack of complete equilibrium data is not uncommon. Extensive use is made of commercial software in the solution of problems. The course concludes with the assignment of an industrial problem as a substantial project requiring that the students exercise virtually all techniques studied.

CHE 620   Chemical Engineering Thermodynamics   (3 - 3 - 0)

This course supplements the clasical undergraduate thermodynamics course by focusing on physical and thermodynamic properties, and phase equilibria. A variety of equations of state and their applicability are introduced as are all of the important liquid activity coefficient equations. Customization of both vapor and liquid equations is introduced by appropriate methods of applied mathematics. Vapor-liquid, liquid-liquid, vapor-liquid-liquid and solid-liquid equilibria are considered with rigor. Industrial applications are employed. A variety of methods for estimating physical and thermodynamic properties are introduced. Students are encouraged to use commercial software in applications. The course concludes with an introduction to statistical thermodynamics.

CHE 626   Manufacturing of Biopharmaceutical Products   (3 - 3 - 0)

This course is focused on topics related to the technology, design and operations of modern biopharmaceutical facilities. It covers process, utilities and facility design issues and encompasses all major manufacturing areas, such as fermentation, harvest, primary and final purification, media and buffer preparation, equipment cleaning and sterilization, critical process utilities, unit operations including cell culture, centrifugation, conventional and tangential flow filtration, chromatography, solution preparation, and bulk filling. The application of current Good Manufacturing Practices and Bioprocessing Equipment Standards will be discussed. Prerequisite: PME 530 or ME 530 or CHE 530

CHE 628   Manufacturing and Packaging of Pharmaceutical Oral Solid Dosage Products   (3 - 3 - 0)

The course covers oral solid dosage (OSD) manufacturing and packaging in the pharmaceutical industry. Production unit operations include blending, granulation, size reduction, drying, compressing, and coating for tablets, as well as capsule filling. Packaging aspects reviewed include requirements for primary and secondary containers and labeling, package testing. The course emphasizes design, scale-up, trouble-shooting, validation, and operation of typical OSD manufacturing and packaging facilities, including equipment, material flow, utilities, and quality assurance. Topics related to cGMP, process validation, manufacturing and packaging documentation, QA and QC in OSD manufacturing will be presented. The term project required for this course involves conceptual design of a contract manufacturing and packaging facility for OSD products, including equipment selection, development of the process flow diagrams, room layouts and other design elements, as well as preparation of Standard Operating Procedures for various unit operations.

CHE 629   Manufacturing of Sterile Pharmaceuticals   (3 - 3 - 0)

This course is focused on the special characteristics and types of sterile dosage forms and the technologies for their manufacturing. Topics such as environmental and contamination controls, facility design, water and air quality, personnel and other requirements for sterile manufacturing are covered. Sterilization methods for the equipment, components, intermediate and finished products are reviewed. Terminal sterilization and aseptic processing technologies including blow-fill-seal and barrier isolation systems are discussed. The course also includes topics such as Good Manufacturing Practices (GMP) regulations and guidance on aseptic manufacturing, quality assurance and control, stability, storage and distribution applicable to sterile dosage forms manufacturing. Prerequisite: CHE 530 or ME 530 or PME 530

CHE 630   Theory of Transport Processes   (3 - 3 - 0)

Generalized approach to differential and macroscopic balances: constitutive material equations; momentum and energy transport in laminar and turbulent flow; interphase and intraphase transport; dimensionless correlations.

CHE 639   Modeling and Simulation of Pharmaceutical Manufacturing Systems   (3 - 3 - 0)

This course will introduce students to the modeling and simulation applications in the pharmaceutical manufacturing. Learn the basics of discrete event simulation and use commercially available software to develop models of various manufacturing and service systems. Approaches to the development of conceptual and computer models, data collection and analysis, model verification and validation, simulation output analysis are discussed. Learn how to model chemical, biochemical and separation processes in pharmaceutical manufacturing using process simulation software. Develop material balances, stream reports, operations and equipment Gantt charts, conduct process debottlenecking and cost analysis. Cross-listed with: PME 639, ME 639

CHE 650   Reactor Design   (3 - 3 - 0)

A graduate-level reaction engineering course that builds on previous student experience in undergraduate reactor design. Review of design equations based on the mole balances of ideal reactor types. Review of algorithms for isothermal reactor design. Theory of reaction rates and the measurement and assessment of rate data. Basis and approach to using the steady-state approximation for catalytic and biological reactions. Residence time distributions, their experimental determination and implementation for the prediction of conversion. Modeling reactors with fundamental equations of transport as the basis. Modeling reactors in three dimensions with computational tools.

CHE 660   Advanced Process Control   (3 - 3 - 0)

Mathematical modeling and identification of chemical processes. State-space process representation and analysis: stability, observability, controllability and reach-ability. Analysis and design of advanced control systems: internal model control, dynamic matrix control and model predictive control. Synthesis of multivariable control systems: interaction analysis, singular value decomposition, decoupler design. Continuous and sampled-data systems, on-line process identification. State and parameter estimation techniques: Luenberger observer and Kalman filter. Knowledge of Laplace transforms, material and energy balances, computer programming and matrix algebra is required.

CHE 661/   Design of Control Systems   (3 - 0 - 3)
ME 623

This course focuses on the application of advanced process control techniques in pharmaceutical and petrochemical industries. Among the topics considered are bioreactor and polymerization reactor modeling, biosensors, state and parameter estimation techniques, optimization of reactor productivity for batch, fed-batch and continuous operations, and expert systems approaches to monitoring and control. An overview of a complete automation project - from design to startup - of a pharmaceutical plant will be discussed. Included: process control issues and coordination of interdisciplinary requirements and regulations. Guest speakers from local industry will present current technological trends. A background in differential equations, biochemical engineering, and basic process control is required.

CHE 662   Chemical Process Simulation   (3 - 3 - 0)

The course comprises a series of workshops, employing an industrial process simulator, Aspen Plus, which explore the primary components required to simulate a chemical process. Most workshops have embedded irregularities designed to heighten the student awareness of the types of errors that could arise when using simulation software. The workshops include facilities to exercise and customize a wide variety of physical and thermodynamic properties as the students develop process models. Heavy concentration is on the equations describing the models used. As the experience level of the students rises, workshops designed to introduce complicated industrial flowsheets are employed.

CHE 670   Polymer Properties and Structure   (3 - 3 - 0)

Stress-strain relationships, theory of linear viscoelasticity and relaxation spectra, temperature dependence of viscoelastic behavior, dielectric properties, dynamic mechanical and electrical testing, molecular theories of flexible chains, statistical mechanics and thermodynamics of rubber-like undiluted systems, morphology of high polymers. Cross-listed with: MT 670

CHE 671   Polymer Rheology   (3 - 0 - 0)

Molecular and continuum mechanical constitutive equations for viscoelastic fluids; analysis of viscometric experiments to evaluate the viscosity and normal stress functions: dependence of these functions on the macromolecular structure of polymer melts: solution of isothermal and nonisothermal flow problems with non-Newtonian fluids which are encountered in polymer processing; development of design equations for extruder dies and molds. Prerequisite: CHE 630

CHE 672   Processing of Polymers for Biomedical Applications   (3 - 0 - 0)

Descriptions of various polymer processing operations and processing requirements of biomedical products, principles of processing of polymers covering melting, pressurization, mixing, devolatilization, shaping using extrusion, spinning, blowing, coating, calendering and molding technologies, surface treatment and sterilization, applications in the areas of prostheses and artificial organs and packaging of various biomedical devices. Prerequisite: CHE 630

CHE 673   Polymerization Engineering   (3 - 3 - 0)

Analysis and design of experimental and industrial polymerization reactors for various polymerization mechanisms: relationship between design parameters and polymer structure, yield and average molecular weight: kinetic and statistical methods; batch and continuous, addition and condensation polymerization in bulk, solution, suspension and emulsion.

CHE 674   Design of Polymer Processing Machinery   (3 - 3 - 0)

A treatment of polymer processing machinery with emphasis on the design of components to implement the various elementary steps involved, and subsequent assembly of these components into processing machines. Use is made of computational models. Principles of control systems are applied to processing machinery. The primary objective is to stimulate creative approaches to the design of processing machinery rather than to familiarize the student with the details of existing machinery. Prerequisite: CHE 672

CHE 675   Polymer Blends and Composites   (3 - 3 - 0)

Recent advances in polymer blend and composite formation; the role of melt rheology in component selection and the resulting morphology; melt mixing processes and equipment; models for predicting processing and performance characteristics; morphology generation and control in manufacturing processes; sample calculations and case histories for polyblends used in film blowing, blow molding and injection molding.

CHE 676   Polymer Mold and Die Design   (3 - 0 - 0)

Principal manufacturing methods utilizing molds and dies; mold and die design characteristics dictated by functional requirements; interaction between molds/dies and processing machinery; mathematical models of forming processes including: flow through dies and into molds, solidification, heat transfer and reaction (in reactive processing); end-product properties (morphology, bulk properties, tolerances, appearance) and operating conditions in alternative manufacturing methods; materials and manufacturing methods for molds and dies; case studies.

CHE 677   Polymer Product Design   (3 - 0 - 0)

Design of polymeric products; design criteria based upon product functions and geometry; material selection by property assessment; selection of molds, dies, and special manufacturing devices (e.g., mold inserts); selection of appropriate forming process (injection, rotational or blow-molding, extrusion, etc.), and determination of optimum operating conditions (such as temperature, pressure, cycle or residence time). Case histories of failure.

CHE 678   Experimental Methods in Polymer Melt Rheology   (3 - 3 - 3)

Discussion of models for flow and deformation in polymers, and a treatment of measurable rheological properties. Analysis of thermoplastic and thermosetting resins for processability. Use of experimental data to determine parameters of the constitutive equations. Laboratory includes use of state-of-art equipment in elongational, rotational, and capillary viscometry.

CHE 682   Colloids and Interfacial Phenomena   (3 - 0 - 0)

A survey course covering the chemical, biological and material science aspects of interfacial phenomena. Applications to adhesion, biomembranes, colloidal stability, detergency, lubrication, coating, fibers, and powders - were surface properties play an important role. Prerequisites: Physical Chemistry and Thermodynamics. Prerequisites: E 321, CH 321, CH 421

CHE 695   Bio/Nano Photonics   (3 - 0 - 0)

This course deals with the principles of light interactions with biological and biomedical-relevant systems. The enabling aspects of nanotechnology for advanced biosensing, medical diagnosis, and therapeutically treatment will be discussed. Cross-listed with: BME 695, NANO 695, NANO 695

CHE 700   Seminar in Chemical Engineering   (3 - 0 - 0)

Lectures by department faculty, guest speakers, and doctoral students on recent research. Cross-listed with: BME 700, MT 700

CHE 701-702   Selected Topics in Chemical Engineering III-IV   (3 - 3 - 0)

Selected topics of current interest in the field of chemical engineering will be treated from an advanced point of view.

CHE 770-771   Selected Topics in Polymer Science and Engineering III-IV   (3 to 6 - 3 to 6 - 0)

A critical review of current theories and experimental aspects of polymer science and engineering.(Three to Six credits.)

CHE 800   Special Problems in Chemical Engineering   (1 to 6 - -)

One to six credits. Limit of six credits for the degree of Master of Engineering (Chemical).

CHE 801   Special Problem in Chemical Engineering   (1 to 6 - -)

One to six credits. Limit of six credits for the degree of Doctor of Philosophy.

CHE 810   Special Topics in Chemical Engineering   (3 - -)

A participating seminar on topics of current interest and importance in Chemical Engineering.

CHE 900   Thesis in Chemical Engineering   (1 to 10 - -)

For the degree of Master of Engineering (Chemical). Credits to be arranged.

CHE 960   Research in Chemical Engineering   (- -)

Original research leading to the doctoral dissertation. Hours and credits to be arranged.

Materials Science and Engineering

MT 501   Introduction to Materials Science and Engineering   (3 - 3 - 0)

An introduction to the structures/properties relationships of materials principally intended for students with a limited background in the field of materials science. Topics include: structure and bonding, thermodynamics of solids, alloys and phase diagrams, mechanical behavior, electrical properties and the kinetics of solid state reactions. The emphasis of this subject is the relationship between structure and composition, processing (and synthesis), properties and performance of materials.

MT 502   Processing of Electronic Materials   (3 - 3 - 0)

This course deals with aspects of the technology of processing procedures involved in the fabrication of semiconductor devices. Topics include crystal growth, epitaxy, silicon oxide growth, impurity doping, ion implantation, photo and electron beam lithography, etching, sputtering, thin film metallization, assivation and packaging. A description of these fabrication techniques used for discrete devices (e.g., bi-polar transistor, field effect transistor, light-emitting diode and solar cell), as well as large-scale integrated thin film circuits, will be presented. Prerequisites: MT 501, E 344

MT 503   Introduction to Solid State Physics   (3 - 0 - 0)

Description of simple physical models which account for electrical conductivity and thermal properties of solids. Basic crystal lattice structures, X-ray diffraction, and dispersion curves for phonons and electrons in reciprocal space. Energy bands, Fermi surfaces, metals, insulators, semiconductors, superconductivity, and ferromagnetism. Fall semester. Cross-listed with: EE 503, PEP 503 Prerequisites: PEP 242, PEP 331

MT 505   Introduction to Biomaterials   (3 - 0 - 0)

Intended as an introduction for the student who is familiar with materials science, this course first reviews the properties of materials that are relevant to their application in the human body. It then introduces proteins, cells, tissues, and their reactions to foreign materials, and the degradation of these materials in the human body. The course then treats the various implants, burn dressings, drug delivery systems, biosensors, artificial organs, and elements of tissue engineering. Cross-listed with: BME 505 Prerequisite: MT 501

MT 506   Mechanical Behavior of Solids   (3 - 3 - 0)

Theory and practical means for predicting the behavior of materials under stress. Elastic and plastic deformation, fracture and high-temperature deformation (creep).

MT 507   Introduction to Microelectronics and Photonics   (3 - 3 - 0)

An overview of microelectronics and photonics science and technology. It provides the student who wishes to specialize in their application, physics or fabrication with the necessary knowledge of how the different aspects are interrelated. It is taught in three modules: design and applications, taught by EE faculty; operation of electronic and photonic devices, taught by physics faculty; fabrication and reliability, taught by materials faculty. Cross-listed with: EE 507, PEP 507

MT 515   Photonics I   (3 - 3 - 0)

This course will cover topics encompassing the fundamental subject matter for the design of optical systems. Topics will include optical system analysis, optical instrument analysis, applications of thin film coatings and opto-mechanical system design in the first term. The second term will cover the subjects of photometry and radiometry, spectrographic and spectrophotometric systems infrared radiation measurement and instrumentation, lasers in optical systems, and photon-electron conversion. Cross-listed with: PEP 515, EE 515 Prerequisite: PEP 209 or PEP 509 or EE 509

MT 516   Photonics II   (3 - 3 - 0)

This course will cover topics encompassing the fundamental subject matter for the design of optical systems. Topics will include optical system analysis, optical instrument analysis, applications of thin film coatings and opto-mechanical system design in the first term. The second term will cover the subjects of photometry and radiometry, spectrographic and spectrophotometric systems infrared radiation measurement and instrumentation, lasers in optical systems, and photon-electron conversion. Cross-listed with: PEP 516, EE 516 Prerequisite: PEP 209 or PEP 509 or EE 509

MT 518   Solar Energy: Theory & Application   (3 - 3 - 0)

This course is an in depth treatment of the principles and practice associated with using solar radiation as an alternate energy source. It examines the science of solar radiation, technologies for its capture and the design principles that are used to apply solar energy in building design. Cross-listed with: ME 518 Prerequisite: MT 518

MT 520   Composite Materials   (3 - 0 - 0)

Composite material characterization; composite mechanics of plates, panels, beams, columns, and rods integrated with design procedures; analysis and design of composite structures; joining methods and procedures; introduction to manufacturing processes of filament winding, braiding, injection, compression and resin transfer molding, machining and drilling; and industrial applications. Cross-listed with: ME 520

MT 521   Chemical and Materials Thermodynamics   (3 - 3 - 0)

The principal areas of concentration include a review of the first and second laws of thermodynamics for closed and open systems; the calculus of thermodynamics; equilibrium criteria and stability criteria; properties of pure materials and unary systems; elementary applications of statistical thermodynamics to determine specific heats; chemical potentials and equilibria in heterogeneous systems, fugacity and activity functions; solution thermodynamics; vapor-liquid, liquid-liquid, vapor-liquid-liquid and solid-liquid equilibria and phase diagrams; chemical equilibria; surfaces and surface tension.

MT 525   Techniques of Surface and Nanostructure Characterization   (3 - 3 - 0)

Lectures, demonstrations and laboratory experiments, selected from among the following topics, depending on student interest: vacuum technology; thin-film preparation; scanning electron microscopy; LEED; infrared spectroscopy, ellipsometry; electron spectroscopies (Auger, photoelectron, field emission); ion spectroscopies (SIMS, IBS; surface properties-area), roughness and surface tension. Cross-listed with: NANO 525, CH 525, PEP 525

MT 528   Solar Energy: System Designs   (3 - 3 - 0)

This course provides an in-depth treatment of how to transfer the latest solar thermal technology available to real world applications. It takes the student through the various phases of development of a solar space heating and photovoltaic integrated building; review occupant's requirements, site analysis, design concept, solar system design, cost estimates, building design, performance predictions and construction. The emphasis of the class is on solar system design methods, economic optimization of solar systems and installation. Cross-listed with: ME 519

MT 544   Introduction to Electron Microscopy   (3 - 3 - 3)

A lecture and laboratory course that introduces basic concepts in the design and operation of transmission electron microscopes and scanning electron microscopes as well as the fundamental aspects of image interpretation and diffraction analysis. Topics include: electron sources, electron optics, kinematic and dynamic theory of electron diffraction, and spectroscopic analysis.

MT 555   Catalysis and Characterization of Nanoparticles   (3 - 3 - 0)

Most processes in petroleum and chemical industries utilize catalytic reactions. Moreover, many emerging technologies in the energy sector and in green chemistry for sustainability rely on catalysis. This course provides the fundamentals of synthesis, characterization and testing of catalytic materials with an emphasis on metal and metal oxide nanoparticles, the most widely used class of catalysts. Methodologies for development of molecular-level reaction mechanisms, material structure-activity relations and kinetic models are described. The course is essential for anyone planning a career in the chemical industry. It is recommended for all professionals working with nanoparticles and also with diverse applications where the solid-gas interface is important. Cross-listed with: CHE 555, NANO 555, EN 555, CH 555

MT 561   Solid State Electronics for Engineering I   (3 - 3 - 0)

This course introduces fundamentals of semiconductors and basic building blocks of semiconductor devices that are necessary for understanding semiconductor device operations. It is for first-year graduate students and upper-class undergraduate students in electrical engineering, applied physics, engineering physics, optical engineering and materials engineering who have no previous exposure to solid state physics and semiconductor devices. Topics covered will include description of crystal structures and bonding; introduction to statistical description of electron gas; free-electron theory of metals; motion of electrons in periodic lattices-energy bands; Fermi levels; semiconductors and insulators; electrons and holes in semiconductors; impurity effects; generation and recombination; mobility and other electrical properties of semiconductors; thermal and optical properties; p-n junctions; metal-semiconductor contacts. Cross-listed with: PEP 561, EE 561

MT 562   Solid State Electronics for Engineeing II   (3 - 3 - 0)

This course introduces operating principles and develops models of modern semiconductor devices that are useful in the analysis and design of integrated circuits. Topics covered include: charge carrier transport in semiconductors; diffusion and drift, injection and lifetime of carriers; p-n junction devices; bipolar junction transistors; metal-oxide-semiconductor field effect transistors; metal-semiconductor field effect transistors and high electron mobility transistors; microwave devices; light emitting diodes, semiconductor lasers and photodetectors; integrated devices. Cross-listed with: EE 562, PEP 562

MT 570   Electronic Materials and Devices   (3 - 3 - 0)

This course serves as introductory course in electronic materials for electrical engineers and materials scientists. It will provide a broad understanding of the materials and devices used in the current semiconductor industry. It is suitable for a broad audience for undergraduate and graduate students with a background in Materials Science, Chemical, Mechanical Engineering, and Physics. The course covers elementary materials science, electrical and thermal conduction in solids, basic physics behind semiconductor materials, dielectric materials and insulations, and basics of devices with emphasis on their electronic characteristics. This course will introduce students to the language, nomenclature, and tools of electronic materials commonly used in semiconductor industry. Industries that value this course: semiconductor device companies like IBM, Intel, Applied Materials, etc. Cross-listed with: PEP 580

MT 581   Materials & Sustainable Development   (3 - 3 - 0)

The course provides a systems-oriented approach and framework for analyzing sustainable development and the critical role of materials in it. In addition to the technical issues such as in material's and process selection, it recognizes the complexity of sustainability and associated social, environmental, economic and legal factors. Pre-requisite: An introduction to materials science and engineering course such as E 344.

MT 585   Physical Design of Wireless Systems   (3 - 3 - 0)

Physical design of wireless communication systems, emphasizing present and next generation architectures. Impact of non-linear components on performance; noise sources and effects; interference; optimization of receiver and transmitter architectures; individual components (LNAs, power amplifiers, mixers, filters, VCOs, phase-locked loops, frequency synthesizers, etc.); digital signal processing for adaptable architectures; analog-digital converters; new component technologies (SiGe, MEMS, etc.); specifications of component performance; reconfigurability and the role of digital signal processing in future generation architectures; direct conversion; RF packaging; minimization of power dissipation in receivers. Cross-listed with: EE 585, PEP 585

MT 595   Reliability and Failure of Solid State Devices   (3 - 3 - 0)

This course deals with the electrical, chemical, environmental and mechanical driving forces that compromise the integrity and lead to the failure of electronic materials and devices. Both chip and packaging level failures will be modeled physically and quantified statistically in terms of standard reliability mathematics. On the packaging level, thermal stresses, solder creep, fatigue and fracture, contact relaxation, corrosion and environmental degradation will be treated. Cross-listed with: EE 595, PEP 595

MT 596   Microfabrication Techniques   (3 - 0 - 0)

Deals with aspects of the technology of processing involved in the fabrication of microelectronic devices and microelectromechanical systems (MEMS). Students will become familiar with various fabrication techniques used for discrete devices and large-scale integrated circuits. Students will also be exposed to MEMS sensor and actuator applications originating from the different engineering disciplines. Cross-listed with: EE 596, PEP 596

MT 601   Structure and Diffraction   (3 - 3 - 0)

Crystal structures, point defects, dislocations, slip systems, grain boundaries and microstructures. Scattering of X-rays and electrons; diffraction by single and polycrystalline materials and its application to material identification, crystal orientation, texture determination, strain measurement and crystal structure analysis.

MT 602   Principles of Inorganic Materials Synthesis   (3 - 3 - 0)

The goal of this course is to learn the basic concepts commonly utilized in the processing of advanced materials with specific compositions and microstructures. Solid state diffusion mechanisms are described with emphasis on the role of point defects, the mobility of diffusing atoms and their interactions. Macroscopic diffusion phenomena are analyzed by formulating partial differential equations and presenting their solutions. The relationships between processing and microstructure are developed on the basis of the rate of nucleation and growth processes that occur during condensation, solidification and precipitation. Diffusionless phase transformations observed in certain metallic and ceramic materials are discussed. Cross-listed with: NANO 602 Prerequisite: MT 603 or MT 521

MT 603   Thermodynamics and Reaction Kinetics of Solids   (3 - 3 - 0)

The principal areas of concentration include a review of thermodynamic laws applying to closed systems, chemical potentials and equilibria in heterogeneous systems, fugacity and activity functions, solution thermodynamics, multicomponent metallic solutions, the thermodynamics of phase diagrams and phase transformations.

MT 626   Optical Communication Systems   (3 - 3 - 0)

Components for and design of optical communication systems; propagation of optical signals in single mode and multimode optical fibers; optical sources and photodetectors; optical modulators and multiplexers; optical communication systems: coherent modulators, optical fiber amplifiers and repeaters, transcontinental and transoceanic optical telecommunication system design; optical fiber local area networks. Cross-listed with: EE 626, NIS 626, PEP 626

MT 650   Special Topics in Materials Science and Engineering   (3 - 3 - 0)

This course will serve to broaden exposure the recent advances in materials engineering and provide training in key skill sets required to succeed in the engineering profession. Students will lead investigations of innovative materials science approaches and solutions required to address the significant technical and societal challenges for a sustainable future. Students will also attend departmental seminars, discuss engineering ethics, intellectual property, and the critical evaluation of technical literature.

MT 665/   Soft Matter Physics   (3 - 3 - 0)
CHE 665

The course will cover soft matter systems, including colloids, gels, polymers, liquid crystals, micelles and biological membranes. Phenomena occurring in these systems, such as crystallization and phase transitions, will be explored at molecular and microscopic levels. Quantitative characterization of the mechanical, electrical, and optical properties of soft matter systems will also be developed. Seminal papers in each of the fields will be assigned as readings and discussed in lectures.

MT 670   Polymer Properties and Structure   (3 - 0 - 0)

Stress-strain relationships, theory of linear viscoelasticity and relaxation spectra, temperature dependence of viscoelastic behavior, dielectric properties, dynamic mechanical and electrical testing, molecular theories of flexible chains, statistical mechanics and thermodynamics of rubber-like undiluted systems, and morphology of high polymers. Cross-listed with: CHE 670

MT 685   Physical Design of Wireless Systems   (3 - 3 - 0)

Physical design of wireless communication systems, emphasizing present and next generation architectures. Impact of non-linear components on performance; noise sources and effects; interference; optimization of receiver and transmitter architectures; indi Cross-listed with: PEP 685

MT 690   Introduction to VLSI Design   (3 - 3 - 0)

This course introduces students to the principles and design techniques of very large scale integrated circuits (VLSI). Topics include: MOS transistor characteristics, DC analysis, resistance, capacitance models, transient analysis, propagation delay, power dissipation, CMOS logic design, transistor sizing, layout methodologies, clocking schemes, case studies. Students will use VLSI CAD tools for layout and simulation. Selected class projects may be sent for fabrication. Cross-listed with: CPE 690, PEP 690, EE 690

MT 700   Seminar in Materials Science and Engineering   (3 - 0 - 0)

Lectures by department faculty, guest speakers, and doctoral students on recent research. Enrollment during the entire period of study is required of all full-time students. No credit. Must be taken every semester.

MT 707   Curriculum Practical Training   (3 - 0 - 0)

A faculty-directed research project involving work in industry or other enterprise external to Stevens. Originates with ongoing collaborations with which Stevens faculty are active engaged. Student must satisfy specific immigration policies to be eligible to participate.

MT 800   Special Problems in Materials   (1 to 6 - -)
One to six credits. Limit of six credits for the degree of Master of Engineering.

MT 801   Special Problems in Materials   (1 to 6 - -)
One to six credits. Limit of six credits for the degree of Doctor of Philosophy.

MT 810   Special Topics in Materials   (3 - -)
A participating seminar on topics of current interest in materials research.

MT 900   Thesis in Materials   (1 to 6 - -)
Research for the degree of Master of Science or Master of Engineering. Hours and credits to be arranged.

MT 960   Research in Materials   (- -)
Original research leading to the doctoral dissertation. Hours and credits to be arranged.

Nanotechnology

NANO 200   Introduction to Nanotechnology   (3 - 3 - 0)

The course addresses the science underpinnings of nanotechnology to provide an understanding of the fundamental challenges and limitations involved in designing and demonstrating nanodevices and systems. The role of solid state physics, chemistry and some biology will be emphasized together with some basic engineering science ideas applied at the nanoscale. By the end of the course, students will understand principles of the fabrication, characterization and manipulation of nanoscale materials, systems, and devices. Prerequisites: CH 115, PEP 111

NANO 325   Introduction to Nanofabrication and Characterization   (3 - 3 - 0)

The course addresses the science underpinnings of nanotechnology to provide a hands-on experience for undergraduate students in nanofabrication and characterization. It will discuss the grand challenges of nanofabrication and will showcase examples of specific applications in electronics, photonics, chemistry, biology, medicine, defense, and energy. NANO 200 would be a pre-requisite for this course. This course will offer hands-on experiments to fabricate prototype devices/systems (e.g. relatively simple sensors or actuators) in order for students to understand the full sequence/spectrum of development of nanodevices and systems, e.g. from concept design, fabrication and characterization. Prerequisite: NANO 200

NANO 503   Introduction to Solid State Physics   (3 - 3 - 0)

Description of simple physical models which account for electrical conductivity and thermal properties of solids. Basic crystal lattice structures, X-ray diffraction and dispersion curves for phonons and electrons in reciprocal space. Energy bands, Fermi surfaces, metals, insulators, semiconductors, superconductivity and ferromagnetism. Fall semester. Typical text: Kittel, Introduction to Solid State Physics. Cross-listed with: PEP 503 Prerequisites: PEP 242, PEP 542

NANO 525   Techniques of Surface and Nanostructure Characterization   (3 - 3 - 0)

Lectures, demonstrations and laboratory experiments, selected from among the following topics, depending on student interest: vacuum technology; thin-film preparation; scanning electron microscopy; infrared spectroscopy, ellipsometry: electron spectroscopies-Auger, photoelectron, LEED; ion spectroscopies SIMS, IBS, field emission; surface properties-area, roughness, and surface tension. Alternate years. Cross-listed with: MT 525, CH 525, PEP 525

NANO 553   Introduction to Quantum Mechanics   (3 - 3 - 0)

This course is an introduction to quantum mechanics for students in physics and engineering. Techniques discussed include solutions of the Schrodinger equation in one and three dimensions, and operator and matrix methods. Applications include infinite and finite quantum wells, barrier penetration and scattering in one dimension, the harmonic oscillator, angular momentum, central force problems, including the hydrogen atom, and spin. Fall semester. Typical text: Quantum Physics by Gasiorowicz. Cross-listed with: PEP 553 Prerequisites: MA 221, PEP 242

NANO 554   Quantum Mechanics I   (3 - 3 - 0)

This course is meant as the first in a two-course sequence on non-relativistic quantum mechanics for physics graduate students, with an emphasis on applications to atomic, molecular, and solid state physics. Undergraduate students may take this course as a Technical Elective. Topics covered include: review of Schrödinger wave mechanics; operator algebra, theory of representation, and matrix mechanics; symmetries in quantum mechanics; spin and formal theory of angular momentum, including addition of angular momentum; and approximation methods for stationary problems, including time independent perturbation theory, WKB approximation, and variational methods. Typical text: Quantum Mechanics by E. Merzbacher. Cross-listed with: PEP 554 Prerequisites: PEP 532, PEP 538, PEP 553

NANO 555   Catalysis and Characterization of Nanoparticles   (3 - 3 - 0)

Most processes in petroleum and chemical industries utilize catalytic reactions. Moreover, many emerging technologies in the energy sector and in green chemistry for sustainability rely on catalysis. This course provides the fundamentals of synthesis, characterization and testing of catalytic materials with an emphasis on metal and metal oxide nanoparticles, the most widely used class of catalysts. Methodologies for development of molecular-level reaction mechanisms, material structure-activity relations and kinetic models are described. The course is essential for anyone planning a career in the chemical industry. It is recommended for all professionals working with nanoparticles and also with diverse applications where the solid-gas interface is important. Cross-listed with: CHE 555, MT 555, EN 555, CH 555

NANO 570   Environmental Chemistry   (3 - 3 - 0)

Principles of environmental reactions with emphasis on aquatic chemistry; reaction and phase equilibria; acid-base and carbonate systems; oxidation-reduction; colloids; organic contaminants classes, sources, and fates; groundwater chemistry; and atmospheric chemistry. Cross-listed with: EN 570

NANO 571   Physicochemical Processes for Environmental Control   (3 - 3 - 0)

A study of the chemical and physical operation involved in treatment of potable water, industrial process water, and wastewater effluent; topics include chemical precipitation, coagulation, flocculation, sedimentation, filtration, disinfection, ion exchange, oxidation, adsorption, flotation, and membrane processes. A physical-chemical treatment plant design project is an integral part of the course. The approach of unit operations and unit processes is stressed. Cross-listed with: EN 571

NANO 596   Fabrication Techniques for Micro and Nano Devices   (3 - 3 - 0)

Deals with aspects of the technology of processing procedures involved in the fabrication of microelectronic devices and microelectromechanical systems (MEMS). Students will become familiar with various fabrication techniques used for discrete devices as well as large-scale integrated thin-film circuits. Students will also learn that MEMS are sensors and actuators that are designed using different areas of engineering disciplines and they are constructed using a microlithographically-based manufacturing process in conjunction with both semiconductor and micromachining microfabrication technologies. Cross-listed with: MT 596, EE 596, PEP 596 Prerequisite: PEP 507

NANO 600   Nanoscale Science and Technology   (3 - 3 - 0)

This course deals with the fundamentals and applications of nanoscience and nanotechnology. Size-dependent phenomena, ways and means of designing and synthesizing nanostructures, and cutting-edging applications will be presented in an integrated and interdisciplinary manner.

NANO 602   Principles of Inorganic Materials Synthesis   (3 - 3 - 0)

The goal of this course is to learn the basic concepts commonly utilized in the processing of advanced materials with specific compositions and microstructures. Solid state diffusion mechanisms are described with emphasis on the role of point defects, the mobility of diffusing atoms, and their interactions. Macroscopic diffusion phenomena are analyzed by formulating partial differential equations and presenting their solutions. The relationships between processing and microstructure are developed on the basis of the rate of nucleation and growth processes that occur during condensation, solidification, and precipitation. Diffusionless phase transformations observed in certain metallic and ceramic materials are discussed. Cross-listed with: MT 602

NANO 610   Health and Environmental Impact of Nanotechnology   (3 - 3 - 0)

This course covers the environmental and health aspects of nanotechnology. It presents an overview of nanotechnology along with characterization and properties of nanomaterials. The course material covers the biotoxicity and ecotoxicity of nanomaterials. A sizable part of the course is devoted to discussions about the application of nanotechnology for environmental remediation along with discussions about fate and transport of nanomaterials. Special emphasis is given to risk assessment and risk management of nanomaterials, ethical and legal aspects of nanotechnology, and nano-industry and nano-entrepreneurship. Cross-listed with: EN 610

NANO 615   Crystallization of Biological Molecules   (3 - 3 - 0)

This course provides an overview and industrial perspectives regarding downstream separation in drug substance development and manufacturing. Basic principles and practical applications of unit operations most commonly employed in the pharmaceutical industry will be discussed, including extraction, absorption, membrane, distillation, crystallization, filtration, and drying. Examples will be discussed to illustrate the intrinsic relationship between process development, equipment selection, and scale-up success. Cross-listed with: CHE 615

NANO 650   Advanced Biomaterials   (3 - 3 - 0)

Upon completion of this course, students will be able to demonstrate an understanding of the major classes of engineering materials, their principal properties, and design requirements that serve as both the basis for materials selection, as well as for the ongoing development of new materials. This course is substantially differentiated from introductory materials courses by its very specific focus on materials whose use puts them in direct contact with physiological systems. Thus, the course begins with brief sections on inflammatory response, thrombosis, infection, and device failure. It then concentrates on developing the fundamental materials science and engineering concepts underlying the structure-property relationships in both synthetic and natural polymers, metals and alloys, and ceramics relevant to in vivo medical device technology. Cross-listed with: BME 650

NANO 652   Design and Fabrication of Micro and Nano Electromechanical Systems   (3 - 3 - 0)

This course follows the introductory course and covers advanced topics in the design, modeling, and fabrication of micro and nano electromechanical systems. The materials will be broad and multidisciplinary including: review of micro and nano electromechanical systems, dimensional analysis and scaling, thermal, transport, fluids, microelectronics, feedback control, noise, and electromagnetism at the micro and nanoscales; the modeling of a variety of new MEMS/NEMS devices; and alternative approaches to the continuum mechanics theory. The goal will be achieved through a combination of lectures, case studies, individual homework assignments, and design projects carried out in teams. Cross-listed with: ME 653

NANO 672   Polymers at Solid-Liquid Interfaces   (3 - 3 - 0)

The course covers recent advances in macromolecular science, including polyelectrolytes and water-soluble polymers, synthetic and biological macromolecules at surfaces, self-assembly of synthetic and biological macromolecules, and polymers for biomedical applications. Cross-listed with: CH 672

NANO 674   Polymer Functionality   (3 - 3 - 0)

Topics at the interface of polymer chemistry and biomedical sciences, focusing on areas where polymers have made a particularly strong contribution, such as in biomedical sciences and pharmaceuticals. Synthesis and properties of biopolymers; biomaterials; nanotechnology smart polymers; functional applications in biotechnology, tissue and cell engineering; and biosensors and drug delivery. Cross-listed with: CH 674 Prerequisite: CH 244

NANO 675   Nanomedicine   (3 - 3 - 0)

This course will provide a comprehensive introduction to the rapidly developing field of nanomedicine and discuss the application of nanoscience and nanotechnology in medicine such as, in diagnosis, imaging and therapy, surgery, and drug delivery. Cross-listed with: BME 675 Prerequisite: NANO 600

NANO 680   Fundamentals of Micro/Nano Fluidics   (3 - 3 - 0)

As an introduction to micro/nano fluidics, course topics include basic fluid mechanical theories, experimental techniques, fabrication techniques and applications of micro/nano fluidics. The theory part will cover continuum fluid mechanics at micro/nano scales, molecular approaches, capillary effects, electrokinetic flows, acoustofluidics and optofluidics. The experimental part will cover micro/nano rheology and particle image velocimetry. The fabrication part will cover materials and machining techniques for micro/nano fluidic devices. The application part will cover micro/nano fluidic devices for flow control, life sciences and chemistry. As a term project, individual students are required to perform a case study for their own selected topic in micro/nano fluidics, to conduct a literature survey/summary and to propose/analyze their own new design idea of a micro/nano fluidic devices by utilizing the knowledge obtained throughout the course. Cross-listed with: ME 680

NANO 682   Colloids and Interfacial Phenomena at the Nanoscale   (3 - 3 - 0)

A survey course covering the chemical, biological and material science aspects of interfacial phenomena. Applications to adhesion, biomembranes, colloidal stability, detergency, lubrication, coatings, fibers and powders - where surface properties play an important role. Cross-listed with: CHE 682

NANO 685   Nanobiotechnology   (3 - 3 - 0)

This course describes the application of nano- and micro-fabrication methods to build tools for exploring the mysteries of biological systems. It is a graduate-level course that will cover the basics of biology and the principles and practice of nano- and microfabrication techniques, with a focus on applications in biomedical and biological research. Cross-listed with: BME 685 Prerequisite: NANO 600

NANO 690   Cellular Signal Transduction   (3 - 3 - 0)

This advanced course covers the mechanism and biological role of signal transduction in mammalian cells. Topics included are extracellular regulatory signals, intracellular signal transduction pathways, role of tissue context in the function of cellular regulation, and examples of biological processes controlled by specific cellular signal transduction pathways. Cross-listed with: CH 690 Prerequisites: CH 381, CH 484 or BIO 381, BIO 484

NANO 691   Physics and Applications of Semiconductor Nanostructures   (3 - 3 - 0)

This course is intended to introduce the concept of electronic energy band engineering for device applications. Topics to be covered are electronic energy bands, optical properties, electrical transport properties of multiple quantum wells, superlattices, quantum wires, and quantum dots; mesoscopic systems, applications of such structures in various solid state devices, such as high electron mobility, resonant tunneling diodes, and other negative differential conductance devices, double-heterojunction injection lasers, superlattice-based infrared detectors, electron-wave devices (wave guides, couplers, switching devices), and other novel concepts and ideas made possible by nano-fabrication technology. Fall semester. Typical text: M. Jaros, Physics and Applications of Semiconductor Microstructures; G. Bastard, Wave Mechanics Applied to Semiconductor Heterostructures. Cross-listed with: PEP 691 Prerequisites: PEP 503, PEP 553

NANO 695   Bio/Nano Photonics   (3 - 3 - 0)

This course deals with the principles of light interactions with biological and biomedical-relevant systems. The enabling aspects of nanotechnology for advanced biosensing, medical diagnosis, and therapeutic treatment will be discussed. Cross-listed with: CHE 695, BME 695 Prerequisite: NANO 600

NANO 700   Seminar in Nanotechnology   (0 - -)

Lectures by department faculty, guest speakers and doctoral students on recent research.

NANO 701   Multiscale Mechanics and Computational Methods   (3 - 3 - 0)

This graduate course will introduce the applications of multiscale theory and computational techniques in the fields of materials and mechanics. Students will obtain fundamental knowledge on homogenization and heterogeneous materials, and be exposed to various sequential and concurrent multiscale techniques. The first half of the course will be focused on the homogenization theory and its applications in heterogeneous materials. In the second half multiscale computational techniques will be addressed through multiscale finite element methods and atomistic/continuum computing. Students are expected to develop their own course projects based on their research interests and the relevant topics learned from the course. Cross-listed with: CE 702

NANO 740   The Physics of Nanostructures   (3 - 3 - 0)

Progress in the technology of nanostructure growth; space and time scales; quantum confined systems; quantum wells, coupled wells, and superlattices; quantum wires and quantum dots; electronic states; magnetic field effects; electron-phonon interaction; and quantum transport in nanostructures: Kubo formalism and Butikker-Landau formalism; spectroscopy of quantum dots; Coulomb blockade, coupled dots, and artificial molecules; weal localization; universal conductance fluctuations; phase-breaking time; theory of open quantum systems: fluctuation-dissipation theorem; and applications to quantum transport in nanostructures. Cross-listed with: PEP 740 Prerequisites: PEP 554, PEP 662

NANO 810   Special Topics in Nanotechnology   (3 - -)

A participating seminar on topics of current interest and importance in Nanotechnology.

Department of Civil, Environmental, & Ocean Engineering

FACULTY

MUHAMMAD HAJJ
DEPARTMENT CHAIR

Yi Bao, Ph.D.
Assistant Professor

Khondokar Billah, Ph.D.
Distinguished Service Professor

Leslie Brunell, Ph.D., P.E.
Teaching Professor

Barry Bunin, Ph.D.
Chief Architect - Maritime Security Laboratory;
Research Professor

Christos Christodoulatos, Ph.D.
Professor and Director of the Center
for Environmental Systems

Raju Datla, Ph.D.
Research Associate Professor

Dimitri Donskoy, Ph.D.
Associate Professor

John Dzielski, Ph.D.
Research Professor

Elizabeth Fassman-Beck, Ph.D.
Associate Professor

Mirjam Furth, Ph.D.
Assistant Professor

Sophia Hassiotis, Ph.D.
Associate Professor

Muhammad Hajj, Ph.D.
George Meade Bond Professor, Director of
Davidson Laboratory and Department Chair

Mohammad Ilbeigi, Ph.D.
Assistant Professor

Sarath Jagupilla, Ph.D., P.E.
Teaching Assistant Professor

George Korfiatis, Ph.D.
McLean Chair Professor

Ellyn Lester, Associate AIA
Teaching Associate Professor

Kaijian Liu, Ph.D.
Assistant Professor

Reza Marsooli, Ph.D.
Assistant Professor

Weina Meng, Ph.D.
Assistant Professor

Xiaoguang Meng, Ph.D., P.E.
Professor

Jon Miller, Ph.D.
Research Associate Professor

Philip Orton, Ph.D.
Research Assistant Professor

Valentina Prigiobbe, Ph.D.
Assistant Professor

Dibyendu (Dibs) Sarkar, Ph.D., P.G.
Professor

Tsan-Liang Su, Ph.D.
Research Associate Professor

Alexander Sutin, Ph.D.
Research Professor

David A. Vaccari, Ph.D., P.E.
Professor

EMERITUS FACULTY

Richard Hires, Ph.D
Professor Emeritus

Daniel Savitsky, Ph.D
Professor Emeritus/Consultant

The Civil, Environmental and Ocean Engineering Department promotes the use of engineering approaches to create solutions for societal needs concerning the built and natural environment by

- providing a high quality, broad-based undergraduate education that emphasizes both fundamental knowledge and design experiences for its students;

- developing new knowledge through cutting-edge and applied research; providing services and leadership to the public and the profession;

- integrating research knowledge and professional service experience into innovative undergraduate and graduate instruction;

- and by fostering in our students a culture of lifelong personal and professional growth.

UNDERGRADUATE PROGRAMS

The department has three programs towards the degree of bachelor of engineering (B.E.): civil engineering, environmental engineering, and engineering (with a concentration in naval engineering). In addition, there are several minors offered to engineering students in other majors. The individual B.E. programs are described below.

B.E. in Civil Engineering

Civil engineering is concerned with the design and construction of infrastructure, including structures, foundations, environmental and transportation systems, waterways, ports, irrigation, storm water and green infrastructure, and water supply and treatment. The civil engineer's vital role is to plan, design, and supervise the construction of these facilities. Civil engineering is one of the most publicly visible technical fields. It has the distinction of being one of the earliest of the engineering disciplines, yet continues to generate new technology. The basic principles of structural analysis, which are the concern of civil engineers, are expressed in every machine and aircraft, and in buildings and other constructed facilities. The study of mechanics is basic to the field of civil engineering. Water is fundamental to all life. Civil engineers design water systems with applications ranging from urban water supply to aquatic ecosystem protection. A thorough foundation in science and mathematics is necessary for the application of basic scientific principles to the design of structures and fluid systems. Computer methods are integrated throughout the civil engineering elective offerings. Graduates of the Stevens program meet the demands for positions of responsibility in various sub-disciplines of civil engineering and contribute to the advancement of the civil engineering practice. Prospective employers include industrial firms, consulting engineering firms, and construction contractors, as well as various government agencies. Our undergraduate offerings include subjects basic to all civil engineering.

Civil Engineering Program Mission and Objectives

The mission of the civil engineering program at Stevens is to educate a new generation of civil engineers who are leaders in the profession. The educational program emphasizes technical competence, professional practice, leadership, lifelong learning, civic contribution and entrepreneurship.

The program of study combines a broad-based core engineering curriculum, and a substantial experience in the humanities and in business engineering management, with specialization in civil engineering. Within the sequence of civil engineering courses, students have the flexibility to concentrate in structural, transportation, geotechnical, water resources, environmental engineering, and construction management.

The objectives of the civil engineering program are provided in terms of our expectations for our graduates. Within several years of graduation:

▸ Our graduates apply mathematics and science to solve complex problems in civil engineering.

▸ Our graduates apply skills in problem solving, teamwork, ethics, management, communication, and awareness of professional and social issues to establish leadership in their chosen career paths.

Civil Engineering Curriculum

Term I

Course #	Course Name	Lecture	Lab	Study	Credit
CH 115	General Chemistry I	3	0	6	3
CH 117	General Chemistry Laboratory I	0	3	1	1
E 101	Engineering Experiences I	1	0	0	1
E 115	Introduction to Programming	1	2	3	2
E 120	Engineering Graphics	0	2	1	1
E 121	Engineering Design I: Introduction to Systems Thinking	0	3	2	2
MA 121; MA 122	Differential Calculus; Integral Calculus	4	0	8	4
CAL 103	Writing And Communications Colloquium	3	0	6	3
	Total	**12**	**10**	**27**	**17**

Term II

Course #	Course Name	Lecture	Lab	Study	Credit
CH 116	General Chemistry II[1]	3	0	6	3
PEP 111	Mechanics	3	0	6	3
E 122	Engineering Design II: Field Sustainable Systems with Sensors	0	3	3	2
MA 123; MA 124	Series, Vectors, Functions, and Surfaces; Calculus of Two Variables	4	0	8	4
CAL 105	CAL Colloquium: Knowledge, Nature, Culture	3	0	6	3
MGT 103	Introduction to Entrepreneurial Thinking	1	2	0	2
	Total	**14**	**5**	**29**	**17**

Term III

Course #	Course Name	Lecture	Lab	Study	Credit
MA 221	Differential Equations	4	0	8	4
PEP 112	Electricity and Magnetism	3	0	6	3
E 126	Mechanics of Solids	4	0	8	4
E 245	Circuits and Systems	2	3	7	3
E 231	Engineering Design III: Structural Performance and Failure	0	3	2	2
Hum	Humanities[2]	3	0	6	3
PE 200	Physical Education	0	2	0	0
	Total	**16**	**8**	**37**	**19**

Term IV

Course #	Course Name	Lecture	Lab	Study	Credit
MA 227	Multivariable Calculus	3	0	6	3
E 232	Engineering Design IV: Systems with Analog Circuits	2	3	7	3
E 234	Thermodynamics	3	0	6	3
CE 373	Structural Analysis	3	0	3	3
Hum	Humanities[2]	3	0	6	3
BIO 281 Or CE 240	Biology and Biotechnology[1] Or Intro. to Geosciences	3	0	6	3
PE 200	Physical Education II	0	2	0	0
	Total	**17**	**5**	**34**	**18**

Term V

Course #	Course Name	Lecture	Lab	Study	Credit
E 243	Probability and Statistics for Engineers	3	0	6	3
E 321	Engineering Design V: Materials Selection and Process Optimization	0	3	2	2
E 344	Materials Processing	3	0	6	3
CE 342	Fluid Mechanics	3	3	6	4
CE 486	Structural Steel Design	3	0	3	3
Hum	Humanities[2]	3	0	6	3
PE 200	Physical Education III	0	2	0	0
	Total	**15**	**8**	**29**	**18**

Term VI

Course #	Course Name	Lecture	Lab	Study	Credit
E 355	Engineering Economics	3	3	6	4
CE 322	Engineering Design VI	1	3	2	2
CE 304	Water Resources Engineering	3	0	3	3
CE 483	Geotechnical Engineering	2	3	6	3
G.E.	General Elective[3]	3	0	6	3
CE 345	Modeling & Simulation	3	0	3	3
PE 200	Physical Education IV	0	2	0	0
IDE 400	Senior Innovation I[5]	1	0	2	1
	Total	**16**	**11**	**28**	**19**

Term VII

Course #	Course Name	Lecture	Lab	Study	Credit
CE 381	Civil Engineering Measurements Lab	2	3	3	3
T.E.	Technical Elective[4]	3	0	6	3
G.E.	General Elective[3]	3	0	6	3
CE 423	Engineering Design VII	0	8	3	3
IDE 401	Senior Innovation II	1	0	2	1
CE 484	Reinforced Concrete Design	3	0	3	3
	Total	**12**	**12**	**23**	**16**

Term VIII

Course #	Course Name	Lecture	Lab	Study	Credit
T.E.	Technical Elective[4]	3	0	6	3
IDE 402	Senior Innovation III	1	0	2	1
G.E.	General Elective[3]	3	0	6	3
CE 424	Engineering Design VIII	0	8	3	3
Hum	Humanities[2]	3	0	6	3
T.E.	Technical Elective[4]	3	0	6	3
	Total	**13**	**8**	**29**	**16**

(1) Science electives – one elective must have a laboratory component
(2) Humanities requirements can be found on pages 599-600.
(3) General electives – chosen by the student – can be used towards a minor or option- can be applied to research or approved international studies
(4) Technical Electives: Any 500 and 600-level course in Civil, Environmental, Ocean, or Mechanical Engineering is acceptable. At least one of the Technical Electives should be chosen from EN 377, CE 410 or CE 541.
(5) IDE 400 can be taken concurrently with IDE 401 in Term VII as determined by the engineering program

B.E. in Environmental Engineering

Environmental engineering has traditionally been taught as a branch of civil engineering concerned with the supply of safe drinking water and the sanitary disposal of municipal wastes. The field has expanded in recent years to include many new areas, such as the treatment of industrial and hazardous wastes, the prediction of the fate and transport of pollutants in the environment, and the design of systems for remediation of sites contaminated with hazardous wastes. Furthermore, the field continues to grow into new directions such as sustainability and green engineering. These changes have placed new demands on engineers to understand the fundamental environmental transformation processes that describe natural and engineered systems for which this program is designed to prepare our students.

Environmental Engineering Program Mission and Objectives

The mission of the environmental engineering program is to provide a broad-based education that prepares students in the technical and social fundamentals that will enable them to have a wide impact in the improvement of interactions between humans and their environment.

The objectives of the program are aligned with these expectations for our graduates

▸ Graduates of our program will be recognized as being among "the best in the business" by their peers by leveraging their strong technical basis to continuously increase their skills and knowledge in their area of expertise, and will develop the qualifications for licensure.

▸ Graduates of our program will have a positive impact on their workplace through multidisciplinary collaboration, teamwork and leadership.

▸ Graduates of our program effectively navigate important contextual factors in their careers, including the historical, regulatory, political, policy, economic, ethical and public relations aspects of environmental problems.

Environmental Engineering Curriculum

Term I

Course #	Course Name	Lecture	Lab	Study	Credit
CH 115	General Chemistry I	3	0	6	3
CH 117	General Chemistry Laboratory I	0	3	1	1
E 121	Engineering Design I: Introduction to Systems Thinking	0	3	2	2
E 120	Engineering Graphics	0	2	1	1
E 101	Engineering Experiences I	1	0	0	1
E 115	Introduction to Programming	1	2	3	2
MA 121; MA 122	Differential Calculus; Integral Calculus	4	0	8	4
CAL 103	Writing And Communications Colloquium	3	0	6	3
	Total	**12**	**10**	**27**	**17**

Term II

Course #	Course Name	Lecture	Lab	Study	Credit
CH 116	General Chemistry II	3	0	6	3
CH 118	General Chemistry Laboratory II	0	3	1	1
PEP 111	Mechanics	3	0	6	3
E 122	Engineering Design II: Field Sustainable Systems with Sensors	0	3	3	2
MA 123; MA 124	Series, Vectors, Functions, and Surfaces; Calculus of Two Variables	4	0	8	4
CAL 105	CAL Colloquium: Knowledge, Nature, Culture	3	0	6	3
MGT 103	Introduction to Entrepreneurial Thinking	1	2	0	2
	Total	**14**	**8**	**30**	**18**

Term III

Course #	Course Name	Lecture	Lab	Study	Credit
MA 221	Differential Equations	4	0	8	4
E 245	Circuits and Systems	2	3	7	3
E 231	Engineering Design III: Structural Performance and Failure	0	3	2	2
Hum	Humanities[2]	3	0	6	3
PEP 112	Electricity and Magnetism	3	0	6	3
E 126	Mechanics of Solids	4	0	8	4
PE 200	Physical Education	0	2	0	0
	Total	**16**	**8**	**37**	**19**

Term IV

Course #	Course Name	Lecture	Lab	Study	Credit
MA 227	Multivariable Calculus	3	0	6	3
E 232	Engineering Design IV: Systems with Analog Circuits	2	3	7	3
Hum	Humanities[2]	3	0	6	3
S.E.	Science Elective II[1]	3	0	6	3
EN 377	Introduction to Environmental Engineering Systems	3	0	0	3
EN 379	Environmental Engineering Laboratory	0	3	0	1
CHE 234	Chemical Engineering Thermodynamics	4	0	8	4
PE 200	Physical Education II	0	2	0	0
	Total	**18**	**8**	**33**	**20**

Term V

Course #	Course Name	Lecture	Lab	Study	Credit
CE 342	Fluid Mechanics	3	3	6	4
E 344	Materials Processing	3	0	6	3
E 321	Engineering Design V: Materials Selection and Process Optimization	0	3	2	2
CHE 210	Process Analysis	3	0	3	3
EN 541	Fate and Transport of Environmental Contaminants	3	0	6	3
Hum	Humanities[2]	3	0	6	3
PE 200	Physical Education III	0	2	0	0
	Total	**15**	**8**	**29**	**18**

Term VI

Course #	Course Name	Lecture	Lab	Study	Credit
EN 345	Modeling and Simulation of Environmental Systems	3	0	6	3
E 355	Engineering Economics	3	3	6	4
EN 322	Engineering Design VI	1	3	5	2
EN 570	Environmental Chemistry	3	0	6	3
EN 571	Physicochemical Processes for Environmental Control	3	0	6	3
G.E.	General Elective[3]	3	0	6	3
PE 200	Physical Education IV	0	2	0	0
IDE 400	Senior Innovation I[5]	1	0	2	1
	Total	**17**	**8**	**37**	**19**

Term VII

Course #	Course Name	Lecture	Lab	Study	Credit
EN 573	Biological Processes for Environmental Control	3	0	6	3
EN 575	Environmental Biology	3	0	6	3
EN 423	Engineering Design VII	1	7	4	3
E 243	Probability and Statistics for Engineers	3	0	6	3
IDE 401	Senior Innovation II	1	0	2	1
G.E.	General Elective[3]	3	0	6	3
	Total	**15**	**7**	**32**	**16**

Term VIII

Course #	Course Name	Lecture	Lab	Study	Credit
EN 506	Air Pollution Principles and Control	3	0	6	3
EN 551	Environmental Chemistry of Soils and Natural Surfaces	3	0	6	3
EN 424	Engineering Design VIII	1	7	4	3
Hum	Humanities[2]	3	0	6	3
IDE 402	Senior Innovation III	1	0	2	1
G.E.	General Elective[3]	3	0	6	3
	Total	**14**	**7**	**32**	**16**

(1) Science elective – Science II can be one of the following: CH 281 Biology, PEP 151 Introduction to Astronomy, NANO 200 Intro to Nanotechnology, EN250 Quantitative Biology or PEP201 Physics III for Engineers – one elective must have a laboratory component
(2) Humanities requirements can be found on pages 599-600.
(3) General electives – chosen by the student – can be used towards a minor or option – can be applied to research or approved international studies
(4) Technical Electives: Any 500 and 600-level course in Civil, Environmental, Ocean, or Mechanical Engineering is acceptable. At least one of the Technical Electives should be chosen from EN 377, CE 410 or CE 541.
(5) IDE 400 can be taken concurrently with IDE 401 in Term VII as determined by the engineering program

B.E. in Engineering (Concentration in Naval Engineering)

The naval engineering concentration within the engineering program is a broad-based discipline that involves the design, construction, operation, and maintenance of surface and subsurface ships, ocean structures, and shore facilities. Although these vessels and facilities are traditionally employed in the defense of the nation, many are also employed in the support of the civilian (commercial) Marine Transportation System. Because of the complexities of today's naval and civilian vessels and supporting infrastructure, the naval engineer must possess a strong background in the physical sciences, mathematics, and modeling, as well as the more specialized fields of naval architecture, marine engineering, systems engineering, and environmental engineering.

Engineering Program Mission and Objectives

The mission of the engineering program with a concentration in naval engineering at Stevens is to develop innovative engineers capable of international leadership in the profession. The educational program emphasizes design innovation, trans-disciplinary study, a systems perspective on complex ship and infrastructure designs, lifelong learning, and opportunities for international study and internships. As is the case for the other Stevens engineering programs, the engineering program includes a broad-based core engineering curriculum and a substantial experience in the humanities.

The program is conducted in concert with the Stevens leadership in the Office of Naval Research-sponsored Atlantic Center for the Innovative Design and Control of Small Ships and in collaboration with University College London.

The objectives of the engineering program are provided in terms of our expectations for our graduates. Within several years of graduation,

▸ Graduates of the engineering program will be recognized as being among "the best in the business" by their peers in technical disciplines that engineering graduates are engaged in. They will leverage their broad engineering background to continuously expand their areas of expertise.

▸ Graduates of our program will professionally enhance their workplace through multidisciplinary collaboration, teamwork and leadership.

▸ Graduates of our program will maintain exemplary sensitivity to social factors including the environmental, historical, legal, political, policy, economic, ethical and public relations aspects of problems in various engineering disciplines.

Engineering (with a concentration in Naval Engineering) Curriculum

Term I

Course #	Course Name	Lecture	Lab	Study	Credit
CH 115	General Chemistry I	3	0	6	3
CH 117	General Chemistry Laboratory I	0	3	1	1
E 101	Engineering Experiences I	1	0	0	1
E 121	Engineering Design I: Introduction to Systems Thinking	0	3	2	2
E 120	Engineering Graphics	0	2	1	1
E 115	Introduction to Programming	1	2	3	2
MA 121; MA 122	Differential Calculus; Integral Calculus	4	0	8	4
CAL 103	Writing And Communications Colloquium	3	0	6	3
	Total	**12**	**10**	**27**	**17**

Term II

Course #	Course Name	Lecture	Lab	Study	Credit
	Science Elective I[1]	3	0	6	3
PEP 111	Mechanics	3	0	6	3
E 122	Engineering Design II: Field Sustainable Systems with Sensors	0	3	3	2
MA 123; MA 124	Series, Vectors, Functions, and Surfaces; Calculus of Two Variables	4	0	8	4
CAL 105	CAL Colloquium: Knowledge, Nature, Culture	3	0	6	3
MGT 103	Introduction to Entrepreneurial Thinking	1	2	0	2
	Total	**14**	**5**	**29**	**17**

Term III

Course #	Course Name	Lecture	Lab	Study	Credit
MA 221	Differential Equations	4	0	8	4
PEP 112	Electricity and Magnetism	3	0	6	3
E 126	Mechanics of Solids	4	0	8	4
E 245	Circuits and Systems	2	3	7	3
E 231	Engineering Design III: Structural Performance and Failure	0	3	2	2
Hum	Humanities[2]	3	0	6	3
PE 200	Physical Education I	0	2	0	0
	Total	**16**	**8**	**37**	**19**

Term IV

Course #	Course Name	Lecture	Lab	Study	Credit
MA 227	Multivariable Calculus	3	0	6	3
E 234	Thermodynamics	3	0	6	3
	Science Elective II[1]	3	0	6	3
E 232	Engineering Design IV: Systems with Analog Circuits	2	3	7	3
Hum	Humanities[2]	3	0	6	3
OE 524	Introduction to Ship Design and Ship Building	3	0	6	3
PE 200	Physical Education II	0	2	0	0
	Total	**17**	**5**	**37**	**18**

Term V

Course #	Course Name	Lecture	Lab	Study	Credit
CE 342	Fluid Mechanics	3	3	6	4
E 344	Materials Processing	3	0	6	3
E 321	Engineering Design V: Materials Selection and Process Optimization	0	3	2	2
E 243	Probability and Statistics for Engineers	3	0	6	3
Hum	Humanities[2]	3	0	6	3
OE 525	Principles of Naval Architecture	3	0	6	3
PE 200	Physical Education III	0	2	0	0
	Total	**15**	**8**	**32**	**18**

Term VI

Course #	Course Name	Lecture	Lab	Study	Credit
OE 528	Computer-Aided Ship Design	3	0	6	3
E 355	Engineering Economics	3	3	6	4
NE 322	Engineering Design VI	1	3	5	2
OE 520	Design of Marine Structures	3	0	6	3
G.E.	General Elective[3]	3	0	6	3
CE 373	Structural Analysis	3	0	3	3
PE 200	Physical Education IV	0	2	0	0
IDE 400	Senior Innovation I[5]	1	0	2	1
	Total	**17**	**8**	**34**	**19**

Term VII

Course #	Course Name	Lecture	Lab	Study	Credit
T.E.	Technical Elective[4]	3	0	6	3
OE 527	Laboratory in Naval Architecture	0	3	0	3
G.E.	General Elective[3]	3	0	6	3
NE 423	Engineering Design VII	1	7	4	3
IDE 401	Senior Innovation II	1	0	2	1
OE 531	Total Ship Design I	3	0	6	3
	Total	**11**	**10**	**24**	**16**

Term VIII

Course #	Course Name	Lecture	Lab	Study	Credit
T.E.	Technical Elective[4]	3	0	6	3
OE 532	Total Ship Design II	3	0	6	3
NE 424	Engineering Design VIII	1	7	4	3
IDE 402	Senior Innovation III	1	0	2	1
G.E.	General Elective[3]	3	0	6	3
Hum	Humanities[2]	3	0	6	3
	Total	**14**	**7**	**30**	**16**

(1) Science electives can be found on pages 79-80.
(1) Humanities requirements can be found on pages 599-600.
(3) General Electives are chosen by the student and can be used towards a minor or option or can be applied to research or approved international studies.
(4) Technical Electives: discipline specific course
(5) IDE 400 can be taken concurrently with IDE 401 in Term VII as determined by the engineering program

Graduation Requirements

Physical Education Requirements

▸ All undergraduate students must complete a minimum of four semesters of Physical Education (P.E.). A large number of activities are offered in lifetime, team and wellness areas.

▸ All P.E. courses must be completed by the end of the sixth semester. Students can enroll in more than the minimum required P.E. for graduation and are encouraged to do so.

▸ Participation in varsity sports can be used to satisfy up to three semesters of the P.E. requirement.

▸ Participating in club sports can be used to satisfy up to two of the P.E. requirements.

Note: Student may repeat Physical Education class but the repeated course (excluding varsity and club sports) will not count toward the graduation requirement.

Humanities Requirement

All undergraduate students are required to fulfill certain Humanities requirements in order to graduate. Please see pages 599-600 for a breakdown of specific requirements by program.

Minors

Students may qualify for minors in structural engineering, coastal engineering, water resources, green engineering, or environmental engineering by taking the required courses indicated below. Completion of a minor indicates proficiency beyond that provided by the Stevens engineering curriculum in the basic material of the selected area. The minor program must be in a discipline other than that of a student's major program of study, and at least two courses in the minor must be overload courses, beyond the credit requirements for all other programs being pursued by the student.

Structural Engineering

A minimum of six of courses must be selected from the following:

‣ CE 345 Modeling and Simulation

‣ CE 373 Structural Analysis

Two of the following courses:

‣ CE 484 Concrete Structures or CE 486 Structural Steel Design

‣ CE 519 Advanced Structures

‣ CE 681 Finite Elements

And one or two of the following:

‣ CE 579 Advanced Reinforced Concrete Structures

‣ CE 623 Structural Dynamics

‣ CE 660 Advanced Steel Structures

Water Resources

‣ CE 304 Water Resources Engineering

‣ CE 342 Fluid Mechanics

‣ CE 535 Stormwater Management

‣ CE 578 Coastal and Floodplain Engineering or CE 537 Introduction to GIS

‣ CE 685 Advanced Hydraulics or CE 652 Hydrologic Modeling

‣ EN 686 Groundwater Hydrology and Pollution

Or

‣ EN 553 Groundwater Engineering

Coastal Engineering

‣ CE 304 Water Resources Engineering

‣ CE 342 Fluid Mechanics

‣ OE 501 Oceanography

‣ OE 589 Coastal Engineering

‣ OE 535 Ocean Measurements and Analysis

‣ CE 578 Coastal and Floodplain Engineering

Environmental Engineering

‣ CHE 210 Process Analysis

‣ CE 342 Fluid Mechanics

And any three of the following courses:

▸ EN 570 Environmental Chemistry

▸ EN 541 Fate and Transport of Environmental Contaminants

▸ EN 571 Physicochemical Processes for Environmental Control

▸ EN 573 Biological Processes for Environmental Control

Minor in Green Engineering

Issues of sustainability are of increasing concern for the developed and the developing nations of the world. Engineers have to take a central role in providing the needed solutions and associated leadership to address those issues. In the design, implementation and use of products, processes and systems that impact all facets of our lives, fundamental decisions are made by engineers. Those decisions can either contribute to an exacerbation of the negative impact of human endeavors on the environment, or they can be the means to reduce that impact. Engineering decisions are not just technical; they essentially must include economic considerations as well as be influenced by the ethical, social and political dimensions that shape their context.

The application of the principles by which engineers can have a positive impact on sustainability is known as Sustainable Engineering or more colloquially as Green Engineering. The latter terminology has found resonance with the general resurgence of interest in the environmental impact of human activity and the associated "green" approaches to mitigating them. While elements of sustainable engineering are permeating the broad-based Stevens undergraduate engineering programs, the scope is relatively limited so far. It is therefore proposed that for the student who wishes to explore sustainable approaches to engineering in some depth, the appropriate vehicle is to pursue a minor program.

Objectives of the Green Engineering Minor

▸ Provide a holistic, systems perspective to the impact of human activity on the environment, including the role of engineering.

▸ Educate students in the concepts of sustainable development and industrial ecology.

▸ Provide insight into sustainability tools and metrics such as life cycle analysis and ecological footprint.

▸ Show how engineering decisions, particular with regard to design, can support sustainability goals.

▸ Develop awareness of the ethical, economic, social and political dimensions that influence sustainability.

Content of the Green Engineering Minor

The Green Engineering Minor consists of six courses, three of which are required. It provides a two-course foundation. This is followed by two technical electives which can also provide a sustainable engineering focus area. Two additional courses are intended to allow students to explore ethical, social, economic and political contextual issues associated with sustainability; one of these courses is part of the core requirement. It should be noted that some of the courses taken towards the minor might also be applicable to meet Humanities/Social Science as well as General Education course requirements where appropriate.

General requirements for engineering minors include:

▸ A minimum of two courses are required beyond those needed to meet the requirements of the student's BE degree (including general electives)

▸ A minimum course grade of C in a minor course is required for it to count

▸ A minimum GPA of 2.5 is required to commence the minor program

Green Engineering Minor - Core Requirements

The following three core courses are required for the minor:

‣ EN 530 Sustainable Engineering

‣ E 580 Sustainable Energy

‣ SM 510 Perspective in Environmental Management

Green Engineering Minor - Technical Electives

Two technical electives are required from the following list. The technical electives could be used to create a focus area as indicated. A Minor technical elective in some circumstances might also be applied to the student's degree program if it meets the requirements.

Chemical/Biochemical Processes

‣ CHE 580 Biofuels Engineering Technology

Civil Structures

‣ CE 304 Water Resources Engineering

‣ CM 560 Sustainable Design

‣ CM 561 Green Construction

Environmental Engineering

‣ EN 375 Environmental Systems

‣ EN 545 Environmental Impact Analysis and Planning

‣ EN 575 Environmental Biology

‣ ME 532/EN 506 Air Pollution Principles and Control

Power & Energy

‣ ME 511 Wind Energy- Theory & Application

‣ ME 421 Energy Conversion Systems

‣ ME 510 Power Plant Engineering

‣ E 518 Solar Energy: Theory & Application

‣ E 528 Solar Energy: System Design

NOTE: E423-424 Capstone Design, with significant "green" content, can replace one technical elective if it is approved by the Green Engineering Program Director.

Green Engineering Minor - Contextual Course

One elective is to be selected from the following list:

▸ EN 587/SM 587 Environmental Law and Management

▸ HPL 370 Philosophy of Technology

▸ HPL 380 Environmental Ethics

▸ HPL 480 Environmental Policy

▸ SM 531 Sustainable Development

GRADUATE PROGRAMS

The goal of the graduate programs is to prepare students to be technical leaders in their field, including the ability to do original research. The department offers master of engineering, master of science, doctoral degrees, and the degree of civil engineer. The master's degrees may be with or without thesis. Major areas of current research in civil engineering include wind engineering, multi-scale modeling and stochastic mechanics, nondestructive evaluation and damage identification, bridge and infrastructure evaluation and design, soil-structure interactions, soil mechanics, deep foundation systems, and green infrastructure for urban stormwater management. In environmental engineering we have been studying advanced oxidation of hazardous wastes, statistical process control of wastewater treatment, stabilization/solidification of contaminated soil, and physicochemical treatment of heavy metal contaminated wastes. Our ocean engineering group conducts research on hydrodynamic modeling of currents and the dispersion of effluents in the coastal zone, experimental and computational marine hydrodynamics, coastal sediment transport, climate change, port security, coastal hazards, inland and coastal flooding, storm surges, maritime transportation, and analysis of current and wave observations in the coastal ocean.

An undergraduate degree in engineering or related disciplines with a "B" average from an accredited college or university is generally required for graduate study in civil, environmental, and ocean engineering. It is required that any applicants requesting assistantship appointments, and applicants to the Ph.D. program, provide GRE scores as well as evidence of ability to carry out independent work. Examples of such evidence include a description of master's degree thesis work and/or completed work-related projects. GRE scores are not otherwise required, but may be submitted in support of the application. International students must demonstrate their proficiency in the English language prior to admission by scoring at least 550 (79 computer-based) on the TOEFL examination. Applications for admission from qualified students are accepted at any time.

Master's Programs

Master's degree programs build on baccalaureate degrees to provide the student with added depth and specialization. The Master of Engineering (M.E.) degree is offered with programs in civil, environmental, ocean engineering, and Construction Engineering and Management, and the Master of Science (M.S.) is offered in Construction Management and Sustainability Management. The programs require 30 credit-hours of course work. A thesis is optional and may be substituted for five to ten credit hours of course work. The thesis option is strongly recommended for full-time students, those receiving financial support, or those planning to pursue doctoral studies.

Master of Engineering - Civil Engineering

Concentrations are available in the areas of structural, transportation, geotechnical, and water resources engineering. The student must complete core courses depending on the areas of concentration as follows:

<u>Civil Engineering Concentrations</u>

Structural Engineering

> ‣ CE 519 Advanced Structural Analysis
>
> ‣ CE 579 Advanced Reinforced Concrete Structures
>
> ‣ CE 595 Geotechnical Design
>
> ‣ CE 660 Advanced Steel Structures
>
> ‣ CE 681 Finite Element Methods

Geotechnical/Geoenvironmental Engineering

> ‣ CE 595 Geotechnical Design
>
> ‣ EN 520 Soil Behavior and its Role in Environmental Applications
>
> ‣ EN 654 Environmental Geotechnology
>
> ‣ EN 686 Ground Water Hydrology and Pollution
>
> *Or*
>
> ‣ EN 553 Groundwater Engineering

Water Resources Engineering

> ‣ CE 525 Engineering Hydrology or CE 504 Water Resources Engineering
>
> ‣ CE 535 Stormwater Management
>
> ‣ CE 652 Hydrologic Modeling
>
> ‣ CE 565 Numerical Methods in Civil and Environmental Engineering
>
> ‣ EN 686 Ground Water Hydrology and Pollution

Substitutions for core courses may be considered on a case-by-case basis in consultation with your advisor.

Master of Engineering - Environmental Engineering

The Environmental Engineering graduate program is divided into two areas of concentration: Environmental Control Processes and Groundwater and Soil Pollution Control.

The Environmental Processes concentration addresses the treatment of industrial and domestic water and wastewater, and hazardous wastes. Process fundamentals are integrated with a design-based approach to meeting treatment objectives. Students will be prepared for careers in both design and operation of facilities for pollution control. Graduates of this program are best qualified for design and operation work in public and private treatment facilities such as for drinking water, wastewater, and industrial wastes.

The Groundwater and Soil Pollution Control concentration emphasizes the transport and fate of contaminants in the subsurface environment and on engineering processes to mitigate their adverse environmental impact. Some specific areas of study in this option are the modeling of contaminant transport in local or regional geohydrologic systems, the impact of contamination in the subsurface environment, the management of municipal and industrial waste disposal, and the remediation of groundwater and soil. Many of our graduates in this option work in remediation of contaminated properties or of groundwater resources.

Master's candidates without a previous engineering degree may, on a case-by-case basis, be allowed to enroll for the Master of Engineering in Environmental Engineering if they have a bachelor's degree in a relevant science discipline. These students may be required to take additional engineering courses, including undergraduate courses, not for credit towards a degree. All applicants must have at least two years of calculus and one year of chemistry.

Core Courses

- CE 565 Numerical Methods for Civil and Environmental Engineering

- EN 541 Fate and Transport of Environmental Contaminants

- EN 570 Environmental Chemistry

Environmental Engineering Concentrations

Environmental Control Processes

- EN 570 Environmental Chemistry

- EN 571 Physicochemical Processes for Environmental Control

- EN 573 Biological Processes for Environmental Control

- EN 575 Environmental Biology

- EN 637 Environmental Control Laboratory

- EN 751 Design of Wastewater Facilities

Environmental Management Concentration

Required Courses

- EN 510/SM 510 Perspectives in Environmental Management

- EN 517/SM 520 Environmental Assessment

- EN 531/SM 531 Sustainable Development

Plus, either one of the following options

Option 1
- EN 586 Hazardous Waste Management

- EN 571 Physicochemical Processes for Environmental Control

- EN 573 Biological Processes for Environmental Control

Option 2
- CE 535 Stormwater Management

- EN 553 Groundwater Engineering

- CE 525 Engineering Hydrology

Or

- EN 686 Groundwater Hydrology and Pollution

Groundwater and Soil Pollution Control

- EN 520 Soil Behavior and its Role in Environmental Applications

- EN 551 Environmental Chemistry of Soils

- EN 553 Groundwater Engineering

- EN 686 Groundwater Hydrology and Pollution

- EN 690 Soil and Groundwater Remediation Technologies

The remaining courses are electives, which are selected in consultation with the academic advisor. Electives may be concentrated in specific areas, such as:

Modeling of Environmental Systems

- CE 679 Regression and Stochastic Methods

- EN 680 Modeling of Environmental Systems

- EN 780 Nonlinear Correlation and System Identification

Inland and Coastal Environmental Hydrodynamics

- CE 525 Engineering Hydrology

- OE 501 Oceanography

- OE 616 Sediment Transport

Water Resources

- CE 525 Engineering Hydrology

- CE 535 Stormwater Management

- EN 553 Groundwater Engineering

Air Pollution Control

- EN 505 Air Pollution Principles and Control

- EN 550 Environmental Chemistry of Atmospheric Processes

- OE 591 Introduction to Dynamic Meteorology

Environmental Sustainability

- EN 545 Environmental Impact Analysis and Planning

- EN 547 Project Life Cycle Analysis

- EN 548 Environmental Compatibility in Design and Manufacturing

Master of Engineering - Ocean Engineering

The Ocean Engineering graduate program has six areas of concentration that are rooted in traditional and emerging topics in ocean engineering. Concentrations are offered in Coastal Engineering, Naval Engineering, Maritime Systems Engineering, Maritime Structures, Global Change & Urban Coastal Resilience, and Earth Systems. The program requires the completion of three core courses that can be combined with other courses in the program to create degrees focused on any number of ocean engineering topics, including: ocean and atmospheric modeling, sediment transport, green infrastructure design, mixing processes in coastal and estuarine waters, environmental fluid mechanics, estuarine and coastal ocean modeling, motion of vessels in waves, underwater acoustics, renewable energy, and urban coastal resilience. The master's degree program requires one graduate-level applied mathematics course, one time series analysis course and satisfaction of the following additional requirements by concentration:

Core Courses

- OE 501 Oceanography or OE 511 Urban Oceanography

- OE 630 Hydrodynamics

- MA 530 Applied Mathematics for Engineers & Scientists II
  or PEP 527 Mathematical Methods of Engineering and Science I

One or more of the required core courses may be waived with the approval of your academic advisor.

Ocean Engineering Concentrations

Coastal Engineering Concentration

- OE 535 Ocean Measurements and Analysis

- CE 578 Coastal and Floodplain Engineering

- OE 585 Littoral Processes

- OE 589 Coastal Engineering

The remaining courses in the Coastal Engineering Concentration are electives, which are selected in consultation with the academic advisor.

Naval Engineering Concentration

- OE 524 Introduction to Ship Design and Ship Building

- OE 525 Principles of Naval Architecture

- CE 527 Laboratory in Naval Architecture

- OE 528 Computer Aided Ship Design

The remaining courses in the Naval Engineering Concentration are electives, which are selected in consultation with the academic advisor.

Maritime Systems Engineering Concentration

This concentration provides the participant with a fundamental working knowledge of the principles of systems engineering and systems architecture and applies these to the key issues facing the evolving maritime transportation system. The courses for this concentration are:

- OE 505 Maritime Systems Engineering

- SYS 605 Systems Integration

▸ SYS 625 Fundamentals of Systems Engineering

▸ SYS 650 System Architecture and Design

▸ OE 626 Port Planning and Development

The remaining courses in the Maritime Systems Engineering Concentration are electives, which are selected in consultation with the academic advisor.

Maritime Structures Concentration

This concentration provides knowledge of the specific structure types and design analyses associated with port and maritime systems. Students are given instruction in the various design and maintenance considerations unique to the marine and inland waterway environments. In addition, students will gain skills in using state-of-the-art design tools, including computer and physical models of maritime structures for consideration in construction and maintenance applications. The courses for this concentration are:

▸ OE 520 Designs of Marine Structures

▸ CE 530 Nondestructive Evaluation

▸ OE 589 Coastal Engineering

▸ OE 622 Design of Port Structures I

▸ CE 649 Earth Supported Structures Or

▸ CE 687 Design of Hydraulic Structures

The remaining courses in the Maritime Structures Concentration are electives, which are selected in consultation with the academic advisor.

Global Change & Urban Coastal Resilience Concentration

This concentration provides a background in Urban Ocean and Meteorology with a particular focus on the coastal zone. It also prepares students to address challenges faced by cities in a changing climate.

▸ OE 578 Coastal and Floodplain Engineering

▸ OE 592 Global Warming: Weather, Climate and Society

▸ ES 520 The Nature of Urban Design

The remaining courses in the Global & Urban Resilience Concentration are electives, which are selected in consultation with the academic advisor.

Earth Systems Concentration

This concentration gives a foundation in aspects of the earth system through the components (oceanography, meteorology, and hydrology) and as a whole (climate).

▸ OE 591 Introduction to Dynamic Meteorology

▸ OE 633 Dynamic Oceanography

▸ CE 652 Hydrologic Modeling

▸ OE 592 Global Warming: Weather, Climate and Society

The remaining courses in the Earth Systems Concentration are electives, which are selected in consultation with the academic advisor from the following list:

- OE 511 Urban Oceanography
- OE 535 Ocean Measurements and Analysis
- OE 634 Air-Sea Interactions: Theory and Measurement
- OE 637 Estuarine Oceanography
- CE 648 Numerical Hydrodynamics
- CE 681 Introduction to Finite Element Methods
- CE 684 Mixing Processes in Inland and Coastal Waters
- OE 688 Coastal Ocean Dynamics I

Master of Engineering - Construction Engineering and Management

The Stevens Institute of Technology degree in Construction Engineering and Management prepares engineers to lead efforts in designing, planning, constructing, and managing society's buildings, green infrastructure, and utility projects in addition to endeavors yet-to-be-envisioned such as implementing construction of facilities for alternative energy distribution and global megaprojects.

Our students will lead the teams and manage the resources that are crucial to global human health and other demands of developing nations. The classes build upon the student's engineering undergraduate degree to develop technical, managerial and leadership expertise through advanced areas of study and initiatives including experiential learning and engagement with industry. Both full and part-time graduate students can take advantage of the flexible curriculum designed to fit into the busy schedule as some classes are offered online.

The Master of Construction Engineering and Management is for students with an undergraduate degree in civil engineering wishing to obtain specialized knowledge in construction engineering, project controls and management. Students with other engineering backgrounds may have to take additional prerequisites which will be determined on a case by case basis at time of admission.

The master's degree requires completion of a total of 30 hours of credit. Each student must complete six core courses (18 credit hours). Students choosing to complete a master's thesis shall take CM900 for six credits and choose six additional credits from approved electives. Students not choosing to complete a thesis will take a practicum class for three credits and choose nine additional credits from approved electives. The elective classes must be chosen from among the Civil Environmental and Ocean Engineering Department's graduate courses in this catalog. Elective courses not in the CM program or the CEOE department are available upon the approval of the student's academic advisor.

Core Courses

- CM 501 Construction Engineering I
- CM 601 Construction Engineering II
- CM 605 Construction Safety Management
- CE 649 Earth Supporting Structures
- CE 541 Project Management for Construction or CM 592 Advanced Controls in the Built Environment
- CM 581 Temporary Structures in Heavy Construction

One of the following:

▸ CM 900 Construction Management Master's Thesis, or

▸ CM 671 Construction Management Practicum

One or more of the required core courses may be waived with the approval of your academic advisor.

Master of Science - Construction Management

The construction industry today challenges the world economy with a huge volume of infrastructure-related mega projects annually. These projects become more and more complex as advancing technology demands. The future construction project will typically not only involve implementing a complex design, but also leading a diverse and technically competent labor pool, coordinating teams of Architecture and Engineering experts and reacting to changing geopolitical influences.

As a professional, the Construction Manager has evolved as the leader responsible for coordinating the resources necessary for successful completion of a high quality project, on-time and within budget expectations. The Construction Manager must master the skills of leadership, project controls, and digital-proficiency beyond estimating and scheduling software. The industry also demands inquiry into this age-old profession so that mega projects, infrastructure renewal, and urban resiliency can be planned and delivered with confidence.

The program is designed to focus on the complex mega projects and allows students to select courses from the Schools of Systems and Enterprises, Technology Management and Arts and Letters. An undergraduate degree in Architecture, Construction Management, Engineering or related disciplines from a recognized school is a prerequisite for graduate study in construction management. Applicants not meeting this prerequisite will be reviewed on a case-by-case basis and may be required to enroll in CM 510 (Construction Management Fundamentals) course if accepted.

Stevens offers a Master of Science degree and several Graduate Certificates in Construction Management. The successful degree graduate will complete three core courses for 9 credits and an additional 21 credits from graduate-level courses within Construction Management or pre-approved courses offered institute-wide.

Core Courses

▸ CM 506 Computer Applications in the Construction Process

▸ CM 592 Avanced Project Controls for the Built Envirnment

▸ CM 605 Construction Safety Management

Master of Science - Sustainability Management

The M.S. in Sustainability Management is for students in science, engineering, architecture, planning, business, social science, communications, law and policy fields who want to be a part of the relatively new, but rapidly-growing cadre of trained sustainability experts and managers. The program intends to turn their passion for sustainability into impactful careers by devising a dynamic, mission-driven curriculum that focuses on application of sustainability principles in all spheres of life – environmental, economic, social - for protection of the environment and earth's natural resources, in promoting economic development without impacting the environment, and in implementing practical solutions based on principles of social inclusion, thus ensuring a better quality of life for all members of the society. Students benefit from close interaction with an internationally recognized faculty with diverse educational and professional backgrounds; hybrid format of many classes that are offered in the evenings; and networking opportunities with industry and academic experts via participation in the weekly Sustainability Seminar Series. Graduates of the program will be well positioned to lead the workforce in devising and implementing sustainable strategies for development in business, non-profit organizations, and in the public sector (municipal government to federal).

Admission into the MS degree program in Sustainability Management is available to students with an undergraduate degree in science, engineering, architecture, planning, business, social science, communications, law, policy or any other relevant discipline with a grade point average of "B" or better from an accredited college or university. The degree program caters to the interests of new graduates, early- to mid-career professionals in sustainability related fields who can use formal training in sustainability for career advancement, and those wishing to make a career change from any other field to the exciting area of sustainability management.

The following are required courses for the M.S. in Sustainability Management:

- SM 510 / EN 510 Perspectives in Environmental Management
- SM 515 / EN 515 Statistical Methods in Sustainability
- SM 587 / EN 587 Environmental Law and Management
- MGT 609 Project Management
- SM 520 / EN 517 / CE 517 Environmental Assessment
- SM 530 Sustainable Business Strategies
- SM 690 / EN 592 Project in Sustainability Management
- SM 501 / EN 501 Seminar in Sustainability Management[1]

    (1) 1 credit course required for 3 semesters

In addition, two elective courses will be selected in consultation with the advisor based on factors such as whether the student has a background in science or engineering or in social science or in business. SM 900 (Master's Thesis) can substitute for one or both elective courses.

Dual MS-MBA Degree in Sustainability Management

The dual MS-MBA degree is designed for students from a variety of disciplinary backgrounds, such as engineering, science, business, management, finance, architecture, planning, communications, social science, policy, and law who are interested in honing their business and management skills offered by the MBA program while pursuing a STEM graduate degree in sustainability. The students will earn two separate Master's degrees at completion of this dual degree program.

This dual program offers an exceptional combination of management skills with deep and practical knowledge of the technical aspects of the sustainability. In-depth training in strategic management enables the graduates of the dual program to evaluate and implement sustainability-related projects from financial and managerial perspectives. The program emphasizes development of sustainable models for business operations, i.e., promoting economic and business development without damaging the environment, and implementation of practical solutions inside of organizations resulting in cost-saving through sustainable practices.

Students in this program benefit from close interaction with an internationally recognized faculty body with diverse educational and professional backgrounds both in the School of Engineering and Science and in the School of Business; from the hybrid format of many classes; summer classes; and networking opportunities with industry and government experts via participation in the weekly Sustainability Seminar Series. Hands-on training is emphasized in the program to prepare students for life after graduation, which includes a standalone training module in sustainability consulting as part of the capstone project course. The program requires industry mentors to work directly with students on their capstone projects; students are connected with senior professionals from local/regional companies who act as their guides. Graduates of the program will be well positioned to devise sustainable business strategies; form new ventures and startups on sustainability; join leading management consulting firms; and lead sustainability projects and initiatives within midsize or large corporations or with a government institution.

Core Courses (MS - 24 hours)

- ▸ SM 501 Seminar in Sustainability Management (1 credit course repeated for 3 semesters)
- ▸ SM 510 Perspectives in Environmental Management
- ▸ SM 515 Statistical Methods in Sustainability
- ▸ SM 530 Sustainable Business Strategies
- ▸ SM 520 Environmental Assessment
- ▸ SM 587 Environmental Law and Management
- ▸ SM 531 Sustainable Development
- ▸ SM 690 Project in Sustainability Management (Capstone)

Core Courses (MBA - 36 hours)

- ▸ FIN 600 Financial and Managerial Accounting
- ▸ BIA 600 Business Analytics
- ▸ MGT 606 Economics for Managers
- ▸ MGT 609 Project Management Fundamentals
- ▸ MGT 612 Leader Development
- ▸ FIN 623 Financial Management
- ▸ MGT 635 Managerial Judgment and Decision Making
- ▸ MGT 641 Marketing Management
- ▸ MGT 657 Operations Management
- ▸ MGT 663 Discovering and Exploiting Entrepreneurial Opportunities
- ▸ MGT 696 Human Centered Design
- ▸ MGT 699 Strategic Management

The program can be completed by full-time students in 2 years including Summers as follows. Part-time students will need more time.

FALL 1	SPRING 1	SUMMER 1	FALL 2	SPRING 2	SUMMER 2
SM 510 (3)	SM 530 (3)	MGT 609	SM 531 (3)	SM 520 (3)	SM 690 (3)
SM 515 (3)	BIA 600 (3)	MGT 657	MGT 635 (3)	SM 587 (3)	
FIN 600 (3)	MGT 612 (3)		MGT 641 (3)	MGT 663 (3)	
MGT 606 (3)	FIN 623 (3)		MGT 696 (3)	MGT 699 (3)	
SM 501 (1)	SM 501 (1)		SM 501 (1)		
(13 credits)	(13 credits)	(6 credits)	(13 credits)	(12 credits)	(3 credits)

The objectives of the program are to train the students such that:

- ▸ they develop basic skills in management as well as the ability to integrate managerial and technical aspects of sustainability at various levels of their organization,
- ▸ they are knowledgeable in current sustainability practices and can apply that knowledge toward optimal decision-making process,

▸ they are capable of integrative thinking to holistically analyze a sustainability problem,

▸ they develop qualitative and quantitative analytical skillsets in the area of sustainability management, such as sustainability data analysis, evaluation of sustainability aspects of technology applications, etc.,

▸ they develop strong written and oral communication skills and are able to communicate the value of sustainability to both technical and lay audience,

▸ they understand the value of professionalism and the code of ethical conduct.

3 to 6 years after graduation, students will be able to:

▸ Head an organization's sustainability program as Sustainability Manager. Sustainability managers find jobs in business, non-profit and public sectors (municipal, state, or federal government). They lead the corporate social responsibility team in a medium or large company or work in the sustainability and environmental management sections of management consulting firms.

▸ Establish new ventures and startups offering sustainability services as sustainability consultants.

▸ Pursue further studies: Based on their disciplinary backgrounds, students with this degree may decide to pursue a PhD and join academia as a researcher and/or faculty member (e.g., PhD in Sustainable Development, Sustainability Science, or Sustainability Management with focus on finance, marketing, or operations management). Other requirements may be necessary for PhD application.

Students graduating with an MS-MBA Sustainability Management are expected to develop in-depth insights required for critical thinking in pursuing deeper understanding and concomitant solutions to important sustainability problems. Specifically, the graduates will:

1. Develop basic skills of management as well as gain knowledge of analytical methods for approaching organization problems.

2. Be able to integrate managerial and technical aspects of sustainability.

3. Demonstrate fluency in the current body of knowledge in sustainability and apply that knowledge toward optimal decision-making process in their respective field of practice.

4. Exhibit proper use of integrative thinking in order to holistically analyze the relationship between human activity and the natural, social, and economic environments.

5. Integrate sustainability at various levels in their organizations.

6. Acquire both qualitative and quantitative analytical skills and apply those skills in solving sustainability-related problems in the context of their professional interests and expertise.

7. Evaluate the sustainability of current and future technology applications.

8. Able to perform sustainability data management.

9. Possess high quality written and oral communication skills to efficiently communicate complex sustainability issues to a varied audience.

10. Demonstrate high level of professionali

Admission into the dual MS-MBA degree program in Sustainability Management requires an undergraduate degree in science, engineering, business, management, architecture, planning, social science, communications, law, policy or any other relevant discipline with a grade point average of "B" or better from an accredited college or university, as well as an acceptable GRE/GMAT score. The degree program caters to the interests of new graduates; early- to mid-career professionals

in sustainability related fields who can use formal training in sustainability for career advancement; and individuals wishing to make a career change from any other field to the exciting area of sustainability management.

1. Despite tremendous student interest in sustainability education in business and management in the Tri-state area, there is no program at present in Stevens which offers that option. This dual program will fill that void taking advantage of existing faculty synergy between the two schools without an immediate need for creating new faculty lines.

2. Some of the MS courses will be taught by existing Stevens faculty; for example, the program director, Dr. Sarkar will teach 3 core courses: Perspectives in Environmental Management, Project in Sustainability Management, Seminar in Sustainability Management. Some other MS courses will be taught by industry experts. Many of the MBA courses will be taught by full-time SoB faculty as part of the existing MBA program. A few of them will be taught by industry experts.

3. All courses will be offered in evenings. Courses will be offered in traditional in-class format as well as in online and hybrid formats to promote a flexible learning environment. Summer courses will be offered.

4. Hands-on training is emphasized in the program to prepare students for life after graduation, which includes a standalone training module in sustainability consulting as part of the capstone project course. The program requires students to work directly with industry mentors on their capstone project; they are connected with senior professionals from local/regional companies who act as their guides.

What semester is it planned that the program will first be offered: Fall 2018

Admissions: Admission decisions for the dual program will be decided upon jointly by the two directors listed below for students. Students who are accepted into one program and then decide to do the dual program can apply for the second program after consultation with the program directors.

SES-MS: Dr. Dibyendu "Dibs" Sarkar, Professor of Environmental Engineering, and Director, Sustainability Management MS Program, Department of Civil, Environmental, and Ocean Engineering, School of Engineering and Science, 201-216-8028, dsarkar@stevens.edu

SoB-MBA: Dr. Brian Rothschild, Graduate Management Programs Director, School of Business, 201-216-3677, brothsch@stevens.edu

Graduate Certificate Programs

The department offers the following programs leading to graduate certificates. Students need to meet regular admissions requirements for the master's program and complete the courses listed below. The courses may also be used toward corresponding Master of Engineering or Master of Science within the department with approval of your academic advisor.

Applied Coastal Oceanography

Required:

- ▸ OE 501 Oceanography
- ▸ OE 589 Coastal Engineering

Choose two from the following list:

- ▸ OE 620 Marine Structures
- ▸ OE 630 Hydrodynamics
- ▸ OE 635 Stochastic Analysis of Ocean Waves

▸ OE 641 Dynamics of Ocean Waves

▸ OE 647 Advanced Hydrodynamics Laboratory

Atmospheric and Environmental Science and Engineering (Interdisciplinary)

▸ PEP 575 Fundamentals of Atmospheric Radiation and Climate

▸ CE 591 Introduction to Dynamic Meteorology

▸ ME 532/EN 506 Air Pollution Principles and Control

▸ EN 550 Environmental Chemistry of Atmospheric Processes

Construction Professional Certificate

▸ CM 605 Construction Safety Management

▸ CM 50 Computer Applications in Construction Projects

▸ CM Elective I

▸ CM Elective II

Construction Accounting/Estimating

▸ CM 509 Construction Cost Analysis and Estimating

▸ CM 511 Construction Accounting

▸ CM 580 Construction Management I

▸ CM 590 Construction Management II

Environmental Compatibility in Engineering

▸ EN 505 Environmental Engineering

▸ EN 541 Fate and Transport of Environmental Contaminants

▸ EN 545 Environmental Impact Analysis and Planning

▸ EN 547 Project Life Cycle Management

▸ EN 548 Environmental Compatibility in Design and Manufacturing

Environmental Management

Required:

▸ SM 510 / EN 510 Perspective in Environmental Management

▸ SM 520 / EN 517 / CE 517 Environmental Assessment

Two elective courses to be decided in consultation with the Program Director. Example courses:

▸ SM 587 / EN 587 Environmental Law and Management

▸ EN 686 Groundwater Hydrology and Pollution

▸ SM 530 Sustainable Business Strategies

▸ SM 531 Sustainable Development

▸ MGT 509 Project Management

▸ EN 586 Hazardous Waste Management

▸ CE 535 Stormwater Management

Environmental Processes

▸ EN 541 Fate and Transport of Environmental Contaminants

▸ EN 570 Environmental Chemistry

▸ EN 571 Physiochemical Processes for Environmental Control

▸ EN 573 Biological Processes for Environmental Control

Geotechnical Engineering

▸ CE 520 Soil Behavior and its Role in Environmental Applications

▸ CE 560 Advanced Soil Testing

▸ CE 595 Geotechnical Design

▸ CE 649 Earth Supporting Structures

Inland and Coastal Environmental Hydrodynamics

▸ OE 501 Oceanography

▸ EN 541 Fate and Transport of Environmental Contaminants

▸ CE 684 Mixing Processes in Inland and Coastal Waters

Ocean Engineering

Required:

▸ OE 501 Oceanography

▸ OE 589 Coastal Engineering

Choose two from the following list:

▸ OE 620 Marine Structures

▸ OE 630 Hydrodynamics

▸ OE 635 Stochastic Analysis of Ocean Waves

▸ OE 641 Dynamics of Ocean Waves

▸ OE 647 Advanced Hydrodynamics Laboratory

Ship Hydrodynamics

Required:

▸ OE 525 Principles of Naval Architecture

▸ OE 620 Marine Structures

Choose two from the following list:

▶ OE 530 Yacht Design

▶ OE 526 Computer Aided Aspects of Naval Architecture

▶ OE 642 Motion of Vessels in Waves

▶ OE 645 Hydrodynamics of High Speed Craft

▶ OE 647 Advanced Hydrodynamics Laboratory

Soil and Groundwater Pollution Control

▶ EN 520 Soil Behavior and its Role in Environmental Applications

▶ EN 553 Groundwater Engineering

▶ EN 686 Groundwater Hydrology and Pollution

▶ EN 690 Soil and Groundwater Remediation Technologies

Structural Engineering

▶ CE 613 Matrix Analysis of Structures

▶ CE 519 Advanced Structural Analysis

▶ CE 623 Structural Dynamics

▶ CE 681 Introduction to Finite Element Methods

Water Resources Engineering

▶ CE 525 Engineering Hydrology

▶ CE 535 Stormwater Management or CE 537 Introduction to GIS

▶ CE 652 Hydrologic Modeling or CE 685 Advanced Hydraulics

▶ EN 686 Ground Water Hydrology and Pollution

Maritime Security

The objectives of this program are to provide the student with the operational and technological skills to deal with the international safety and security issues facing the Maritime Transportation System. The student's perspective may be that of a vessel or port operator, Port Authority, or military or governmental security agency. Risk-based analyses are performed to assess concerns related to vessel and shore labor practices, navigational security and safety including cargo (e.g., oil spills) and vessel traffic (e.g., collisions). Acoustic and electromagnetic sensor and security technologies are studied, with a focus on their application to various security threat scenarios, including terrorism, piracy, and crime.

▶ OE 529 Maritime Safety and Security

▶ OE 560 Fundamentals of Remote Sensing

▶ OE 628 Technologies for Maritime Security

▶ OE 629 Advanced Maritime Security

Doctoral Program

The program leading to the Doctor of Philosophy degree is designed to develop the student's capability to perform research or high-level design in civil, environmental, ocean engineering or the Built Enviornment. Admission to the doctoral program is made through the departmental graduate admissions committee, based on review of the applicant's scholastic record. One's master's level academic performance must reflect your capability to pursue advanced studies and perform independent research.

Eighty-four credits of graduate work in an approved program of study beyond the bachelor's degree are required for completion of the doctoral program. Up to 30 credits obtained in a master's program can be included in this program. Of the remaining 54 credits, 15 to 30 credit hours of course work, as well as 30 to 45 credit hours of dissertation work, are required. Within two years from the time of admission, a student must take a qualifying examination that tests his/her basic knowledge and ability to critically analyze the research literature. Upon satisfactory performance in the qualifying examination, and completion of the required course work, (s)he must take an oral preliminary examination. This examination is primarily intended to evaluate the student's aptitude for advanced research and examine his/her understanding of the subjects associated specifically with the dissertation topics. Upon satisfactory completion of the preliminary examination and all course work, a student will become a doctoral candidate and start his/her dissertation research. Doctoral research work must be based on an original investigation and the results must make a significant, state-of-the-art contribution to the field, and must be worthy of publication in current professional literature. At the completion of the research, a student must defend his/her thesis in a public presentation.

Civil Engineer Degree

The Civil Engineer Degree is an advanced graduate program with an emphasis on design. To be qualified to enter the civil engineer degree program, a student must have completed a master's degree in engineering. The degree candidate must also demonstrate professional competence by having at least two years of responsible industrial experience in one of the areas of civil engineering. The industrial experience is to be completed prior to entering the program or in the process of being satisfied upon entering the program. Thirty credits beyond the master's degree are required for the degree of civil engineer. Eight to 15 of those credits must be on a design project. A student will be assigned an advisor who will help him/her develop a study plan and who will supervise his/her design project. The study plan, which should include details of the professional experience and of the design project, must be submitted to the departmental committee on the civil engineer degree for approval. Upon completion of the design project, (s)he will submit a written report to the departmental committee for approval, and the student will be required to take an oral examination on the substance of the design project.

COURSE OFFERINGS

Civil Engineering

CE240   Introduction to Geoscience
This course is designed to promote a basic understanding of earth system science among engineering students. In addition to learning how to identify common rocks and minerals and how they are formed, students will learn about the earth's interior, plate tectonics, and how various geological processes modify the surface on which we live. Furthermore, we will explore the human contribution to environmental disasters, our impact on natural cycles, and how we can move forward towards a more sustainable future.

CE 304   Water Resources Engineering   (3 - 3 - 0)
Principles of engineering hydrology, the hydrologic cycle, rainfall-runoff relationships, hydrographs, hydrologic and hydraulic routing; groundwater resources; planning and management of water resources; probabilistic methods in water resources, reservoir design, water distribution systems. Prerequisite: E 243 or Corequisite: E 243

CE 322   Engineering Design VI   (2 - 1 - 3)

Introduction to AutoCAD and computer graphics. Introduction to SAP2000 finite element code. Application of software and design codes to analyze and design full structure. Case studies and projects taken from architectural drawings of real structures. Prerequisite: E 321 Corequisite: CE 486

CE 342   Fluid Mechanics   (4 - 3 - 3)

Fluid properties: fluid statics, stability of floating bodies, conservation of mass, Euler and Bernoulli equations, impulse-momentum principle, laminar and turbulent flow, dimensional analysis and model testing, analysis of flow in pipes, open channel flow, hydrodynamic lift and drag. Practical civil engineering applications are stressed. Prerequisite: E 126

CE 345   Modeling and Simulation   (3 - 3 - 0)

Introduction to linear systems and eigenvalue problems. Matrix analysis of trusses and frames, stress analysis, free and forced vibrations of structures. Introduction to nonlinear ODEs and PDEs with applications to civil engineering problems. Use of MATLAB or equivalent to simulate solutions.

CE 373   Structural Analysis   (3 - 3 - 0)

Shear and bending moment diagrams for beams and frames. Statically determinate trusses influence lines and moving loads, deflection of beams using moment-area and conjugate-beam methods, introduction to energy methods, deflection of beams and frames using unit-load method, introduction to statically indeterminate structures, approximal methods, moment-distribution and slope-deflection methods. Prerequisite: E 126

CE 381   Civil Engineering Measurements Lab   (3 - 2 - 3)

This course explores testing and measurement methods in Civil Engineering including: land surveying, the experimental analysis to explore the engineering properties of metals and concrete and on destructive evaluation techniques. Students will gain a basic knowledge of drawing in the digital environment using AutoCAD or Civil 3-D, the engineering industry design standard.

CE 410   Transportation Engineering Design   (3 - 3 - 0)

Description of design elements of system components of transportation, including the driver, vehicle, and roadway. Traffic flow design elements including volume, density, and speed. Intersection design elements including delay, capacity and accident counter-measures. Terminal design elements.

CE 423   Engineering Design VII   (3 - 0 - 8)

Senior Design courses. Complete design sequence with a required capstone project spanning two semesters. While the focus is on the capstone disciplinary design experience, it includes the two-credit core module on Engineering Economic Design (E421) during the first semester. Cross-listed with: EN 423

CE 424   Engineering Design VIII   (3 - 0 - 8)

Senior Design courses. Complete design sequence with a required capstone project spanning two semesters. While the focus is on the capstone disciplinary design experience, it includes the two-credit core module on Engineering Economic Design (E421) during the first semester. Cross-listed with: EN 424 Prerequisite: CE 423

CE 483   Geotechnical Engineering   (3 - 2 - 3)

Principles of engineering geology and solid mechanics covering: properties and classification of soils, seepage analysis, theory of soil strength, stress distribution theory and settlement prediction, consolidation theory, introduction to the stability of slopes and the design of shallow foundations. The course is accompanied by concurrent weekly laboratory sessions where students are introduced to geotechnical laboratory tests in a hands-on fashion. Prerequisite: E 126

CE 484   Reinforced Concrete Design   (3 - 3 - 0)

Ultimate strength design for bending and shear of rectangular sections, slabs, "T" sections and continuous beams, girders, columns, retaining walls and footings. Code requirements. Prerequisite: CE 373

CE 486   Structural Steel Design   (3 - 3 - 0)

ASD and LRFD design for tension members, beams and columns. Design of steel frame systems. Code requirements. Prerequisite: CE 373

CE 504   Water Resources Engineering   (3 - 0 - 0)

Principles of engineering hydrology, the hydrologic cycle, rainfall – runoff relationships, hydrographs, hydrologic and hydraulic routing. Ground water resources. Planning and management of water resources. Probabilistic methods in water resources, reservoir design, water distribution systems. Cross-listed with: CE 304

CE 510   Structural Health Monitoring   (3 - 3 - 0)

The course provides a broad overview of structure health monitoring technologies, sensing and data acquisition, life-cycle analysis, structure rating and risk assessment as well as signal processing. A strong emphasis is given to Smart Materials for use as sensors and actuators. The students taking this course will learn about the strength and importance of structure health monitoring which is expected to significantly change structures into smart structures with built-in autonomous diagnostics and prognosis. Prerequisite: CE 373

CE 515   Long-Term Structural Integrity   (2 - 0 - 0)

This course introduces the fundamental mechanisms of mechanically and environmentally induced aging of metal and composite infrastructure. Efficient analytical and numerical approaches are discussed to assess aging-induced damage on the material level affecting the load-carrying performance of structural components and the global system, which enables life-cycle assessment of structures. Further contents of the course are repair and rehabilitation methods of aged infrastructure, and technology to mitigate or even prevent aging. Thorough understanding of the impact of aging to our metal and composite infrastructure enables future engineers to respond effectively to the infrastructure crisis and exploding maintenance costs the world is facing, and contribute to sustainable design of infrastructure. Prerequisite: CE 373

CE 518   Advanced Mechanics of Materials   (3 - 0 - 0)

A second course in Mechanics of Materials that will introduce failure criteria, energy methods, beams on elastic foundation, curved beams, unsymmetric bending, buckling and theory of elasticity. The emphasis is on classical problems and solutions without numerical procedures. Prerequisite: E 126

CE 519   Advanced Structural Analysis   (3 - 3 - 0)

Analysis of structures using methods of work, slope deflection and moment distribution; force acceleration and energy methods; variable moments of inertia; continuous beams, trusses and frames; arch analysis; plasticity and limit design; slab and shell structures. Prerequisite: CE 373

CE 520   Soil Behavior and its Role in Environmental Applications   (3 - 3 - 0)

An overview of soil mineralogy, soil formation, chemistry, and composition. Influence of the above factors in environmental engineering properties; study of colloidal phenomena; fate and transport of trace metals in sediments, soil fabric, and structure; conduction phenomena; and compressibility, strength, deformation properties, and stress-strain-time effects, as they pertain to environmental geotechnology applications (i.e., contaminated soil remediation, soil/solid waste stabilization, waste containment alternatives, soil-water-contaminant interactions, and contaminant transport). Cross-listed with: EN 520 Corequisite: EN 520

CE 525   Engineering Hydrology   (3 - 3 - 0)

Principles of hydrology and their application to engineering projects, including the hydrologic cycle, measurement and interpretation of hydrologic variables, stochastic hydrology, flood routing and computer simulations in hydrology.

CE 526   Watershed Modeling   (3 - 3 - 0)

This course is intended to provide graduate students with the tools necessary to simulate the water quality of a complex watershed. The course will focus on the development of models for examining the water quality and water quantity issues that are associated with watershed management. Students will learn various modeling technologies from simplistic mass balance models to more complex dynamic models. The models required for fully understanding the effects of both point and nonpoint sources of pollution on a natural waterway will be examined. The students will also develop an understanding of how to design a monitoring program to collect the data that are appropriate for simulating a natural system. Current state and federal guidelines and regulations will be discussed including the development of a wasteload allocation for a point source, a load allocation for a nonpoint source and a Total Maximum Daily Load (TMDL) for an impaired waterway. This course will not only provide the student with the tools necessary to simulate a watershed but also provide a keen insight into the watershed management process. The final project will require the students to work in teams to analyze a specific watershed.

CE 527   Wetland Hydrology   (3 - 3 - 0)

Over the past two decades, there has been a rise in wetland mitigation projects across the country. The success of a wetland depends mainly on it hydrology. Central to the course will be the principle of water budgeting. This course will outline the hydrologic principles involved in freshwater and coastal wetland engineering. Dynamic and steady state mathematical modeling will be presented as techniques to estimate wetland hydrology.

CE 535   Stormwater Management   (3 - 3 - 0)

The management of stormwater must be addressed for any modern development or construction project. The interdisciplinary nature of stormwater is relevant to protecting environmental resources and water supplies, preventing combined sewer overflows and local flooding, minimizing pollutant discharges to water bodies, and planning for livable cities. This course will focus on technical design for urban stormwater control, including Green Infrastructure technologies such as living/green roofs, bio-retention, permeable pavement, and conventional solutions such as detention and retention ponds and constructed wetlands. The course will emphasize engineering solutions for practical applications, in the context of regulations imposed by both state and federal agencies. Prerequisite: CE 304 or CE 525

CE 541   Project Management for Construction   (3 - 0 - 0)

This course deals with the problems of managing a project. A project is defined as a temporary organization of human and nonhuman resources, within a permanent organization, for the purpose of achieving a specific objective. Both operational and conceptual issues will be considered. Operational issues include definition, planning, implementation, control and evaluation of the project; conceptual issues include project management vs. hierarchical management, matrix organization, project authority, motivation and morale. Cases will include construction management, chemical plant construction and other examples. Cross-listed with: CM 541 Prerequisite: CM 511

CE 554   Water Resources Sustainability

This course addresses issues of sustainability of water resources at the local, regional and global level. Topics include water distribution on the earths surface and water budgets, freshwater resources and their use, water consumption, sustainable management practices in surface and ground water systems, threats to water quality and quantity, water security, water conflicts and social and economic impacts. Cross-listed with: EN 554, SM 554

CE 560   Advanced Soil Testing   (3 - 3 - 0)

An advanced treatment of methods and techniques of soil testing. It entails the execution of tests, data presentation and data interpretation associated with soil mechanics practice and research. Tests include soil classification, compaction, shear strength, permeability soil-moisture extraction and soil compressibility. Use of microcomputers in data reduction and presentation.

CE 561   Fundamentals of Remote Sensing   (3 - 0 - 0)

This course exposes the student to the physical principles underlying remote sensing of ocean, atmosphere, and land by electromagnetic and acoustic passive and active sensors: radars, lidars, infrared and microwaves thermal sensors, sonars, sodars, infrasound/seismic detectors. Topics include fundamental concepts of electromagnetic and acoustic wave interactions with oceanic, atmospheric, and land environment, as well as with natural and man-made objects. Examples from selected sensors will be used to illustrate the information extraction process, and applications of the data for environmental monitoring, oceanography, meteorology, and security/military objectives. Cross-listed with: OE 560, EN 560, EE 560, CE 561, PEP 560 Prerequisites: PEP 201, PEP 112

CE 565   Numerical Methods for Civil and Environmental Engineering   (3 - 3 - 0)

An introduction to numerical and methods applied to civil and environmental engineering. Methods for solution of nonlinear equations, systems of linear equations, interpolation, regression, and solution of ordinary and partial differential equations. Applications include trusses, beams, river oxygen balances and adsorption isotherms. Several computer projects are required.

CE 576   Multi-Hazard Engineering   (3 - 3 - 0)

Identification and assessment of wind, flood, earthquake, surge, wave, tsunami, erosion, subsidence, and landslide hazards and their associated loading on the built environment, and comprehensive engineering and planning techniques presented to mitigate extreme loads generated by individual and multi-hazards in the natural environment. Prerequisites: CE 342, CE 373

CE 578   Coastal and Flood Plain Engineering   (3 - 3 - 0)

Identification, assessment, and risk analysis of river and coastal flood hazards. Introduction to flood plain analysis, surge, and overland wave propagation. Development of flood, surge, and wave load analysis. Presentation of flood hazard mitigation techniques and engineering design of flood proofing techniques. Prerequisites: CE 342, CE 373

CE 579   Advanced Reinforced Concrete Structures   (3 - 3 - 0)

Ultimate Strength Design of beams, deep beams, slender columns, walls, two-way and plate slabs. Study of bending, shear, torsion, deflections, shrinkage, creep and temperature effects. Code Requirements. Prerequisite: CE 484

CE 591   Introduction to Dynamic Meteorology   (3 - 3 - 0)

Introduction to meteorology presents a cogent explanation of the fundamentals of atmospheric dynamics. The course begins with a discussion of the Earth's atmospheric system includingglobal circulation, climate, and the greenhouse effect. The basic conservation laws and the applications of the basic equations of motion are discussed in the context of synoptic scale meteorology.The thermodynamics of the atmosphere are derived based on the equation of state of the atmosphere with specific emphasison adiabatic and pseudo-adiabatic motions. The concept of atmospheric stability is presented in terms of the moist and dry lapse rate. The influence of the planetary boundary layer on atmospheric motions is presented with emphasis on topographic and open ocean frictional effects, temperature discontinuity between land and sea, and the generation of sea breezes. The mesocale dynamics of tornadoes and hurricanes are discussed as well as the cyclogenesis of extratropical coast allows. The course makes use of a multitude of web-based prducts including interactive learning sites, weather forecasts from the National Weather Service (NWS), tropical predictions from the National Hurrican Center and NWS model outputs (AVN, NGM, ETA, and WAM). Cross-listed with: OE 591 Prerequisite: CE 342

CE 595   Geotechnical Design   (3 - 3 - 0)

A design oriented course in which geotechnical engineering principles are applied to the computer-aided design of shallow and pile foundations, bulkheads and retaining walls. The course also deals with advanced soil mechanics concepts as applied to the determination of lateral earth pressures needed for the design of retaining walls.

CE 596   Trans Systems Planning & Operation   (3 - 3 - 0)

This course in Transportation Systems Planning provides the engineering student with an introduction to traditional planning processes and exposure to new planning approaches being adopted in public and private sectors. Specific transportation engineering materials and case studies will be used to increase the students' breath of knowledge and familiarity with the state of the practice in the discipline. Upon completion of the course the student will be prepared to become involved in activities requiring project evaluation of context, assessment of facility siting issues, and preliminary design of transportation facilities in urban and suburban areas (e.g., highways, transit systems, bike lanes and footpaths).

CE 601   Theory of Elasticity   (3 - 0 - 0)

Review of matrix algebra; the strain tensor, including higher order terms; the stress tensor; derivation of the linear form of Hooke's law and the higher order form of Hooke's law; equilibrium equations, boundary conditions and compatibility conditions; applications to the bending and torsion problems; variational and approximate methods of solving the Dirichlet type boundary value problems with particular application to the torsion problem. Fall semester.

CE 607   Theory of Elastic Stability   (3 - 0 - 0)

Buckling failure of beams, columns, plates and shells in the elastic and plastic range; postbuckling strength of plates; application of variational principles.

CE 608   Theory of Plates and Shells   (3 - 0 - 0)

Bending of laterally loaded plates of various shapes and edge conditions; large deflection of plates; membrane stresses in shells; bending of cylindrical shells; energy solutions. Spring semester

CE 613   Matrix Analysis of Structures   (3 - 3 - 0)

Formulation of structural theory based on matrix algebra; discussion of force method and displacement method; use of matrix transformation chain in structural analysis; application to indeterminate structures, space frames, vibration and buckling of structures; computer application. Spring semester.

CE 621   Bridge Design for Structural Engineers   (3 - 0 - 0)

This course will concentrate on the typical highway bridge design and analysis. The design will be based on the current AASHTO specifications and other applicable codes. Major topics will include detailing and seismic design considerations. In addition, emphasis will be placed on inspection procedures and the development of contract plans, specifications and construction cost estimating. Grading for the course will be based on a midterm exam and a comprehensive design project. Included in the scope of the project will be the design of the superstructure and substructure, the development of influence lines and a construction cost estimate. Prerequisites: CE 486, CE 483, CE 484, CE 519

CE 623   Structural Dynamics   (3 - 3 - 0)

Introduction to theory of structural dynamics with emphasis on civil engineering problems. One-degree systems; lumped parameter and multi-degree systems; approximate methods; analysis and design applications using computers.

CE 626   Earthquake Engineering Design   (3 - 0 - 0)

A new approach to the overall earthquake-engineering problem is presented in a form that may be utilized by engineering design offices. New earthquake invariants are obtained. The emphasis is placed on the two major topics (1) damage assessment and (2) structural design, but some consideration is also given to the development of a new "mechanism" theory consistent with deep-foci earthquakes. The fundamental data bases the sources for the basic hypotheses and the resultant theories are the accelerograms and the isoseismal maps. These lead to temporal and spacewise energy variations that are the key elements in the theoretical approach.

CE 628   Wind Effects on Structures   (3 - 3 - 0)

Wind characteristics; deterministic and stochastic response; static wind effects and building code; effects of lateral forces; dynamic effects; self-excited motion, flutter, galloping and vortex-induced vibration; tornado and hurricane effects; case studies on tall buildings, long-span bridges, etc.

CE 640   Prestressed Concrete   (3 - 0 - 0)

Basic concepts of prestressing, partial loss of prestress, flexural design, shear, torsion, camber, deflection, indeterminate prestressed structures, connections, and prestressed circular tanks.

CE 648   Numerical Hydrodynamics   (3 - 0 - 0)

Potential flows around bodies: Panel singularities methods and conformal mapping methods. Finite-difference and spectral methods for Poisson equations: numerical inversion of matrices, potential flows in or around irregular domains. Consistency, stability and convergence of numerical methods: linear stability analysis. Numerical methods for diffusion equations: methods for ordinary differential equations. One-dimensional Burgers equation: nonlinear problems, Newton iteration, error analysis. Numerical methods for stream function vorticity equations: flows in or around irregular domains. Current research in computational fluid dynamics: discussions. Four (4) exercise projects and one (1) examination project will be assigned to each student. Cross-listed with: OE 648

CE 649   Earth Supporting Structures   (3 - 3 - 0)

A course of lectures dealing with the design, performance and quality control of earth supporting structures. It includes an outline of the available methods of evaluating slope stability by field studies, numerical computer analysis and hand calculations. Finally, the last portion of the course covers the principles involved in the design and construction of earth and rockfill dams including such topics as soil compaction, hydraulic fill dams, design criteria, seepage control, slope stability analyses, seismic design and case history studies.

CE 650   Water Distribution Systems Analysis   (3 - 3 - 0)

The design of an effective and proper system for the distribution of potable water for domestic, institutional, commercial, and industrial use, requires an understanding of the principles of planning, design and construction of pipe networks. This course will focus on the critical elements of planning, design, and modeling of a water distribution systems.

CE 651   Drainage Design and Modeling   (3 - 3 - 0)

Drainage design includes watershed analysis combined with hydrologic and hydraulic computations. The basic laws of drainage design will be discussed including the environmental and economic implications. Regulations pertinent to the area will also be addressed. Concepts of open channel, pressure and gravity flow will be discussed. Mathematical and computer models will be used to educate the engineer in the techniques available in industry. These models combined with the mathematical principals presented will aid the engineer in developing the best possible design for a particular region.

CE 652   Hydrologic Modeling   (3 - 3 - 0)

Water is probably the most used, the most abused, and the most taken for granted natural resource. Few people realize what is involved in the planning and building of urban water-distribution and management systems. Environmental costs must also be considered when analyzing any water resources project. Efforts continue toward conservation and environmental protection, which increases the need for engineers to be educated in the behavior of water as it moves through the water cycle. This course will address the modern day hydrologic processes, the mathematical and scientific processes for hydrology and introduce several models commonly used in industry. These models will aid the engineer in analyzing the hydrologic processes of a particular region and help provide the best solution for a very sensitive issue.

CE 654   Environmental Geotechnology   (3 - 0 - 0)

The objective of the course is to provide the students with exposure to the geotechnical nature of environmental problems. The topics covered include: principles of geochemistry, contaminant transport and hydrogeology; an overview of landfill liners and other disposal facilities and their design, construction, safe operation, performance monitoring, structural and physicochemical stability; an overview of the general principles governing the design, implementation and monitoring of existing remediation technologies with special emphasis on stabilization/solidification, vapor extraction, bioremediation, soil washing, pump and treat, cover systems and alternative containment systems such as slurry walls. A concurrent laboratory section introduces the student to the chemical analyses, absorption behavior, mineralogical and crystallographical identification and characterization of various waste forms as they pertain to surface chemistry considerations. The main emphasis of the course consists of providing hands-on experience with analyses involving the use of spectrometric, X-ray diffraction and scanning electron microscope equipment. Cross-listed with: EN 654 Prerequisite: EN 520

CE 660   Advanced Steel Structures   (3 - 3 - 0)

Ultimate Strength Design, deep beams, torsion, deflections, shrinkage, creep and temperature effects, biaxially loaded columns, slender columns, walls, two-way and plate slabs. Prerequisite: CE 486

CE 679   Regression and Stochastic Methods   (3 - 3 - 0)

An introduction to the applied nonlinear regression, multiple regression and time-series methods for modeling civil and environmental engineering processes. Topics include: coefficient estimation of linear and nonlinear models; construction of multivariate transfer function models; modeling of linear and nonlinear systems; forecast and prediction using multiple regression and time series models; statistical quality control techniques; ANOVA tables and analysis of model residuals. Applications include monitoring and control of wastewater treatment plants, hydrologic-climatic histories of watercourses, and curve-fitting of experimental and field data.

CE 681   Introduction to Finite Element Methods   (3 - 3 - 0)

A concise introduction for advanced undergraduate and graduate engineering students. Includes numerical discretization, finite-differences, variational principle, weighted residual method, Galerkin approximations, continuous and piecewise-defined basis functions, finite-element methods, computer coding of one-dimensional problems, triangular elements - coding of two-dimensional problems, time-dependent problems.

CE 682   Design of Hydraulic Equipment   (3 - 0 - 0)

This course will provide an understanding of the hydraulic equipment design associated with integrated water and wastewater facilities. Topics include manifold pipe flow, sludge flow, multiport diffusers, open channel flow, flow measurement, hydraulic control points, chemical feed hydraulics, pump and valve selection and hydraulics, and use of computer tools for pump selection and sizing.

CE 684   Mixing Processes in Inland and Coastal Waters   (3 - 3 - 0)

Development of advective-diffusion equations for conservative and non-conservative substances. Fickian diffusion, turbulent diffusion, shear flow dispersion. Description and specification of mixing processes in rivers, reservoirs and estuaries. Methods and analyses of conservative dye tracer studies. Monte Carlo simulations of diffusion processes, and numerical models for simulation of advection diffusion processes in rivers and estuaries. Cross-listed with: OE684

CE 685   Advanced Hydraulics   (3 - 3 - 0)

Fundamentals of open channel flows; types of open channels and their properties; velocity distribution in open channels. Specific energy, momentum and specific force principles; critical flows; principles of uniform flow and its computation. Gradually varied flow; channel transitions and controls. Rapidly varied flow; hydraulic jump and energy dissipaters. Unsteady flows; waves and wave propagation; flood routing. Applications of numerical methods in hydraulic engineering.

CE 695   Traffic Flow Modeling & Operations   (3 - 3 - 0)

An introduction course for machine learning theory, algorithms and applications. This course aims to provide students with the knowledge in understanding key elements of how to design algorithms/systems that automatically learn, improve, and accumulate knowledge with experience. Topics covered in this course include decision tree learning, neural networks, Bayesian learning, reinforcement learning, ensembling multiple learning algorithms, and various application problems. The students will have a chance to simulate their algorithms in programming language and apply them to solve real-world problems. Prerequisite: EE 605 or equivalent

CE 701   Multiscale Mechanics and Computational Methods

This graduate course will introduce the applications of multiscale theory and computational techniques in the fields of materials and mechanics. Students will obtain fundamental knowledge on homogenization and heterogeneous materials, and be exposed to various sequential and concurrent multiscale techniques. The first half of the course will be focused on the homogenization theory and its applications in heterogeneous materials. In the second half multiscale computational techniques will be addressed through multiscale finite element methods and atomistic/continuum computing. Students are expected to develop their own course projects based on their research interests and the relevant topics learned from the course. Cross-listed with: NANO 701

CE 702   Multiscale Mechanics and Computational Methods   (3 - 3 - 0)

This graduate course will introduce the applications of multiscale theory and computational techniques in the fields of materials and mechanics. Students will obtain fundamental knowledge on homogenization and heterogeneous materials, and be exposed to various sequential and concurrent multiscale techniques. The first half of the course will be focused on the homogenization theory and its applications in heterogeneous materials. In the second half multiscale computational techniques will be addressed through multiscale finite element methods and atomistic/continuum computing. Students are expected to develop their own course projects based on their research interests and the relevant topics learned from the course. Cross-listed with: NANO 701 Prerequisites: CE 681, E 234, CE 518

CE 741   Hydraulic Structures   (3 - 3 - 0)

This course will focus on the design of hydraulic structures including small dams, spillways, weirs and culverts. These are complex structures, the design of which must account for the water forces, which act upon them as well as their impacts upstream and downstream. Structural topics will be covered along with backwater curves and downstream effects. Models such as the US Army HEC II and HEC RAS will be used to model the associated hydraulic impacts of these structures. Structural models will also be used were appropriate to assist in the design of the structures. Environmental and economic implications of hydraulic structures will also be addressed. Prerequisites: CE 525, CE 685

CE 746   Advanced Soil Mechanics   (3 - 3 - 0)

Advanced topics in soil mechanics and geotechnology. Application of theory of elasticity to geotechnical problems; two and three dimensional consolidation theories; settlement analysis, strength of soils. Prerequisite: CE 595

CE 780-781   Special Topics in Civil and Environmental Engineering I-II   (3 - -)

An advanced seminar course concerned with recent research developments in civil engineering. Areas of concentration can be in Structures, Geotechnical, Earthquake, or Environmental Engineering. The topics are subject to current faculty and student interests. The student must have completed certain prerequisite courses and can enroll only with the consent of the instructor.

CE 800   Special Problems in Civil Engineering   (1 to 6 - -)

One to six credits. Limit of six credits for the degree of Master of Engineering (Civil).

CE 801   Special Problems in Civil Engineering (PHD)   (3 - -)

A thorough investigation of an advanced research topic under the direction of a faculty member.

CE 802   Special Problems in Civil Engineering (Deg CE)   (1 to 6 - -)

One to six credits. Limit of six credits for the degree of Civil Engineer.

CE 900   Thesis in Civil Engineering (ME)   (1 to 10 - -)

For the degree of Master of Engineering (Civil). Credits to be arranged.

CE 950   Civil Engineering Project (Deg CE)   (8 - 0 - 0)

Design project for the degree of Civil Engineer.

CE 960   Research in Civil Engineering (PHD)   (- - -)

Original research of advanced level in Civil Engineering, which may serve as the topics for the dissertations for the degree of Doctor of Philosophy. Hours and credits to be arranged.

Construction

CM 501   Construction Engineering I   (3 - 3 - 0)

This course is a study of construction industry customs, practices and methods from project conception to close-out. Equipment usage, construction estimating, scheduling, and management techniques are woven into the fabric of this course.

CM 502   Construction Engineering II   (3 - 3 - 0)

This course provides the student in the construction field with a practical analysis and study of the completed construction facility. Case studies are discussed along with the performance of the constructed facility and elements of possible failure within the completed facility. Alternate solutions are discussed along with their economic feasibilty.

CM 506   Computer Application in the Construction Process   (3 - 0 - 0)

Today's construction manager and engineer should have a thorough knowledge of the latest technology and methods so that various elements within the construction process can be produced, analyzed, and reviewed in an efficient manner. The course gives the construction executive the tools to provide proper planning and scheduling, estimating, cost accounting, cost reports, and other valuable and necessary information in a rapid and professional manner.

CM 508   Transportation Engineering   (3 - 0 - 0)

A description of and introduction to the major areas of transportation engineering planning and management which deals with roadways, streets, and highways and the people and vehicles that interact with each other. Topics of discussion include land use, energy, transportation economics, and transportation systems management, along with the traditional areas of traffic engineering. Open-ended problem solving using practical case examples is stressed. Cross-listed with: CE 508

CM 510   Construction Industry Fundamentals   (3 - 3 - 0)

This course introduces the student to the construction industry, built environment history, development and current theories.

CM 511   Construction Accounting   (3 - 3 - 0)

This course presents the principles of accounting for construction projects. Topics include elements of cost accounting, project accounting, and financial analysis used by the construction manager.

CM 512   Problems in Heavy Construction   (3 - 0 - 0)

The general superintendent, engineering staff and construction manager, in order to manage, schedule and complete the heavy construction project, must be aware of problems associated with the completion of the complex project. Problems associated with pile driving & shoring, excavation methods, tunneling, trenchless technology, and rock excavation are reviewed. Examples and case studies are discussed with alternate solutions reviewed based on site conditions and economic considerations. Prerequisite: CM 609

CM 521   Construction Organizations   (3 - 0 - 0)

This course provides the student with an understanding of human behavior including individual and group performance, motivation, leadership, and industrial relations. Next, the student will examine various theories of management and the basic functions of planning, organizing, leading, and controlling. This body of knowledge will be applied to the management of construction companies and projects.

CM 522   Labor Relations   (3 - 3 - 0)

This course provides the student with a basic understanding of the practices involved in construction labor relations. Topics include the discussion of union and open shop contractors, job site agreements, collective bargaining and local union negotiations, double-breasted construction operations and termination of the labor agreement, along with case studies in selected areas.

CM 530   Strategic Responses to Cyclical Environments   (3 - 3 - 0)

In this graduate-level course students will develop an understanding of strategic planning and its place in successfully guiding built environment organizations and the careers of the industry's professionals. Via case studies, the class will analyze specific real world situations, consider various alternatives and produce successful outcomes.

CM 531   Construction Materials   (3 - 3 - 0)

This lecture course covers civil engineering materials, their properties, and their construction use. Specifics to be discussed include physical and mechanical properties of steel, concrete, asphalt, wood, plastic, timber, and soil. Coverage of ASTM standard tests covering these properties is also presented.

CM 532   Unmanned Aerial Systems-Technology and Applications   (3 - 3 - 0)

In recent years, Unmanned Aerial Systems (UAS) have been successfully used in military applications. This success has driven major advances in UAS technology and its use in a rapidly expanding set of civilian, law enforcement, and security applications. In this course, we will begin by reviewing the evolution of UAS technology and the various types of Unmanned Aerial Vehicles (UAV) such as fixed wing and rotary propeller UAV's, and the overall system components, including the Flight Controllers, and the communications links. Next, we will study some of the many UAS applications including environmental (e.g. oil spills, changing ice formations), construction management (e.g. inspecting major construction sites), and security (e.g. detection of maritime crime) and the underlying sensor technologies, e.g photogrammetry, infrared). Finally, we will consider the concerns raised by UAS as a threat. Prerequisites: PEP 112 or equivalent.

CM 535   Cyber-Physical Security in Critical Infrastructure and the Built Environment   (3 - 3 - 0)

The need for a working knowledge of cyber and physical security basics among engineers and industry professionals is rapidly growing. This is driven by the trends toward Smart Buildings, Unmanned Vehicles, and the confluence of Information Technology and Operations Technology in critical infrastructure (such as transportation and manufacturing). In this course, we will study the cyber and physical vulnerabilities of these diverse areas, attack types, mitigating technologies, and industry initiatives to develop comprehensive security plans to manage the risks. The intended audience for this course is engineering students and industry professionals that are not computer science experts, but who need a working knowledge of cyber and physical security.

CM 541   Project Management for Construction   (3 - 3 - 0)

This course deals with the problems of managing a project. A project is defined as a temporary organization of human and nonhuman resources, within a permanent organization, for the purpose of achieving a specific objective. Both operational and conceptual issues will be considered. Operational issues include definition, planning, implementation, control and evaluation of the project; conceptual issues include project management vs. hierarchical management, matrix organization, project authority, motivation and morale. Cases will include construction management, chemical plant construction and other examples. Cross-listed with: CE 541 Prerequisite: CM 511

CM 542   Quality Management & Construction Performance   (3 - 3 - 0)

This course presents the principles and techniques of total quality management (TQM), with emphasis on its application to construction projects and firms. Students will form teams to apply TQM concepts and techniques to construction projects/firms.

CM 543   Construction Contract Management   (3 - 0 - 0)

This course deals with and discusses in detail the complex set of relationships that are involved when a construction project is undertaken. The course also reviews these relationships and how they interact with the planning, administration, start-up, and completion of the project. Risk in the construction project is discussed as it relates to the management and successful completion of the project, while also reviewing the legal relationships that can evolve during the project duration. Prerequisites: CM 541, CM 580, CM 511

CM 545   Environmental Impact Analysis and Planning   (3 - 0 - 0)

The impact of engineering projects on the physical, cultural, and socioeconomic environment, preparation of environmental impact statements, regulatory framework, and compliance procedures will be discussed. Topics include: major federal and state environmental regulations, environmental impact analysis and assessment, risk assessment and risk management, and regulatory compliance. Cross-listed with: EN545

CM 550   Construction Contract Law I   (3 - 3 - 0)

This course introduces the principle areas of construction law and contracts. Areas of discussion include contract formulation, scope of work, changes, delays, no damage for delays, insurance and sureties, completion, termination, and claims and dispute resolutions. Case studies are presented with class presentations and discussions.

CM 551   Construction Contract Law II: Claims and Disputes   (3 - 3 - 0)

This course presents a review and analysis of the methods used in presenting and solving construction contract disputes. Topics of discussion include the origins of the construction dispute, the contract documents, the design deficiency, the construction schedule, construction of the project and resolving the dispute. Prerequisite: CM 550

CM 560   Sustainable Design   (3 - 3 - 0)

A study of sustainable design principles and techniques. The course is designed to make the construction manager familiar with the procedures used by designers to achieve sustainable projects. Students will study the role of government mandates for sustainable design, the selection of materials and systems that meet sustainable requirements, the ecolabeling of buildings, and the economic and environmental impact of sustainable designs. Prerequisite: CM 580

CM 561   Green Construction   (3 - 0 - 0)

A study of green construction principles and techniques. The course is designed to make the manager familiar with the procedures required to achieve green construction. Students will study the role of government regulations requiring contractors to produce green construction projects, green building commissioning and the economic and environmental impact of green construction. Cross-listed with: CM 580

CM 580   Construction Management I   (3 - 3 - 0)

This course provides a survey and study of the management process for domestic and international contracting business enterprises. Topics of discussion include the roles of the construction manager, bonds and insurance elements of the estimating process, finance and cost control, labor relations, and work culture. Cross-listed with: CM 561

CM 581   Temporary Structures in Heavy Construction   (3 - 3 - 0)

This course is a study of the elements and concepts of temporary supportive structures involved with heavy construction process. Topics of discussion will include codes, construction, cofferdams, temporary sheeting and bracing, falsework and shoring, and concrete form design.

CM 587   Environmental Law and Management   (3 - 3 - 0)

This class addresses a survey of legal and regulatory approaches to environmental protection. Topics include: environmental ethics, National Environmental Policy Act, state and federal environmental agencies; Clean Water Act, Safe Drinking Water Act, Superfund, Resource Recovery andConservation Act, Right-to-know, Environmental Cleanup Responsibility Act, and wetlands protection. Cross-listed with: EN 587

CM 590   Construction Management II   (3 - 3 - 0)

This course discusses the principles of construction marketing and strategic planning. Marketing engineering and construction company services and products are discussed with an eye towards the most economical and competitive sales techniques. Case studies and practical applications are presented for class analysis and discussion.

CM 592   Advanced Project Controls in the Built Environment   (3 - 3 - 0)

This class introduces students to procedures for balancing key project constraints in the face of adversarial contractual arrangements, multiple prime, and single source contracting as well as externalities.

CM 605   Construction Safety Management   (3 - 3 - 0)

Various aspects of construction and safety techniques are discussed along with strategies for building a corporate culture of zero accidents, planning for high project safety performance, establishing accountability for safety, and maintaining a safety communication network.

CM 609   Large-Scale Project Cost Analysis   (3 - 3 - 0)

This course provides the construction-orientated professional with the analysis tools and methodology to organize and prepare an accurate construction estimate. Topics include development of productivity data, analysis, and applications of historical data, break-even and cost-to-complete analysis and the study and analysis of job cost reporting systems as they relate to the construction estimate. Estimating methods and systems will be discussed, along with field trips and practical case studies.

CM 671   Practicum in Construction Management   (3 - 3 - 0)

This will be a capstone course taken at the end of a student's program of studies. The students will be organized into construction management groups.

CM 699   Research Methods in Construction Management   (3 - 3 - 0)

This course is designed to support graduate students in developing their research project and to assist them in defining their research methodology. The course has been constructed to guide students through a range of issues and deliberations which should inform their general approach to research. It will give students a general introduction to research in the Construction Management field, its methodologies, its challenges and its organization. Students will be introduced to a range of research reports , data analysis so that they will be equipped to plan and organize their research, conduct a literature review, as well as to communicate their findings in writing and verbally.

CM 701   Curricular Practical Training   (1 to 3 - -)

International graduate students may arrange an internship or paying position off campus and receive Curricular Practical Training (CPT) credit via this course, provided that the position constitutes and integral part of their educational program. Students must maintain full-time student status while enrolled in CPT. During the semester, the student must submit written progress reports and/or provide presentations, per the course syllabus. Students may enroll in from 1-3 credits; the course may be repeated up to a total of three credits.

CM 799   Built Environment Research Colloquium   (3 - 3 - 0)

This is a course for PhD-level students in the Built Environment program. It is a series of classes designed for the PhD student to support the journey from discovery, through research design. Students are required to take this class in the Fall and Spring of their first year. The Fall offering is a structured research writing class with in-class and out of class activities and projects intended to explore scholarly writings about Built Environment Theory. The spring class focuses on scientific discovery and the interpretation of research findings taught in a seminar format.

CM 800   Special Problems in Construction Management (MS)   (1 to 6 - -)

One to six credits. Limit of six credits for the degree of Master of Science.

CM 810   Special Topics in Construction Management   (3 - -)

A participating seminar on topics of current interest and importance in Construction Management.

CM 900   Thesis in Construction Management   (1 to 10 - -)

Credits to be arranged.

Environmental

EN 250   Quantitative Biology   (3 - 3 - 0)

Topics in biology are discussed from a quantitative point of view to develop an appreciation for biology and mathematics and the connections between them. Living systems are viewed through an engineering perspective as open systems using descriptive and quantitative models. Mathematical approaches are taken to heredity and genetics, cellular organization, transport and metabolism, human physiology, ecology, and toxicology. These are presented as applications of probability, linear algebra, ordinary differential equations, and other methods. The relevant mathematical principles are introduced as needed in each module. Prerequisite: MA 116 or MA 124 Corequisite: MA 116

EN 301   Sustainable Engineering   (3 - 3 - 0)

This course examines the global environmental and resource issues that we face as a result of human actions, in particular those to which engineering has been a contributor and also for which it can offer the potential for solutions that move us along the path to a sustainable future. A variety of techniques and paradigms will be studied that can make production, use and disposal of our engineered products sustainable. These include industrial ecology, life cycle analysis, green engineering, and design for the environment. Prerequisites: CH 115, and MA 116 or MA 124

EN 322   Engineering Design VI   (2 - 1 - 3)

Introduction to AutoCAD and computer graphics. Introduction to SAP2000 finite element code. Application of software and design codes to analyze and design full structure. Case studies and projects taken from architectural drawings of real structures. Prerequisite: E 321

EN 345   Modeling and Simulation of Environmental Systems   (3 - 3 - 0)

Incorporation of fundamental phenomena into mass balances to describe the fate and transport of contaminants in lakes, rivers, estuaries, groundwater, the atmosphere, and in pollution control processes. Several computer projects involving numerical solutions of models are required. Prerequisite: CHE 210 or EN 541

EN 377   Introduction to Environmental Engineering Systems   (3 - 3 - 0)

An introduction to environmental engineering, including: environmental legislation; water chemistry including pH and alkalinity relationships, solubility and phase equilibria; environmental biology; fate and transport of contaminants in lakes, streams and groundwater; design and analysis of mechanical, physicochemical and biochemical treatment processes. Prerequisite: CH 115 or CH 116

EN 379   Environmental Engineering Laboratory   (1 - 0 - 3)

An introduction to environmental engineering through laboratory experiments, including: principles of laboratory methods, including common instrumental methods of analysis; application of experimental results to the design of environmental treatment processes. Corequisite: EN 377

EN 423   Engineering Design VII   (3 - 1 - 7)

Senior design courses. Complete design sequence with a required capstone project spanning two semesters. While the focus is on the capstone disciplinary design experience, it includes the two-credit core module on E 421 Engineering Economic Design during the first semester. Cross-listed with: CE 423

EN 424   Engineering Design VIII   (3 - 1 - 7)

Senior design courses. Complete design sequence with a required capstone project spanning two semesters. While the focus is on the capstone disciplinary design experience, it includes the two-credit core module on E 421 Engineering Economic Design during the first semester. Cross-listed with: CE 424 Prerequisite: EN 423

EN501   Seminar in Sustainability Management   (1-credit course repeated for 3 semesters)

This is a weekly seminar series that features invited speakers from various professional fields related to Sustainability Management. Speakers are recognized experts from academia, industry, and the government who present on a spectrum of topics ranging from research work to industry projects. Speakers attend a meet and greet with students, thereby providing valuable networking opportunities for future job seekers in the sustainability field. Seminars are open to all members of the Stevens community. Students enrolled for credit will have specific task requirements. Cross-listed with: SM501

EN 505   Environmental Engineering   (3 - 3 - 0)

An introduction to environmental engineering, including: environmental legislation; water usage and conservation; water chemistry including pH and alkalinity relationships, solubility and phase equilibria; environmental biology; fate and transport of contaminants in lakes, streams and groundwater; design and analysis of mechanical, physicochemical and biochemical water and wastewater treatment processes.

EN 506   Air Pollution Principles and Control   (3 - 3 - 0)

An introduction to the principles and control of air pollution, including: types and measurement of air pollution; air pollution chemistry; atmospheric dispersion modeling; compressible fluid flow; particle dynamics; ventilation systems; inertial devices; electrostatic precipitators; scrubbers; filters; absorption and adsorption; combustion; and condensation. Cross-listed with: ME 532 Prerequisite: EN 377

EN 515   Statistical Methods in Sustainability   (3-3-0)

This course introduces various data analysis techniques in the field of sustainability management using statistical tools. It focuses on environmental data analysis as well as quantitative business and social science research methods. Students learn how to design experiments for environmental management studies, how to statistically analyze scientific data, and how to present and report processed data. Students also learn the principles of survey design that are standard practices in business and social science sustainability fields, including how to frame survey questionnaire, how to design appropriate survey plans (sample volume, time frame etc.), statistical methods to analyze survey data, and interpret survey results. Cross listed with SM 515

EN 517   Environmental Assessment   (3 - 3 - 0)

This course is tailored for environmental scientists, marketing and project managers, economists, environmental lawyers and policy makers, but is also relevant to engineers, which addresses environmental assessment and its role in sustainability management. The course introduces students to issues and tools relevant to sustainability management practice such as environmental risk management, life cycle assessment, socio-economic impact assessment, environmental economics, total life cycle costing, decision making, resource management, environmental audits, and environmental management systems, along with an overview of the regulatory framework and methodologies used in environmental impact assessment. Students will learn from the course instructor and carefully selected materials in a soft-technical manner that is intended for adequate comprehension by students from diverse fields of study. Cross-listed with SM 520.

EN 520   Soil Behavior and its Role in Environmental Applications   (3 - 3 - 0)

An overview of soil mineralogy, soil formation, chemistry, and composition. Influence of the above factors in environmental engineering properties; study of colloidal phenomena; fate and transport of trace metals in sediments, soil fabric, and structure; conduction phenomena; and compressibility, strength, deformation properties, and stress-strain-time effects, as they pertain to environmental geotechnology applications (i.e., contaminated soil remediation, soil/solid waste stabilization, waste containment alternatives, soil-water-contaminant interactions, and contaminant transport). Cross-listed with: CE 520

EN 530   Introduction to Sustainable Engineering   (3 - 3 - 0)

This course assesses current and potential future energy systems, covers resources, extraction, conversion, and end-use, and emphasizes meeting regional and global energy needs in the 21st century in a sustainable manner. Topics relevant to renewable and conventional energy technologies will be presented including fossil fuels, combustion, environmental effects, carbon sequestration, nuclear power, wind power, solar energy, hydrogen, and fuel cells. Key attributes will be described within a framework that aids in evaluation and analysis of energy technology systems in the context of political, social, economic, and environmental goals.

EN 541   Fate and Transport of Environmental Contaminants   (3 - 3 - 0)

Description of fundamental processes in natural and engineered systems, including intermedia transport of contaminants between environmental compartments (air, water, soil, and biota) and chemical and biochemical transformations within these compartments. Prerequisite: EN 377

EN 545   Environmental Impact Analysis and Planning   (3 - 3 - 0)

The impact of engineering projects on the physical, cultural, and socioeconomic environment, and preparation of environmental impact statements, regulatory framework, and compliance procedures. Topics include: major federal and state environmental regulations, environmental permitting processes, environmental impact analysis and assessment, risk assessment and risk management, and regulatory compliance. Cross-listed with: CM 545

EN 547   Project Life Cycle Management   (3 - 3 - 0)

This course addresses the environmental management of engineering projects from the research through the development, operation, maintenance, and ultimate disposal phases. Topics include: impacts of exploitation of raw materials and energy resources and transportation; pollution from use and ultimate disposal of products; and economics of environmental resources.

EN 551   Environmental Chemistry of Soils and Natural Surfaces   (3 - 3 - 0)

Soil is a mixture of inorganic and organic solids, air, water, and microorganisms. Soil affects the environmental chemistry through the interactions at solution-solid and air-solid interfaces, and the soil in turn is affected by the environmental and human activities. Soil science is not only important to agriculture, but also to diverse fields, such as environmental engineering, biogeochemistry, and hydrology. This course will enable students to understand the chemical properties of soil, soil minerals, natural surfaces, and mechanisms regulating solute chemistry in soil solutions. The fate and transport of inorganic and organic pollutants in soil and soil remediation technologies are discussed. One year of introductory chemistry is required for students who want to take this course.

EN 552   History of Water Technology   (3 - 3 - 0)

This course examines how the quest for water as a basic element of life has contributed to the development of innovative technology and how it has impacted humanity from ancient to modern times. Topics covered include: water devices, water wells, water lifting machines, conveyance systems and hydraulic works, irrigation structures, reservoirs and dams, potable water treatment methods and systems, public health issues related to water, water conflicts, the historical evolution of water policies, legal, economic and societal issues related to water exploitation and use.

EN 553   Groundwater Engineering   (3 - 3 - 0)

Fundamental and advanced topics in groundwater engineering analysis and design. Aquifers and well aquifer relationships; aquifer tests by well methods; in situ permeability determination; and flow nets. Seepage principles and seepage control measures; filter and drain design; and computer methods in groundwater engineering.

EN 554   Water Resources Sustainability   (3 - 3 - 0)

This course addresses issues of sustainability of water resources at the local, regional and global level. Topics include water distribution on the earth's surface and water budgets, freshwater resources and their use, water consumption, sustainable management practices in surface and ground water systems, threats to water quality and quantity, water security, water conflicts and social and economic impacts. Cross-listed with: SM 554 and CE 554

EN 570   Environmental Chemistry   (3 - 3 - 0)

Principles of environmental reactions with emphasis on aquatic chemistry; reaction and phase equilibria; acid-base and carbonate systems; oxidation-reduction; colloids; organic contaminants classes, sources, and fates; groundwater chemistry; and atmospheric chemistry. Cross-listed with: NANO 570 Prerequisite: EN 377

EN 571   Physicochemical Processes for Environmental Control   (3 - 3 - 0)

A study of the chemical and physical operation involved in treatment of potable water, industrial process water, and wastewater effluent; topics include chemical precipitation, coagulation, flocculation, sedimentation, filtration, disinfection, ion exchange, oxidation, adsorption, flotation, and membrane processes. A physical-chemical treatment plant design project is an integral part of the course. The approach of unit operations and unit processes is stressed. Cross-listed with: NANO 571 Prerequisite: EN 377

EN 573   Biological Processes for Environmental Control   (3 - 3 - 0)

Biological basis of wastewater treatment; river systems and wastewater treatment works analogy; population dynamics; food sources; aerobic and anaerobic systems; reaction kinetics and parameters affecting waste removal; fundamentals of mass transfer and gas transfer; trickling filter, and activated sludge process; aerated lagoons; stabilization ponds; nitrification; denitrification; sludge concentration; aerobic sludge digestion; anaerobic sludge digestio and sludge conditioning; sludge drying, vacuum filtration; and incineration and ocean disposal. A biological treatment plant design project is an integral part of the course. Prerequisite: EN 377

EN 575   Environmental Biology   (3 - 3 - 0)

A survey of biological topics concerning the environment: ecology, population dynamics, pollution microbiology, aquatic biology, bioconcentration, limnology, stream sanitation, nutrient cycles, and toxicology.

EN 585   Need course name

Need course description.

EN 586   Hazardous Waste Management   (3 - 3 - 0)

A comprehensive introduction to hazardous waste management, including laws and regulations, identification and analysis, risk assessment, and techniques and technologies for control and treatment.

EN 587   Environmental Law and Management   (3 - 3 - 0)

A survey of legal and regulatory approaches to environmental protection. Topics include: environmental ethics, National Environmental Policy Act, State and Federal environmental agencies; and the Clean Water Act, Safe Drinking Water Act, Superfund, Resource Recovery and Conservation Act, Right-to-Know, Environmental Cleanup Responsibility Act, and wetlands protection. Cross-listed with: CM 587 and SM 587

EN 637   Instrumental Analysis for Environmental Control Processes   (3 - 0 - 3)

Laboratory verification of the theoretical concepts involved in sampling and analysis of unit operation and unit processes for environmental pollution control and conservation. It is a primarily laboratory course with six lectures of presenting the principles of analytical strategy and applications of contemporary instrumental analytical methods. Laboratory practice explores ultraviolet, visible and infrared spectrophotometer; total organic analyzer, atomic absorption spectroscopy; inductively coupled plasma optical emission spectroscopy; gas-liquid and high-performance liquid chromatography and mass spectrometry. These instrumental techniques are utilized for quantitative and qualitative analyses of organic, inorganic, biological and environmental samples.

EN 654   Environmental Geotechnology   (3 - 3 - 0)

The objective of the course is to provide the students with exposure to the geotechnical nature of environmental problems. The topics covered include: principles of geochemistry, contaminant transport, and hydrogeology; an overview of landfill liners and other disposal facilities and their design, construction, safe operation, performance monitoring, structural, and physicochemical stability; an overview of the general principles governing the design, implementation, and monitoring of existing remediation technologies with special emphasis on stabilization/solidification, vapor extraction, bioremediation, soil washing, pump and treat, cover systems, and alternative containment systems such as slurry walls. A concurrent laboratory section introduces the student to the chemical analyses, absorption behavior, mineralogical, and crystallographical identification and characterization of various waste forms as they pertain to surface chemistry considerations. The main emphasis of the course consists of providing hands-on experience with analyses involving the use of spectrometric, X-ray diffraction, and scanning electron microscope equipment. Cross-listed with: CE 654 Prerequisite: EN 520

EN 680   Modeling of Environmental Systems   (3 - 3 - 0)

Incorporation of fundamental reaction and transport phenomena into mass balances to describe the fate and transport of contaminants in lakes, rivers, estuaries, groundwater, the atmosphere, and in pollution-control processes. Several computer projects involving numerical solutions of models are required. Prerequisites: EN 541, CE 565

EN 683   Coastal Oceanography for Environmental Engineers   (3 - 3 - 0)

This course deals with processes in the coastal ocean and in estuaries that affect the transport and dispersion of materials floating on the surface, dissolved in the water or in suspension. Topics include: fundamentals of surface wave mechanics, wind-generated surface waves, wind-generated currents, Ekman transport and upwelling, estuarine characteristics and buoyancy-driven circulation, and estuarine-coastal ocean exchange processes. Cross-listed with: OE 683

EN 686   Groundwater Hydrology and Pollution   (3 - 3 - 0)

Fundamental concepts in groundwater hydrology and pollution, occurrence, and movement of groundwater; flow nets; well hydraulics; and numerical methods in groundwater hydraulics. Chemical properties of groundwater, sources, and effects of contamination; principles of mathematical modeling of containment transport in groundwater; and numerical methods in groundwater pollution.

EN 690   Soil and Groundwater Remediation Technologies   (3 - 3 - 0)

This course will provide the student with a thorough understanding of soil and groundwater remediation technologies including fundamental principles, site applicability, remedial alternatives, and selection, planning and design of remedial systems, field implementation and economics. Prerequisite: EN 686

EN 702   Curricular Practical Training   (1 - 0 - 0)

International graduate students may arrange an internship or paying position off campus and receive Curricular Practical Training (CPT) credit via this course provided that the course constitutes and integral part of their educational program. Students must maintain their full time status while receiving CPT. Prior approval of the program director is required for enrollment. To justify enrollment, the student must have a concrete commitment from a specific employer for a specific project, and must provide to the program director for his/her approval a description of the project plus a statement from the employer that he/she intends to employ the student. This information must be provided to the program director with sufficient advance notice so that the program director has time to review the materials and determine if the project is appropriate. During the semester, the student must submit written progress reports. At the end of the semester, the student must submit for grading a written report that describes his/her activities during that semester, even if the activity remains ongoing. This is a one-credit course that may be repeated up to a total of three credits.

EN 723   Flow & Mass Transport in Porous Media   (3 - 3 - 0)

An advanced treatment of flow and mass transport in porous media; fluid and porous matrix properties; mathematical description of flow and mass transport in fully and partially saturated soils; diffusion and hydrodynamic dispersion processes; analytical-numerical and conformal mapping techniques for the solution of the governing equations; development of computer models for prediction of flow and contaminant transport in variably saturated soils.

EN 751   Design of Wastewater Facilities   (3 - 3 - 0)

Principles of process design and economics are integrated through open-ended problem-solving situations. Topics include process selection, feasibility studies, equipment design and scale-up, costing and economics, optimization, process identification and control, operation and maintenance, and permitting and other regulatory issues. Prerequisites: EN 573, EN 571

EN 780   Nonlinear Correlation and System Identification   (3 - 3 - 0)

An investigation of tools to identify nonlinear processes and relationships. Mathematical tools covered include nonlinear regression, artificial neural networks, and multivariate polynomial regression. Applications include mass transfer correlations, prediction of drinking water quality, and modeling of wastewater treatment processes. Prerequisites: CE 679 or equivalent, and permission of instructor.

EN 800   Special Problems in Environmental Engineering   (1 to 6 - -)

One to six credits. Limit of six credits for the degree of Master of Engineering (Environmental).

EN 801   Special Problems in Environmental Engineering   (1 to 6 - -)

A thorough investigation of an advanced research topic under the direction of a faculty member. The course is open to students who are or plan to be doctoral candidates. One to six credits for the degree of Doctor of Philosophy.

EN810   Special Topics in Environmental Engineering   (1 to 6 - -)

A participating seminar on topics of current interest and importance in Environmental Engineering.

EN 900   Thesis in Environmental Engineering   (5 to 10 - -)

For the degree of Master of Engineering (Environmental). Hours and credits to be arranged.

EN 960   Research in Environmental Engineering   (- - -)

Original research of advanced level in Environmental Engineering which may serve as the topic for the dissertation for the degree of Doctor of Philosophy. Credits to be arranged.

Nanotechnology

NANO 570   Environmental Chemistry   (3 - 3 - 0)

Principles of environmental reactions with emphasis on aquatic chemistry; reaction and phase equilibria; acid-base and carbonate systems; oxidation-reduction; colloids; organic contaminants classes, sources, and fates; groundwater chemistry; and atmospheric chemistry. Cross-listed with: EN 570

NANO 571   Physicochemical Processes for Environmental Control   (3 - 3 - 0)

A study of the chemical and physical operation involved in treatment of potable water, industrial process water, and wastewater effluent; topics include chemical precipitation, coagulation, flocculation, sedimentation, filtration, disinfection, ion exchange, oxidation, adsorption, flotation, and membrane processes. A physical-chemical treatment plant design project is an integral part of the course. The approach of unit operations and unit processes is stressed. Cross-listed with: EN 571

Naval Engineering

NE 322   Engineering Design VI   (2 - 1 - 3)

This course is intended to teach modern systematic design techniques used in the practice of naval engineering. The emphasis is placed on usage of CAD tools for ship hullform design and development. Methodology for the development of design objective(s), literature surveys, base case designs, and design alternatives are given. Students are encouraged to select their senior capstone design project near the end of the course, form teams, and commence preliminary work. Corequisite: OE 528

NE 423   Engineering Design VII   (3 - 1 - 7)

Senior design courses. Complete design sequence with a required capstone project spanning two semesters. The capstone design project will use the entire range of knowledge and skills acquired in earlier courses. The project will include extensive instruction in, and incorporation of, engineering standards, professional ethics, environmental impacts, and economics. These aims will be accomplished by providing students with realistic ship design performance requirements, and instruction and advice from practicing ship design professionals. Prerequisite: NE 322

NE 424   Engineering Design VIII   (3 - 1 - 7)

Senior design course. Complete design sequence with a required capstone project spanning two semesters. The capstone design project will use the entire range of knowledge and skills acquired in earlier courses. The project will include extensive instruction in, and incorporation of, engineering standards, professional ethics, environmental impacts, and economics. These aims will be accomplished by providing students with realistic ship design performance requirements, and instruction and advice from practicing ship design professionals. Prerequisite: NE 423

NE 453   Advanced Fluid Dynamics   (3 - 3 - 0)

Review of basic concepts of fluid flow, Navier-Stokes equations, introduction to fluid turbulence, inviscid incompressible flow, introduction to airfoil theory, compressible fluid flow and applications. Cross-listed with: ME 453

Ocean Engineering

OE 501   Oceanography   (3 - 3 - 0)

Geophysical description of the earth; the extent, shape. and structure of ocean basins; relief of the sea floor; chemistry of sea water; geochemical balances; physical properties of water and sea water; solar and terrestrial radiation; evaporation and precipitation over the oceans; dissolved gases in sea water; distribution of variables; and general oceanic circulation.

OE 503   Seminar in Ocean Engineering   (3 - 3 - 0)

Seminar course in which you report on selected topics in ocean engineering. Emphasis is on the problems encountered in performing engineering tasks in the ocean and methods employed to surmount them. Students are encouraged to devise alternate methods to improve existing techniques.

OE 511   Urban Oceanography   (3 - 3 - 0)

This course introduces the fundamental principles of urban oceanography by providing a broad overview of all the interacting processes that shape urban ocean ecosystems. The course investigates the geologic history of many urban area waters, in addition to the physics, chemistry, and biology of the waters, while emphasizing how man has significantly influenced how these systems behave. The course includes studying the local waters that surround us, such as the New York-New Jersey Estuary, the Hudson River and the East River. Via field expeditions on an Institute research vessel, students will experience first hand field sampling, data reduction and analysis of field data, and interpretation of processes. Their investigation results will be prepared as a cooperative class report.

OE 512   Intermediate Fluid Dynamics

Differential equations of fluid flow, Navier-Stokes equations, introduction to fluid turbulence, inviscid incompressible flow, introduction to airfoil theory, compressible fluid flow and applications nozzles, ducts and airfoils. Cross-listed with: ME 512

OE 520   Design of Marine Structures   (3 - 3 - 0)

This course is intended to provide a basic understanding of the ocean environment, hydrodynamic loads and the design of marine and coastal structures. Basic hydrodynamics and linear wave theory will be introduced. Essential elements of coastal structure design will be covered including: the determination of design parameters, hydraulic performance, and structural stability. Interaction between floating and fixed marine structures such as vessels and off-shore platform components will be introduced through the following topics: hydrodynamic loads based on linear wave theory; breaking wave loads; application of Morison's equation in load predictions; fluid-induced vibration phenomena such as vortex-induced vibration and flutter; and motion response of floating structures to wave excitation. The discussion of these topics will emphasize application for engineering analysis.

OE 522   Design of Living Shorelines   (3 - 3 - 0)

"Living Shorelines" refers to an innovative approach to stabilizing eroding shorelines that integrates traditional coastal engineering concepts, with elements of bioengineering and coastal ecology. The goal is to create a stable, resilient shoreline that enhances the natural ecosystem. This course is designed to fit an industry need for engineers that are familiar with traditional coastal engineering concepts as well as ecology and/or bioengineering. This will be accomplished through lectures focused on the characteristics of natural organisms (flora and fauna) that contribute to the stability and ecological enhancement of traditional coastal structures. Some of the topics to be presented in this class include evaluating site conditions, integrating ecological considerations with engineering requirements, determining representative costs and understanding project regulations. A significant portion of the class will be dedicated to developing designs for living shorelines projects in New York and New Jersey. Special topics will be addressed through guest lectures and field trips.

OE 524   Introduction to Ship Design and Ship Building   (3 - 3 - 0)

This course will cover basic principles and design calculations in Naval Architecture. A basic understanding of marine/ship terminology, delineation of hull form, loading and transverse stability gained from previous course work and/or experience will be utilized. Course material will include; trim and effects of flooding, introduction to the design of a hull structure, nature of resistance and its variation with hull form and proportions, and introduction to propellers and propulsion. Basic theories in maneuvering and sea-keeping characteristics.

OE 525   Principles of Naval Architecture   (3 - 3 - 0)

Basic principles and design calculations in naval architecture; terminology, delineation of hull form, loading and stability, trim, and effects of flooding; freeboard and tonnage regulations; introduction to design of hull structure; nature of resistance and its variation with hull form and proportions; and introduction to propellers and propulsion. Basic theories in maneuvering and sea-keeping characteristics, computer application in naval architecture, and ship design.

OE 527   Laboratory in Naval Architecture   (3 - 0 - 3)

Solution of problems in naval architecture through model testing, actually conducting a wide variety of model tests at Davidson Laboratory, and prediction of prototype performance.

OE 528   Computer-Aided Ship Design   (3 - 0 - 0)

Basic principles and design calculations in naval architecture as an extension of OE 525 PNA course with emphasis placed on the application of computers. Computer-aided studies of hull-forms, intact stability, damaged stability, resistance and propulsion characteristics, course-keeping analysis, and ship motion predictions. Computer-aided design procedures to achieve mission requirements for various ship types along with determination of major dimension and performance analysis during preliminary design stage are covered.

OE 530   Yacht Design   (3 - 0 - 0)

Calculation of hydrostatic curves to determine trim and sinkage of sailing yachts, static and dynamic stability, calculation of resistance and side force by expansion of tank test results, sail force coefficients, prediction of comparative performance based on tank test results, application of lifting surface theory to the design of keel and rudder, and consideration of structural strength and stiffness. Prerequisite: OE 525

OE 531   Total Ship Design I   (3 - 3 - 0)

This course is the first one of a two-course sequence and the focus will be on marine engineerign aspects and machinery considerations. Topics covered in this course include: Diesel engines, steam turbines and gas turbines as marine prime movers. Thermodynamic cycles, ratings, matching to loads. Engine-propeller matching. Mechanical transmission of power to marine loads. Ship Design Process, Mission and Owner's Requirements, Regulatory and Classification Requirements, Design/Production Integration and Ship Building Process.

OE 532   Total Ship Design II   (3 - 3 - 0)

This is the second part of a two-course sequence where the focus is on shipboard electrical power systems and other components of ship design that are not covered in the first part. Topics covered in this course include: Electric Power Generation and Electric Propulsion, Integrated marine electrical plants, electric load calculations, auxiliary systems, combat systems, ship systems integration, human factors in ship design, general arrangement design, contracts and specifications, cost estimating and ship preservation.

OE 535   Ocean Measurements and Analysis   (3 - 0 - 0)

Basic ocean measurements and instrumentation, sampling requirements, data processing, analysis, and presentation. Prerequisite: Completion of an undergraduate probability and statistics course.

OE 545   Acoustics and Noise Measurement

Need course description

OE 560   Fundamentals of Remote Sensing   (3 - 0 - 0)

This course exposes the student to the physical principles underlying remote sensing of ocean, atmosphere, and land by electromagnetic and acoustic passive and active sensors: radars, lidars, infrared and microwaves thermal sensors, sonars, sodars, infrasound/seismic detectors. Topics include fundamental concepts of electromagnetic and acoustic wave interactions with oceanic, atmospheric, and land environment, as well as with natural and man-made objects. Examples from selected sensors will be used to illustrate the information extraction process, and applications of the data for environmental monitoring, oceanography, meteorology, and security/military objectives. Cross-listed with: EN 560, EE 560, CE 561, PEP 560 Prerequisites: PEP 201, PEP 112, E 246

OE 580   Surfzone Hydrodynamics   (3 - 3 - 0)

This course focuses on the identification of the physical principles and environmental phenomena responsible for driving nearshore circulation on open ocean coasts. The equations governing the hydrodynamics of the surfzone (shoreward of the break point) will be studied in detail and the various types of models used to predict nearshore circulation will be discussed. Real world examples, based on current research projects being conducted at the Stevens Coastal Engineering Research Lab will form an integral part of the curriculum. Topics covered will include: basic hydrodynamics, linear wave theory, wave transformation, wave boundary layers, surfzone currents, and nearshore circulation.

OE 585   Littoral Processes   (3 - 3 - 0)

This course focuses on the physical processes impacting engineered systems in the coastal environment and the resulting impact of these built systems on the coast. The importance of characteristics such as beach composition, shoreline configuration, and both present and past hydrodynamic conditions will be emphasized. Modern approaches for predicting large scale or bulk coastal change based on observed and/or modeled environmental conditions will be presented. The course complements and will feature examples extracted from current research projects being conducted at the Stevens Coastal Engineering Research Laboratory (CERL). Topics covered in this course will include: coastal geomorphology, hydrodynamics, coastal sediment transport, inlet processes, and shore protection methods.

OE 589   Coastal Engineering   (3 - 3 - 0)

An introductory course covering the fundamental principles of coastal engineering. The initial stages of the course are intended to provide an understanding of the physics of the coastal environment. Topics will include basic wave theory (wave generation, refraction, diffraction, and shoaling), wave prediction techniques, tides and coastal circulatio, and sediment transport. The latter stages of the course will be devoted to the application of these basic principles, such as stabilization and harbor development. The course will culminate in a substantial design project, which will incorporate all aspects of the course material, ranging from the estimation of design wave conditions to the actual design of a shore protection structure. Prerequisite: MA 227 or the equivalent and Fluid Mechanics. Prerequisites: MA 227 or the equivalent, Fluid Mechanics.

OE 591   Introduction to Dynamic Meteorology   (3 - 3 - 0)

Introduction to meteorology presents a cogent explanation of the fundamentals of atmospheric dynamics. The course begins with a discussion of the Earth's atmospheric system, including global circulation, climate, and the greenhouse effect. The basic conservation laws and the applications of the basic equations of motion are discussed in the context of synoptic scale meteorology. The thermodynamics of the atmosphere are derived based on the equation of state of the atmosphere, with specific emphasis on adiabatic and pseudo-adiabatic motions. The concept of atmospheric stability is presented, in terms of the moist and dry lapse rate. The influence of the planetary boundary layer on atmospheric motions is presented with emphasis on topographic and open ocean frictional effects, temperature discontinuity between land and sea, and the generation of sea breezes. The mesoscale dynamics of tornadoes and hurricanes are discussed, as well as the cyclogenesis of extratropical coastal storms. The course makes use of a multitude of web-based products, including interactive learning sites, weather forecasts from the National Weather Service (NWS), tropical predictions from the National Hurricane Center, and NWS model outputs (AVN, NGM, ETA, and WAM). Cross-listed with: CE 591

OE 616   Sediment Transport   (3 - 3 - 0)

Theory of sediment transport in open channel flow, including applications to riverine, ocean, and coastal environments. Topics covered include boundary layer dynamics, the initiation of motion, sediment characteristics, suspended load, and bed load. Applications include the estimation of transport rates in waves and currents, and the influence of hydraulic structures.

OE 622   Design of Port Structures I   (3 - 3 - 0)

This course introduces students to the fundamentals of port structures design, including design codes, guidelines, and functional requirements. Students are instructed in optimization procedures for port and marine terminal layout, including issues related to navigation channels and dredging, shore infrastructure and utilities, land reclamation, and environmental and economic considerations. Structural, geotechnical, and materials considerations are discussed for a variety of environmental conditions, including extreme wave and current environments, ice, and seismic loading. Examples and case studies from actual port design projects are utilized to a great extent in the delivery of the course material.

OE 623   Design of Port Structures II   (3 - 3 - 0)

This course instructs students in the functional design of the various components of ports and marine terminals, including steel, concrete, timber, and stone structures. Students are introduced to the detailed design procedures for a variety of structure types, including bulkheads and piers, fender and mooring systems, and breakwaters and revetments. Special considerations such as sedimentation/dredging, structure inspection and rehabilitation, vessel motions, and port downtime are discussed. Students receive instruction in the use of computer and physical model studies in support of structure design. Environmental and permitting issues are discussed.

OE 630   Hydrodynamics   (3 - 3 - 0)

Development of the kinematic and dynamic equations for incompressible fluid flow, the Navier-Stokes equation, velocity potential and stream function, Bernoulli's equation, conformal mapping, free surface flows, wave theory, flow in porous media, and turbulence. Prerequisites: CE 342, MA 227

OE 631   Fluid Dynamics for Ocean Engineering   (3 - 0 - 0)

Cavitation, two-dimensional flows, complex velocity and complex potential; and concentrated and distributed singularities, lift-drag Kutta condition, D'Alembert paradox, Blasius theorem,and Karman vortex street. Conformal mapping, Möbius transformation, Schwartz-Christoffel transformation. Applications, added mass and virtual mass, Taylor's added mass theorem, Lagally's theorem, the Navier-Stokes equation, exact solutions for parallel flow, Couette flow, and Poiseuille flow. Unsteady problems: boundary layer Reynold's number, flat plate boundary layer, Von Karman integral method, and Pohlhausen solution. Prerequisite: OE 630

OE 635   Stochastic Analysis of Ocean Waves   (3 - 3 - 0)

Introduction to probability theory; statistical techniques for characterizing random variables and evaluation of data; statistical techniques for analyzing stochastic processes; and application of power spectral density techniques to the representation of the sea surface and other stochastic marine processes.

OE 641   Dynamics of Ocean Waves   (3 - 3 - 0)

Description and formulation of wave problems in the ocean, development of classical wave theory, free waves and forced waves induced by pulsating and uniformly translating pressures and sources in steady and unsteady states, diffraction, refraction and reflection of waves, application to floating breakwaters, and harbor oscillations.

OE 642   Motion of Vessels in Waves   (3 - 3 - 0)

Dynamic response of a ship in regular and irregular seas, the equation of motion with six degrees of freedom, added mass and damping coefficient of an oscillating ship on the free surface, coupled equation of motion of a ship in waves, and description of ship motion in the irregular sea with the discussion leading to nonlinear equations of motion. Prerequisite: OE 641

OE 643   Stability and Control of Marine Craft   (3 - 3 - 0)

Basic concepts of stability and automatic control, equations of motion of marine craft, representation of hydrodynamic forces and moments, equilibrium conditions and perturbation equations, stability criteria, Routh-Hurwitz method, directional stability and maneuvering control, effects of wind, waves and restricted waters, stability of towed bodies, anti-rolling and anti-pitching control systems, and dynamic simulations of marine systems.

OE 645   Hydrodynamics of High-Speed Marine Craft   (3 - 3 - 0)

Planing craft, life, drag, wetted area of hull, appendage drag, direct and indirect propeller effect, spray formation, impact loads in smooth water and waves, porpoising, rough water behavior, and tank test procedures.

OE 648   Numerical Hydrodynamics   (3 - 3 - 0)

Potential flows around bodies: panel singularities methods and conformal mapping methods. Finite-difference and spectral methods for Poisson equations: numerical inversion of matrices, and potential flows in or around irregular domains. Consistency, stability, and convergence of numerical methods: linear stability analysis. Numerical methods for diffusion equations and methods for ordinary differential equations. One-dimensional Burger's equation and nonlinear problems, Newton iteration, error analysis. Numerical methods for stream function vorticity equations: flows in or around irregular domains. Discussions of current research in computational fluid dynamics. Four exercise projects and one examination project will be assigned to each student. Prerequisite: Computer Programming. Cross-listed with: CE 648

OE 660   Naval Ship Acquisition Process   (3 - 3 - 0)

This course familiarizes the student with naval ship acquisition programs. Focusing on the current process in place by the U.S. Navy, but with a review of methods use in the past, projected to be used in the future, and in use by major world powers today. Topics include the system acquisition life cycle, requirements analysis, contract management, and program planning. Students must have basic naval architecture course work or experience, as determined by advisor.

OE 661   Principle of Naval Ship Systems   (3 - 3 - 0)

This course will provide the student with a broad overview of the many systems and design considerations specific to naval ships. Topics include navigation, surveillance and combat systems for a wide variety of common naval ships. Design considerations, such as underway replenishment, aircraft take-off and landing, launching of boats, port and shore operations, and the effects of ship motions on the limitations of the crew will be covered in the context of developing a systems-based approach to naval ship design. Prerequisites: Students must have basic naval architecture course work or experience, as determined by advisor.

OE 688   Coastal Ocean Dynamics I   (3 - 3 - 0)

Mechanics of rotating flow; inviscid shallow-water theory: topographic Rossby Waves; effects of friction: the Ekman theory; and wind-driven ocean circulation: coastal ocean modeling, supercomputing applications, dispersion, and mixing in coastal waters. Prerequisites: OE 501, MA 529

OE 690-691   Special Topics in Ocean Engineering I,II   (3 - -)

An advanced seminar course concerned with recent research developments in ocean engineering. Special emphasis will be placed on developments in theoretical and applied hydrodynamics. Topics are subject to the currents interest of the faculty and students.

OE 702   Curricular Practical Training   (1 - 0 - 0)

International graduate students may arrange an internship or paying position off campus and receive Curricular Practical Training (CPT) credit via this course provided that the course constitutes and integral part of their educational program. Students must maintain their full time status while receiving CPT. Prior approval of the program director is required for enrollment. To justify enrollment, the student must have a concrete commitment from a specific employer for a specific project, and must provide to the program director for his/her approval a description of the project plus a statement from the employer that he/she intends to employ the student. This information must be provided to the program director with sufficient advance notice so that the program director has time to review the materials and determine if the project is appropriate. During the semester, the student must submit written progress reports. At the end of the semester, the student must submit for grading a written report that describes his/her activities during that semester, even if the activity remains ongoing. This is a one-credit course that may be repeated up to a total of three credits.

OE 800   Special Problems in Ocean Engineering (ME)   (1 to 6 - -)

One to six credits. Limit of six credits for the degree of Master of Engineering (Ocean).

OE 801   Special Problems in Ocean Engineering (PhD)   (1 to 6 - -)

One to six credits. Limit of six credits for the degree of Doctor of Philosophy.

OE 810   Special Topics in Ocean Engineering   (3 - -)

A participating seminar on topics of current interest and importance in Ocean Engineering.

OE 900   Thesis in Ocean Engineering   (1 to 10 - -)

For the degree of Master of Engineering (Ocean). Hours and credits to be arranged.

OE 960   Research in Ocean Engineering (PhD)   (- - -)

Original basic research of high level design in ocean engineering which may serve as the basis for the dissertation for the degree of Doctor of Philosophy. Hours and credits to be arranged.

Sustainability Management

SM 501   Seminar in Sustainability Management (1-credit course repeated for 3 semesters)

This is a weekly seminar series that features invited speakers from various professional fields related to Sustainability Management. Speakers are recognized experts from academia, industry, and the government who present on a spectrum of topics ranging from research work to industry projects. Speakers attend a meet and greet with students, thereby providing valuable networking opportunities for future job seekers in the sustainability field. Seminars are open to all members of the Stevens community. Students enrolled for credit will have specific task requirements. Cross-listed with: EN 501

SM 510   Perspectives in Environmental Management

This course addresses environmental management and its role in sustainability from multiple perspectives, including but not limited to that of a natural scientist, an engineer, a marketing manager, an economist, an environmental lawyer, and a policy maker. The course also introduces students to some of the many tools used by environmental managers, such as life cycle analysis, environmental audit, etc. Students will learn from the course instructor and invited subject matter experts, who will explain in a non-technical manner that is intended for adequate comprehension by students from diverse fields of study on how their respective disciplines contribute to proper management of our environment, thereby making our world more sustainable. Cross-listed with: EN 510

SM 515   Statistical Methods in Sustainability

This course introduces various data analysis techniques in the field of sustainability management using statistical tools. It focuses on environmental data analysis as well as quantitative business and social science research methods. Students learn how to design experiments for environmental management studies, how to statistically analyze scientific data, and how to present and report processed data. Students also learn the principles of survey design that are standard practices in business and social science sustainability fields, including how to frame survey questionnaire, how to design appropriate survey plans (sample volume, time frame etc.), statistical methods to analyze survey data, and interpret survey results. Cross-listed with: EN 515

SM 520   Environmental Assessment

This course is tailored for environmental scientists, marketing and project managers, economists, environmental lawyers and policy makers, but is also relevant to engineers, which addresses environmental assessment and its role in sustainability management. The course introduces students to issues and tools relevant to sustainability management practice such as environmental risk management, life cycle assessment, socio-economic impact assessment, environmental economics, total life cycle costing, decision making, resource management, environmental audits, and environmental management systems, along with an overview of the regulatory framework and methodologies used in environmental impact assessment. Students will learn from the course instructor and carefully selected materials in a soft-technical manner that is intended for adequate comprehension by students from diverse fields of study. Cross-listed with: EN 517, CE 517

SM 530   Sustainable Business Strategies

This course will focus on best practices and emerging trends in sustainable business management. Topics will include corporate social responsibility, sustainable business theories, green business models, value chain management, green marketing, triple bottom line reporting, benefit-cost analysis and sustainability metrics and reporting. Students will explore the relationship between business management and sustainability goals for a number of industrial sectors. The course will include case studies as a tool for assessing strategies, identifying opportunities for improvements and recommending future actions. Students will be introduced to commonly used sustainability reporting frameworks and will use them to evaluate objective-setting and progress towards green goals.

SM 531   Sustainable Development

This course addresses issues of sustainable development at the local, regional and global scales. Topics include understanding of the definitions, history, current status and future outlook of sustainable development. Population dynamics, wealth distribution, principles of economic growth, social dimensions of sustainable growth (poverty, food security, health, education, social inclusion), biodiversity and ecosystem dynamics, climate change. Sustainable development stakeholders and their roles and responsbilities including individuals, advocacy groups, local, regional and country-level governing bodies, NGO's and corporations. Legal, policy and regulatory aspects of sustainable development. A systems view of sustainability and sustainable development including the concepts of global boundaries and resiliency. Cross-listed with: EN 531

SM 554   Water Resources Sustainability

This course addresses issues of sustainability of water resources at the local, regional and global level. Topics include water distribution on the earths surface and water budgets, freshwater resources and their use, water consumption, sustainable management practices in surface and ground water systems, threats to water quality and quantity, water security, water conflicts and social and economic impacts. Cross-listed with: CE 554, SM 554

SM 587   Environmental Law and Management   (3 - 3 - 0)

A survey of legal and regulatory approaches to environmental protection. Topics include: environmental ethics, National Environmental Policy Act, State and Federal environmental agencies; and the Clean Water Act, Safe Drinking Water Act, Superfund, Resource Recovery and Conservation Act, Right-to-Know, Environmental Cleanup Responsibility Act, and wetlands protection. Cross-listed with: EN 587

SM 690   Project in Sustainability Management

This course will provide students an opportunity to develop research and analytical skills needed to design an independent project in sustainability management. In the first part of the course, students will learn how to collect and analyze information from available literature, how to organize conceptual ideas logically and formulate a research proposal, and how to review and present proposals. The second part of the course will focus on studying published articles and project reports on how to design project tasks, how to analyze scientific, engineering, and survey data, and how to present and report processed data. Final products will include a proposal clearly identifying the goals of a sustainability project and proposing methods to fulfill the goals, plus a "mock" journal article based on real life natural science or social science sustainability data that will be provided to students depending on their disciplinary backgrounds. Cross-listed with: EN 692

SM 702   Curricular Practical Training (1 to 3 credits)

International graduate students may arrange an internship or paying position off campus and receive Curricular Practical Training (CPT) credit via this course provided that the course constitutes an integral part of their educational program. Students must maintain their full-time status while receiving CPT. Prior approval of the program director is required for enrollment. To justify enrollment, the student must have a concrete commitment from a specific employer for a specific project, and must provide to the program director for their approval a description of the project plus a statement from the employer that they intend to employ the student. This information must be provided to the program director with sufficient advance notice so that the program director has time to review the materials and determine if the project is appropriate. During the semester, the student must submit written progress reports. At the end of the semester, the student must submit for grading a written report that describes their activities during that semester, even if the activity remains ongoing. This is one-credit course that may be repeated up to a total of three credits.

SM 800   Special Problems in Sustainability Management (1 to 6 credits)
Investigation of a research topic under the direction of a faculty member.

SM 900   Thesis in Sustainability Management (1 to 6 credits)
For the degree of Master of Science in Sustainability Management

Department of Computer Science

FACULTY

GIUSEPPE ATENIESE
DEPARTMENT CHAIR

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The David and GG Farber Endowed Chair in
Computer Science, Professor and Chair

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Assistant Professor

Sandeep Bhatt, Ph.D.
Teaching Professor

Eduardo Bonelli, Ph.D.
Teaching Professor

Brian Borowski, Ph.D.
Teaching Associate Professor / Associate Chair of
Undergraduate Education

Adriana Compagnoni, Ph.D.
Associate Professor

Dimitrios Damopoulos, Ph.D.
Teaching Assistant Professor

Dominic Duggan, Ph.D.
Associate Professor

Enrique Dunn, Ph.D.
Associate Professor

David Farber, Ph.D.
Visiting Distinguished Professor

David Klappholz, Ph.D.
Associate Professor

Samantha Kleinberg, Ph.D.
Associate Professor

Eric Koskinen, Ph.D.
Assistant Professor

Philippos Mordohai, Ph.D.
Associate Professor / Deputy Chair

David Naumann, Ph.D.
Professor

Antonio Nicolosi, Ph.D.
Associate Professor

Yue Ning, Ph.D.
Assistant Professor

Georgios Portokalidis, Ph.D.
Associate Professor

Jie Shen, Ph.D.
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Wendy Wang, Ph.D.
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Jennifer Lebron
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UNDERGRADUATE PROGRAMS

Stevens offers undergraduate majors in Computer Science and Cybersecurity. Each is specifically designed to educate students to take advantage of trends in the IT industry and gain entry into a challenging and rewarding career path in software development, cybersecurity and systems analysis.

Science Requirement

All majors must take one of these science sequences, each consisting of two science courses and a science laboratory:

	Science I	Science II	Science Lab
Physics	PEP 111 Mechanics	PEP 112 Electricity and Magnetism	PEP 221
Chemistry	CH 115 General Chemistry I	CH 116 General Chemistry II	CH 117
Chemistry & Biology	CH 115 General Chemistry I	BIO 281 Biology & Biotechnology	CH 117
Chemistry & Biology	CH 115 General Chemistry I	BIO 281 Biology & Biotechnology	CH 282
Physics & Biology	PEP 111 Mechanics	BIO 281 Biology & Biotechnology	CH 282
Physics & Biology	PEP 111 Mechanics	BIO 281 Biology & Biotechnology	PEP 221
Physics & Chemistry	PEP 111 Mechanics	CH 115 General Chemistry I	CH 117
Physics & Chemistry	PEP 111 Mechanics	CH 115 General Chemistry I	PEP 221

Humanities Requirement

One humanities course must be HSS 371 Computers and Society or HPL 455 Ethical Issues in Science and Technology. In addition, students must follow the requirements of the College of Arts and Letters:

- All freshmen must take CAL 103 Writing and Communication and CAL 105 CAL Colloquium.
- At least one humanities course must be at the 100 or 200 level, and at least one course must be at the 300 or 400 level.
- Courses must be taken in at least two different disciplines within CAL. For details, see Humanities Requirements on pages 599-600.

Physical Education Requirement

- All students must complete a minimum of four semesters of Physical Education (P.E.). A large number of activities are offered in lifetime, team, and wellness areas.
- All P.E. courses must be completed by the end of the sixth semester. Students can enroll in more than the minimum required P.E. for graduation and are encouraged to do so.
- Students can use up to four semesters of Varsity and/or Club sports to fulfill the P.E. requirements.

Note: Students may repeat a Physical Education class but the repeated course (excluding varsity and club sports) will not count toward the graduation requirement.

GETTING STARTED

Study begins with a three-course sequence (CS 115, CS 284, and CS 385) that teaches the fundamentals of computer programming. All students will take these courses in sequence in their first three semesters. CS110 is reserved for non-majors and cannot be taken by Computer Science and Cybersecurity students.

ADVANCED PLACEMENT

Computer Science students who receive a 4 or 5 on the advanced placement computer science exam receive credit for one technical elective. Cybersecurity students who earn the same score will receive credit for one computer science elective. Students who receive a score of 6 or 7 on the International Baccalaureate (IB) computer science exam, Standard Level, are treated similarly. Students who receive a score of 6 or 7 on the IB computer science exam, High Level, receive credit for one free elective course, are exempted from CS 115 and CS 284, and start in CS 385.

BACHELOR OF SCIENCE IN COMPUTER SCIENCE

Besides its technical rigor, the Computer Science major is distinguished by its flexibility. In the junior and senior year, a student can choose from a large number of elective courses.

The Computer Science Department is also the home to world-class research in areas such as computer security, machine learning, computer vision, and data mining. The quality of this research is demonstrated by the publication and funding records of the faculty of the department. Undergraduate students are encouraged to get involved with faculty in their research. Indeed, while graduate students come from all over the world to be involved with research, some undergraduates choose to stay at Stevens for their graduate work, pursuing Ph.D. research with the faculty they came to know during their undergraduate studies.

Computer Science Requirements

The program requires the following courses:

Mathematics

- ▸ MA 121 Differential Calculus
- ▸ MA 122 Integral Calculus
- ▸ MA 123 Series, Vectors, Functions, and Surfaces
- ▸ MA 124 Calculus for Functions of Two Variables
- ▸ CS 135 Discrete Structures
- ▸ MA 222 Probability and Statistics
- ▸ MA 331 Intermediate Statistics
- ▸ CS 334 Automata and Computation

Computer Science

- ▸ CS 115 Introduction to Computer Science
- ▸ CS 146 Introduction to Web Programming and Project Development
- ▸ CS 284 Data Structures
- ▸ CS 306 Introduction to IT Security
- ▸ CS 347 Software Development Process
- ▸ CS 383 Computer Organization and Programming
- ▸ CS 385 Algorithms
- ▸ CS 392 Systems Programming
- ▸ CS 423 Senior Design I
- ▸ CS 424 Senior Design II

▸ CS 442 Database Management Systems

▸ CS 485 Societal Impact of Information Technologies

▸ CS 492 Operating Systems

▸ CS 496 Principles of Programming Languages

▸ CS 511 Concurrent Programming

Management

▸ BT 353 Project Management

Electives

Electives fall into four categories: science/math, software development, technical, and free. Students must take at least two science/math electives and two software development electives. The number of required technical and free electives is determined by how the student starts his/her program. All students must take three technical electives and two free electives.

Not every science or math course may be counted as a science/math elective. Students should consult their advisor or the department web site to learn of any restrictions.

The software development electives must be chosen from the following list of courses that involve substantial programming assignments:

▸ CS 516 Compiler Design

▸ CS 521 TCP/IP Networking and Implementation

▸ CS 522 Mobile Systems and Applications

▸ CS 526 Enterprise and Cloud Computing

▸ CS 537 Interactive Computer Graphics

▸ CS 541 Artificial Intelligence

▸ CS 546 Web Programming

▸ CS 548 Enterprise Software Architecture and Design

▸ CS 549 Distributed Systems and Cloud Computing

▸ CS 554 Web Programming II

▸ CS 555 Agile Methods for Software Development

▸ CS 558 Computer Vision

Please consult the department web site for the rules that define technical electives.

Despite the description "free elective," not every course may be counted as a free elective; in particular, courses that are similar to required courses may not be taken as free electives. Students should consult their advisor or the department web site to learn of any restrictions.

Term I

Course #	Course Name	Lecture	Lab	Study	Credit
CS 115	Introduction to Computer Science	3	2	8	4
	Science I[1]	3	0	6	3
CS 146	Introduction to Web Programming and Project Development	3	0	6	3
MA 121; MA 122	Differential Calculus; Integral Calculus	4	0	8	4
CAL 103	Writing And Communications Colloquium	3	0	6	3
PE 200	Physical Education I	0	2	0	0
	Total	**16**	**4**	**34**	**17**

Term II

Course #	Course Name	Lecture	Lab	Study	Credit
CS 284	Data Structures	4	0	8	4
CS 135	Discrete Structures	3	2	8	4
	Science II[1]	3	0	6	3
	Science Lab[1]	0	3	0	1
MA 123; MA 124	Series, Vectors, Functions, and Surfaces; Calculus of Two Variables	4	0	8	4
CAL 105	CAL Colloquium: Knowledge, Nature, Culture	3	0	6	3
PE 200	Physical Education II	0	2	0	0
	Total	**17**	**7**	**36**	**19**

Term III

Course #	Course Name	Lecture	Lab	Study	Credit
CS 383	Computer Organization and Programming	3	0	6	3
CS 385	Algorithms	4	0	8	4
CS 334	Automata and Computation	3	0	6	3
BT 353	Project Management	3	0	6	3
HUM	Humanities[2]	3	0	6	3
PE 200	Physical Education III	0	2	0	0
	Total	**16**	**2**	**32**	**16**

Term IV

Course #	Course Name	Lecture	Lab	Study	Credit
CS 392	Systems Programming	3	0	6	3
CS 496	Principles of Programming Languages	3	0	6	3
CS 347	Software Development Process	3	0	6	3
MA 222	Probability and Statistics	3	0	6	3
HUM	Humanities[2]	3	0	6	3
PE 200	Physical Education IV	0	2	0	0
	Total	**15**	**2**	**30**	**15**

Term V

Course #	Course Name	Lecture	Lab	Study	Credit
CS 442	Database Management Systems	3	0	6	3
CS 511	Concurrent Programming	3	0	6	3
MA 331	Intermediate Statistics	3	0	6	3
T.E.	Technical Elective	3	0	6	3
HSS 371 Or HPL 455	Computers and Society Or Ethical Issues in Science and Technology[2]	3	0	6	3
	Total	**15**	**0**	**30**	**15**

Term VI

Course #	Course Name	Lecture	Lab	Study	Credit
CS 492	Operating Systems	3	0	6	3
	Science/Math Elective	3	0	6	3
T.E.	Technical Elective	3	0	6	3
	Humanities[2]	3	0	6	3
CS	SD Elective	3	0	6	3
	Total	**15**	**0**	**30**	**15**

Term VII

Course #	Course Name	Lecture	Lab	Study	Credit
CS 423	Senior Design I	3	0	6	3
CS 306	Intro to IT Security	3	1	8	4
	Science/Math Elective	3	0	6	3
CS	SD Elective	3	0	6	3
	Humanities[2]	3	0	6	3
CS 485	Societal Impact of Information Technologies	1	0	2	1
	Total	**16**	**1**	**34**	**17**

Term VIII

Course #	Course Name	Lecture	Lab	Study	Credit
CS 424	Senior Design II	3	0	6	3
	Free Elective	3	0	6	3
	Free Elective	3	0	6	3
	Humanities[2]	3	0	6	3
T.E.	Technical Elective	3	0	6	3
	Total	**15**	**0**	**30**	**15**

(1) Science Electives: see pages 79-80 for details.
(2) The Humanities courses must have your advisor's approval prior to enrolling. For details on Humanities courses and requirements please refer to the Academic Policies of the Office of Undergraduate Academics.

MINOR IN COMPUTER SCIENCE

You may qualify for a minor in computer science by taking the courses indicated below. Enrollment in a minor means you must meet the Institute's requirements for minor programs. As many as four of the six courses may be double-counted toward both your minor and your major, assuming that your major accepts those four courses. Only courses completed with grade of C or better are accepted toward a student's minor.

The minor includes these four courses:

- ▸ CS 115 Introduction to Computer Science
- ▸ CS 135 Discrete Structures or MA 134 Discrete Mathematics
- ▸ CS 284 Data Structures
- ▸ CS 385 Algorithms

plus any two CS courses numbered 300 or higher; these courses must each be 3 or more credits. No course may duplicate another; specifically, students may not count toward the minor CS 501, CS 570, or CS 590; also, students may not count toward the minor both courses in each of the following pairs: CS 383 and CS 550, CS 492 and CS 520, CS 496 and CS 510, CS 442 and CS 561.

Cybersecurity students wishing to earn a Computer Science minor must take at least two additional courses, not counted anywhere else on the Cybersecurity study plan. In other words, the Cybersecurity major will have at least 6 credits in the "Additional Courses" section of the study plan, and the courses used for the minor must be approved by the student's advisor.

For more information regarding the School of Engineering and Science requirements for minor programs, please see the Guidelines for Science Minor Programs on page 82.

BACHELOR OF SCIENCE IN CYBERSECURITY

The Bachelor of Science in Cybersecurity program is structured to provide students with security expertise within the context of a broad education. A solid education in security requires not only a strong focus in science and computer science in particular (e.g., need for robust implementation and software validation), but must also incorporate some aspects of engineering and technology management. While cryptographers strive to develop the best security solution possible, actual implementations of theoretical concepts often fail due to technological limitations, cost restraints, and human factors that were not part of the initial design process. For a solution to gain practical relevance, the end user must be able and willing to use it. From an economical point of view, a solution must provide a substantial monetary benefit to the customer. In order to allow for these complex issues to be better addressed, an education in cybersecurity must integrate science, technology, and management.

Cybersecurity Requirements

The program requires the following courses:

Mathematics

- ▸ MA 121 Differential Calculus
- ▸ MA 122 Integral Calculus
- ▸ MA 123 Series, Vectors, Functions, and Surfaces
- ▸ MA 124 Calculus for Functions of Two Variables

▸ CS 135 Discrete Structures

▸ MA 222 Probability and Statistics

▸ CS 334 Automata and Computation

▸ MA 232 Linear Algebra or MA 236 Mathematical Reasoning

Computer Science

▸ CS 115 Introduction to Computer Science

▸ CS 284 Data Structures

▸ CS 146 Introduction to Web Programming and Project Development

▸ CS 347 Software Development Process

▸ CS 383 Computer Organization and Programming

▸ CS 385 Algorithms

▸ CS 392 Systems Programming

▸ CS 442 Database Management Systems

▸ CS 485 Societal Impact of Information Technologies

▸ CS 488 Computer Architecture

▸ CS 492 Operating Systems

▸ CS 496 Principles of Programming Languages

▸ CS 511 Concurrent Programming

▸ CS 521 TCP/IP Networking

▸ CS 595 Information Security and the Law

Cybersecurity

▸ CS/MA 503 Discrete Mathematics for Cryptography

▸ CS 306 Introduction to IT Security

▸ CS 425 Cybersecurity Capstone I

▸ CS 426 Cybersecurity Capstone II

▸ CS 576 Systems Security

▸ CS 578 Privacy in a Networked World

▸ CS 579 Foundations of Cryptography

Electives

The program includes two CS electives, two Cybersecurity electives, and one free elective. Please consult the department website for the rules that define a CS or free elective. Students must obtain their advisor's approval before enrolling in a course to count as CS or free elective. The following courses are approved as Cybersecurity electives. Note that undergraduate students must meet a minimum GPA requirement in order to be allowed to enroll in 600-level courses.

▶ CS 577 Reverse Engineering

▶ CS 594 Enterprise Security and Information Assurance

▶ CS 665 Forensic Analysis

▶ CS 675 Threats, Exploits, and Countermeasures

▶ CS 693 Cryptographic Protocols

▶ CS 676 Advanced Topics in Systems Security

▶ CS 695 Host Forensics

▶ CS 696 Database Security

▶ CPE 592 Multimedia Network Security

▶ EE 584 Wireless Network Security

▶ FIN 545 Risk Management for Financial Cybersecurity

Other Cybersecurity electives may be approved at the discretion of the program director.

BACHELOR OF SCIENCE IN CYBERSECURITY

Term I

Course #	Course Name	Lecture	Lab	Study	Credit
CS 115	Introduction to Computer Science	3	2	8	4
	Science I[1]	3	0	6	3
CS 146	Introduction to Web Programming and Project Development	3	0	6	3
MA 121; MA 122	Differential Calculus; Integral Calculus	4	0	8	4
CAL 103	Writing And Communications Colloquium	3	0	6	3
PE 200	Physical Education I	0	2	0	0
	Total	**16**	**4**	**34**	**17**

Term II

Course #	Course Name	Lecture	Lab	Study	Credit
CS 284	Data Structures	4	0	8	4
	Science II[1]	3	0	6	3
	Science Lab[1]	0	3	0	1
CS 135	Discrete Structures	3	2	8	4
MA 123; MA 124	Series, Vectors, Functions, and Surfaces; Calculus of Two Variables	4	0	8	4
CAL 105	CAL Colloquium: Knowledge, Nature, Culture	3	0	6	3
PE 200	Physical Education II	0	2	0	0
	Total	**17**	**7**	**36**	**19**

Term III

Course #	Course Name	Lecture	Lab	Study	Credit
CS 334	Automata and Computation	3	0	6	3
CS 383	Computer Organization and Programming	3	0	6	3
CS 385	Algorithms	4	0	8	4
CS 306	Intro to IT Security	3	1	8	4
HSS 371 Or HPL 455	Computers and Society Or Ethical Issues in Science and Technology[2]	3	0	6	3
PE 200	Physical Education III	0	2	0	0
	Total	**16**	**3**	**34**	**17**

Term IV

Course #	Course Name	Lecture	Lab	Study	Credit
CS 392	Systems Programming	3	0	6	3
CS 496	Principles of Programming Languages	3	0	6	3
CS 347	Software Development Process	3	0	6	3
MA 222	Probability and Statistics	3	0	6	3
MA232 Or MA236	Lin. Algebra Or Math. Reasoning	3	0	6	3
PE 200	Physical Education IV	0	2	0	0
	Total	**15**	**2**	**30**	**15**

Term V

Course #	Course Name	Lecture	Lab	Study	Credit
CS 503	Discrete Mathematics for Cryptography	3	0	6	3
CS 442	Database Management Systems	3	0	6	3
CS 578	Privacy in a Networked World	3	0	6	3
CS 576	Systems Security	3	1	8	4
HUM	Humanities[2]	3	0	6	3
	Total	**15**	**1**	**32**	**16**

Term VI

Course #	Course Name	Lecture	Lab	Study	Credit
CS 488	Computer Architecture	3	0	6	3
CS 492	Operating Systems	3	0	6	3
CS 579	Foundations of Cryptography	3	0	6	3
CS 595	Information Security & the Law	3	0	6	3
HUM	Humanities[2]	3	0	6	3
	Total	**15**	**0**	**30**	**15**

Term VII

Course #	Course Name	Lecture	Lab	Study	Credit
CS 425	Cybersecurity Capstone I	3	0	6	3
CS	CS Elective	3	0	6	3
HUM	Humanities²	3	0	6	3
CS	Cybsersecurity Elective	3	0	6	3
CS 511	Concurrent Programming	3	0	6	3
CS 485	Societal Impact of Information Technologies	1	0	2	1
	Total	**16**	**0**	**32**	**16**

Term VIII

Course #	Course Name	Lecture	Lab	Study	Credit
CS 426	Cybersecurity Capstone II	3	0	6	3
CS	Cybsersecurity Elective	3	0	6	3
	Free Elective	3	0	6	3
CS 521	TCP/IP Networking	3	0	6	3
CS	Cybsersecurity Elective	3	0	6	3
	Total	**15**	**0**	**30**	**15**

(1) Science Electives: see pages 79-80 for details.

(2) The Humanities courses must have your advisor's approval prior to enrolling. For details on Humanities courses and requirements please refer to the Academic Policies of the Office of Undergraduate Academics.

MINOR IN CYBERSECURITY

You may qualify for a minor in cybersecurity by taking the courses indicated below. Enrollment in a minor means you must meet the Institute's requirements for minor programs. As many as five of the seven courses may be double-counted toward both the minor and your major, assuming that your major accepts those five courses. Only courses completed with grade of "C" or better are accepted toward a student's minor.

The minor includes these seven courses:

▶ CS 115 Introduction to Computer Science

▶ CS 135 Discrete Structures

▶ CS 284 Data Structures

▶ CS 385 Algorithms

Plus one of the following tracks:

▶ CS 503 Discrete Mathematics for Cryptography

▶ MA 232 Linear Algebra or MA 236 Mathematical Reasoning

▶ CS 579 Foundations of Cryptography

Or:

▶ CS 306 Introduction to IT Security

▶ CS 392 Systems Programming

▶ CS 576 Systems Security

The Cybersecurity minor is available to Computer Science majors who can only take the CS 503, CS 579 and MA 232/236 option. Computer Science students wishing to earn a Cybersecurity minor must take at least two additional courses, not counted anywhere else on the Computer Science study plan. In other words, the Computer Science major will have at least 6 credits in the "Additional Courses" section of the study plan, and the courses used for the minor must be approved by the student's advisor.

For more information regarding the School of Engineering and Science requirements for minor programs, please see the Guidelines for Science Minor Programs on page 82.

PREREQUISITE DIAGRAMS

The figure below shows prerequisite and corequisite relationships among required undergraduate courses. A dashed line indicates a corequisite. For example, the dashed line from CS 135 to CS 284 means that a student taking CS 284 must either have already passed CS 135 or be taking it at the same time as CS 284. (All numbers refer to CS courses.)
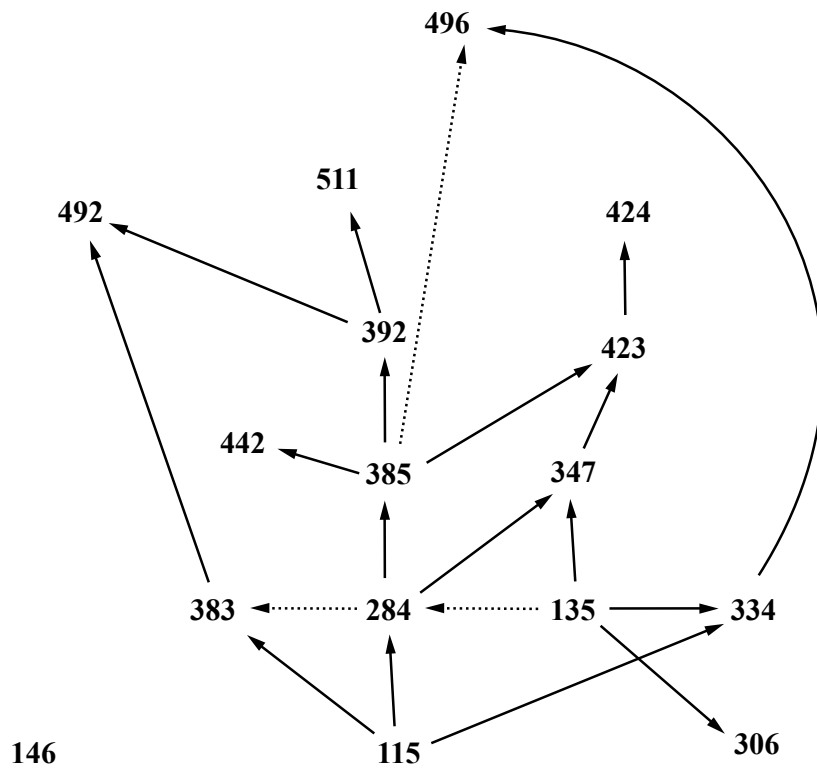
Graduate Programs

The Computer Science Department offers five master's degrees, several graduate certificates, an engineer degree, and a doctoral degree.

▸ **Master of Science in Computer Science:** The MS/CS is the flagship graduate program. It is designed to be flexible in allowing students to combine several areas of concentration, such as software engineering, cybersecurity, databases, and service-oriented architecture. Ph.D. students who do not already have a M.S. degree should consider pursuing a M.S. in Computer Science to develop breadth before their Ph.D. studies.

▸ **Master of Science in Enterprise and Cloud Computing:** The MS/ECC is intended to educate high-end IT professionals with an interest in enterprise computing. Students learn about distributed computing from both the reliability and security points of view, including service-oriented architecture (SOA). This program has a particular emphasis on systems administration and governance. A typical back-end setup will involve several virtualized servers, running heterogeneous guest operating systems on top of hypervisors, organized in a highly available cluster. Data processing and Web service applications will have service level agreements (SLAs) that must be honored. This program develops the skills sets for the professionals who administer such operations.

▸ **Master of Science in Cybersecurity:** The MS/CyS is a rigorous program in the art and practice of cybersecurity, including fundamentals of cryptography, and threats and defenses for secure systems. The emphasis in this program is on deep technical skills that may be complemented with courses in security management, in addition to the security courses suggested for the MS/CS which emphasize broad principles and security administration.

▸ **Master of Engineering in Media and Broadcast Engineering:** Media and broadcast engineering lies at the intersection of audio/video processing, networking, software design, and complex system integration. The Master of Science in Media and Broadcast Engineering provides students with a comprehensive foundation in all aspects of media production, delivery, and management, and prepares them for relevant careers as media and broadcast engineers, network managers and developers, streaming media developers, and project managers for broadcast networks. It provides similar education and opportunities to professionals in the field who wish to enhance their skillsets. It also covers media engineering in emerging media publishing channels such as through the Internet and mobile applications.

▸ **Master of Science in Machine Learning:** The MS/ML aims to provide theoretical and practical foundations that enable its graduates to be at the forefront of progress in machine learning and related disciplines. Machine learning is a rapidly expanding field with many applications in diverse areas, such as intelligent systems, perception, robotics, finance, information retrieval, bioinformatics, healthcare, weather prediction among others. In addition to established employers in these industries, a large number of startups have also entered the market seeking to hire machine learning scientists. Besides careers in industry, this program will prepare students for the pursuit of doctoral degrees and careers in research.

▸ **Graduate Certificate:** A graduate certificate typically consists of four graduate courses in a targeted area of study. The courses for a graduate certificate also may be used toward another graduate degree, such as a master's degree.

▸ **Engineer in Computer Science:** The degree of Engineer in Computer Science is for students who already have a Master's degree in computer science or a closely related field and who wish to continue to study computer science deeply at an advanced level, but who do not wish to or cannot make the time commitment necessary for the Ph.D. degree. The degree requires 30 credits of computer science beyond the M.S. degree. Nine to twelve of these credits must be for a single long-term project on an advanced computer science topic (course CS 950).

▸ **Ph.D. in Computer Science:** The doctoral degree is a program of full time on-campus study only, aimed at preparing the student for a career in computer science research.

Master of Science - Computer Science

Degree Requirements

1. Completion of at least thirty credits at the graduate level (500 level and above), with no grade less than a C in any course and a minimum GPA of 3.000.

2. At least twenty-one credits must be from computer science courses, identified by the CS prefix.

3. At least three of the courses must be drawn from this set:

- CS 510 Principles of Programming Languages
- CS 511 Concurrent Programming
- CS 513 Data Mining and Knowledge Management
- CS 520 Introduction to Operating Systems
- CS 521 TCP/IP Networking
- CS 522 Mobile Systems and Applications
- CS 524 Introduction to Cloud Computing
- CS 526 Enterprise and Cloud Computing
- CS 537 Interactive Computer Graphics
- CS 541 Artificial Intelligence
- CS 545 Human Computer Interaction
- CS 546 Web Programming
- CS 548 Enterprise Software Architecture and Design
- CS 549 Distributed and Cloud Computing
- CS 561 Database Management Systems I
- CS 573 Fundamentals of Cybersecurity
- CS 578 Privacy in a Networked World
- CS 600 Advanced Algorithm Design and Implementation
- CS 677 Parallel Programming for Many-core Processors
- CS 694 Advanced Computational Modeling in Biology and Biomaterials

4. The remaining nine credits can be from computer science or any other disciplines.

Some students may seek to take electives that form a focused area of study. Accordingly, several suggested focus areas of logically related electives are defined including:

- Cloud Computing
- Databases
- Gaming and Simulation
- Mobile Systems
- Modeling, Simulation, and Visualization
- Network and Systems Administration
- Secure Systems
- Software Development
- Visual Computing and Information Extraction
- Web Application Development

See the Computer Science Department web site for definition of these focus areas.

Master of Engineering – Media and Broadcast Engineering

Degree Requirements

1. Completion of at least thirty credits at the graduate level (500 level and above), with a minimum grade of C and a minimum GPA of 3.00.

2. Three core courses that are mandatory in all tracks.

3. Three courses from a chosen track.

4. Two technical electives from any track.

5. Two general electives that can be any Stevens course at the 500 level or above, including a relevant M.S. thesis in one of the program's home departments.

Core courses

▸ EE 612 Principles of Multimedia Compression

▸ CS 521 TCP/IP Networking

▸ SYS 625 Fundamentals of Systems Engineering

Track I: Signal Processing and Data Communication

As a traditional branch of Electrical and Computer Engineering, this track provides fundamental knowledge and skills related to audio and video processing, information compression, data communication and networking, which are enabling technologies in the media and broadcasting industry.

Track courses

▸ CPE 645 Image Processing and Computer Vision

▸ CPE 548 Digital Signal Processing

▸ CPE 591 Introduction to Multimedia Networking

▸ EE 585 Physical Design of Wireless Systems

▸ EE 626 Optical Communication Systems

▸ EE 670 Information Theory and Coding

Elective courses

▸ CS 537 Interactive Computer Graphics

▸ CS 558 Computer Vision

Track II: Software Infrastructure for Media and Broadcast Engineering

This track covers aspects of software design and development that are critical for media and broadcast engineering, including networking, distributed and cloud computing, web programming, programming for mobile systems, databases, and algorithms/

Track courses

▸ CS 522 Mobile Systems and Applications

▸ CS 524 Introduction to Cloud Computing

▸ CS 526 Enterprise and Cloud Computing

▸ CS 546 Web Programming

▸ CS 548 Enterprise Software Architecture & Design

▸ CS 554 Web Programming II

Elective courses

▸ CS 520 Introduction to Operating Systems

▸ CS 561 Database Management Systems I

▸ CS 570 Introduction to Programming, Data Structures, and Algorithms

▸ CS 590 Algorithms

▸ CS 600 Advanced Algorithm Design and Implementation

▸ CS 615 Systems Administration

Master of Science - Cybersecurity

Reports of cybersecurity breaches have become a fixed presence in news headlines. The theft of customer account data from large retailers such as Target (2013), Staples (2014), Michaels (2014), The Home Depot (2014), and of information about government employees and contractors from the computer systems of federal offices (2015), continues to inconvenience millions of people every year. Internet pandemics such as those caused by the Code Red (2001), Sobig.F (2003), MyDoom (2004) and Conficker (2008) worms have cost several billion dollars to the global economy in recent years. Conservative estimates by security experts are that millions of residential computers are *"zombies"* (or "bots") taken over by attackers unbeknownst to their owners, organized into *"bot-nets,"* and used routinely for spamming everyone that uses the Internet. Denial of service attacks have been staged against major corporations that rely on network access, such as eBay (2000) and PayPal (2010), as well as against the root servers for the internet Domain Naming System (DNS), using bot-nets whose "services" can be purchased on the black market for just a few hundred dollars. Criminal gangs are hiring expert programmers to break into law enforcement databases to learn the names of informants. Consumers are becoming more and more reliant on computer systems, even for sensitive activities like home banking, while companies and governments are exposing themselves to potential attacks due to the need to establish and maintain a *"Web presence."* On the legislative level, increasing privacy concerns are giving rise to legislation of which companies must be aware and to which they must be able to adapt.

In response to these trends, Stevens has developed a graduate program in cybersecurity that provides deep and rigorous training in cybersecurity to IT professionals who already have a background in computer science, computer engineering, or other closely related discipline in the information sciences. The program aims to provide a nationally recognized credential for cybersecurity professionals. Academically inclined graduates of this program will also be well poised to pursue Ph.D. study in cybersecurity, should they so choose. The program provides a rigorous education in the foundations of security and privacy, including cryptography and secure systems.

Degree Requirements

Completion of at least thirty credit-hours of study at the graduate level (500-level and above), with a minimum grade of C and a minimum cumulative GPA of 3.00. The seven core courses listed below must be completed.

Beyond the core courses listed below, students may choose from a list of approved electives posted on the department web site.

<u>Core Courses</u>

▸ CS 520 Introduction to Operating Systems

▸ CS/MA 503 Discrete Mathematics for Cryptography

▸ CS 573 Fundamentals of Cybersecurity

▸ CS 578 Privacy in a Networked World

▸ CS 579 Foundations of Cryptography

▸ CS 600 Advanced Algorithm Design and Implementation

▸ CS 675 Threats, Exploits, and Countermeasures

▸ or CS 665 Forensic Analysis

CS 520 and CS 600 may be replaced by electives if the student already has taken these courses as an undergraduate.

Master of Science - Machine Learning

Degree Requirements

1. Completion of at least thirty credits at the graduate level (500 level and above), with no grade less than a C in any course and a minimum GPA of 3.000.

2. At least four of the courses must be drawn from the set of core courses:

   ▸ CS 559 Machine Learning: Fundamentals and Applications

   ▸ CS 541 Artificial Intelligence

   ▸ CS 583 Deep Learning

   ▸ CS 584 Natural Language Processing

   ▸ CS 560 Statistical Machine Learning

3. At least three elective courses from the list below:

   ▸ CS 513 Knowledge Discovery and Data Mining

   ▸ CS 532 3D Computer Vision

   ▸ CS 541 Human Computer Interaction

   ▸ CS 544 Health Informatics

   ▸ CS 558 Computer Vision

   ▸ CS 582 Causal Inference

   ▸ CS 598 Visual Information Retrieval

   ▸ CS 609 Data Management and Exploration on the Web

   ▸ BIA 654 Experimental Design

   ▸ BIA 660 Web Analytics

   ▸ BIA 662 Cognitive Computing

   ▸ BIA 678 Big Data Technologies

   ▸ CPE 608 Applied Modeling and Optimization

   ▸ CPE 695 Applied Machine Learning

   ▸ FE 541 Applied Statistics with Applications in Finance

- MA 541 Statistical Methods

- MA 630 Advanced Optimization Methods

- MA 641 Time Series Analysis

- MA 661 Dynamic Programming and Learning

- CS 800 Special Problems in Computer Science (with one of the program faculty members, up to 6 credits)

- CS 900 MS Thesis in Computer Science (with one of the program faculty members, 5-10 credits)

4. Up to three free electives, which can be any graduate course.

Graduate Certificate Programs

The Computer Science department offers graduate certificate programs to students meeting the regular admission requirements for the master's program. Each certificate program is self-contained and highly focused, comprising 12 or more credits. Courses taken for a Graduate Certificate may also be used toward a master's degree.

Databases

This program provides a firm grounding in enterprise architecture, particularly as supported by modern database management systems and platforms such as Web services. Students may also focus on data mining, including both algorithms and applications of existing data mining tools.

- CS 561 Database Management Systems I

- CS 562 Database Management Systems II

- CS 546 Web Programming

- CS 574 Object-Oriented Analysis and Design or CS 513 Knowledge Discovery and Data Mining

Cybersecurity

Students will obtain a deep technical background in security and privacy, particularly in the cryptographic foundations of the tools that the security specialist will need to use. They will know that cryptographic tools require a deep understanding of their properties to be deployed properly, rather than simply treated as black boxes. They will obtain a background in algorithm design and implementation, and discrete mathematics for cryptography, prior to learning about the most popular cryptographic algorithms and protocols. They will also learn about both the technical and the social aspects of privacy, where legislation is still grappling with how to resolve individuals' privacy rights with the immense benefits to be gained from vast on-line information resources, and where technical solutions can inform the legal and social debate.

- CS/MA 503 Discrete Mathematics for Cryptography

- CS 578 Privacy in a Networked World

- CS 579 Foundations of Cryptography

- CS 600 Advanced Algorithm Design and Implementation

Enterprise Security and Information Assurance

This program is for students interested in security and privacy, particularly as it pertains to businesses, governments, and other forms of enterprises. They will get a basic grounding in security concepts, including the various forms of threats and defenses. Students will learn how enterprises can protect against attacks and exploits both from inside and outside the organization, including ensuring that critical data survives such attacks. Security governance is an important part of such mechanisms. They will learn how to recover from a security attack, determining the cause and sometimes the source of the

exploit. Finally, students will also learn about both the technical and the social aspects of privacy, where legislation is still grappling with how to resolve individuals' privacy rights with the immense benefits to be gained from vast on-line information resources, and where technical solutions can inform the legal and social debate.

▸ CS 548 Enterprise Software Architecture and Design

▸ CS 578 Privacy in a Networked World

▸ CS 594 Enterprise Security and Information Assurance

▸ CS 573 Fundamentals of Cybersecurity or CS 506 Introduction to IT Security

Enterprise and Cloud Computing

This program is for students who want to become high-end IT professionals with an interest in enterprise computing. Students will learn about distributed computing from both the reliability and the security points of view. They will learn about distributed computing "in the large," including enterprise application integration and service-oriented architectures (SOA). They will build on skills learned in courses in operating systems, databases, and systems programming for enterprise computing, to learn how to administer server back-ends that are the crux of modern SOA. This will involve ensuring that applications meet their goals in terms of performance, reliability, security, and privacy. A typical backend setup will involve several virtualized servers, running heterogeneous guest operating systems on top of hypervisors, organized in a highly available cluster. Data processing and Web service applications will have service level agreements (SLAs) that must be honored. The administrator must be able to respond to performance issues by dynamically reallocating resources between applications, while at the same time responding to component failures, and potentially also security attacks.

▸ CS522 Mobile Systems and Applications

▸ CS526 Enterprise and Cloud Computing or CS548 Enterprise Software A & D

▸ CS549 Distributed Systems and Cloud Computing

▸ CS594 Enterprise and Cloud Security

Health Informatics

Students of this program will learn to use data mining methods to derive, in an exploratory manner, valuable healthcare knowledge in terms of associations, sequential patterns, classifications, predictions and symbolic rules. They will be able to describe and use tools for preserving the privacy of confidential data, as well as explain some of the social and legal aspects of privacy. Students will be able to explain health care IT standards such as UDEF and HL7, explain health care terminology, and perform system selection and evaluation in the areas of telemedicine, dental informatics, consumer health informatics, and hospital/clinical informatics. Special attention is given to web services and mobile computing as they relate to the health care industry.

▸ CS 513/SOC 550 Knowledge Discovery and Data Mining

▸ CS 544/SOC 552 Health Informatics

▸ CS 548/SOC 542 Enterprise Software Architecture and Design

▸ CS 578/SOC 551 Privacy in a Networked World

Machine Learning

Machine learning has been at the forefront of technological innovation in the past few years, with a wide spectrum of impactful applications that are presented in the market every year. This upward trend of machine learning applications is predicted to keep going up. With innovation at our core as institution, we make sure our students excel in state of the art technologies. This graduate certificate provides a firm and practical grounding in the large and diverse field of artificial

intelligence, and machine learning. Students will obtain a thorough understanding of recent advances in the field, and a technical background in the tools used in applications on fields such as computer vision, data mining, knowledge discovery, natural language processing and more.

- ▸ CS 559 Machine Learning: Fundamentals & Applications
- ▸ CS 541 Artificial Intelligence
- ▸ CS 582 Causal Inference
- ▸ CS 513 Knowledge Discovery and Data Mining or CS 553 Introduction to Text Mining and Statistical Natural Language Processing or CS 593 Data Mining II: Advanced Algorithms for Mining Big Data

Engineer Degree

The degree of Engineer in Computer Science is for students who already have a Masters degree in computer science or a closely related field and who wish to continue to study computer science deeply at an advanced level, but who do not wish to or cannot make the time commitment necessary for the Ph.D. degree. The degree requires 30 credits of computer science beyond the M.S. degree. Nine to 12 of these credits must be for a single long term project on an advanced computer science topic (course CS 950). For part time students, the project topic cannot be drawn from the student's activity. The project must be work beyond the student's job activity, so as to expand the student's sphere of expertise. The student must be advised at all times by a full time Computer Science department faculty member. The advisor must approve and supervise the project. The project must be described in a substantial document that is reviewed by a committee of faculty, presented in a public defense, and submitted to the library for archival publication.

Doctoral Program

The purpose of the Ph.D. program is to educate students for a career in computer science research. The goal is for the quality of Stevens graduates to be on par with those produced by the best Computer Science departments in the country.

Full-time study

To make progress on leading-edge subjects in a fast moving field like computer science requires full-time study. It is nearly impossible to do work that is important, timely, and novel at the pace afforded by part-time effort-either one's result will be "scooped" or conditions will change within the field, rendering the work no longer current. Accordingly, Ph.D. students will be admitted only for full-time on-campus study.

Advised study

Each doctoral student must at all times have a single advisor who is a tenured or tenure-track Stevens faculty member. The relationship between advisor and student is not merely an administrative one. Starting early in his/her career, the student will work on research projects to be determined by the advisor and student. Through this day-to-day interaction, the student will learn the form and content of high quality research. The student's advisor will also guide the student through the program, e.g., advising on such matters as which courses to take, when to attempt the qualifying exam, what dissertation topic to pursue, etc.

Advisor-advisee relationship

The department aims to admit only students whose background and interests match those of the faculty. Each admitted student will be assigned an advisor whose expertise is well matched to the student. It is hoped that most students will remain with their initial advisors throughout their career, performing research with him/her. However, the advisor-advisee relationship is a voluntary one. If either the student or the faculty member becomes dissatisfied with the relationship, then the student

must seek another advisor among the faculty. A student can change advisors at any time provided that the student's new advisor is willing to accept the student.

Requirements

The Ph.D. degree requires 84 credits beyond the bachelor's degree. Students who already possess a master's degree may be granted up to 30 credits. The 84 credits may be fulfilled by some combination of: prior M.S. degree, enrollment in classroom courses, and enrollment in research participation (course CS 960). The division of a student's effort between classroom courses and research participation will vary from case to case, and is a decision that should be made by the student in consultation with and with the approval of the student's advisor. There is no minimum number of classroom courses for the doctorate.

Progress review

Each student's progress is reviewed by the entire computer science faculty near the end of the fall and spring semesters. Preparatory to this review, the student must submit a brief progress report describing the student's progress since the last review, as well as his/her plans for the time up to the next review. After drafting the report, the student must submit it to his/her advisor for approval. Once approved, the report must be submitted to the Computer Science department office.

Students who are doctoral "candidates" must also submit a second, separate, report to the Graduate Academics & Student Success' office. The definition of the term "candidate" is left to each department, and the Computer Science department defines candidates to be students who have passed the qualifying exam, both written and oral parts. The report for the graduate dean must be submitted on a special form-the "Doctoral Activity Report," (DAR). It is acceptable to write a single report and submit the DAR to the department as well as to the graduate office.

The outcome of the progress review meeting is that a student is placed into one of three categories: good standing, probation, or terminated. A student in good standing is making satisfactory progress toward his/her degree, and is expected to follow through on the plans outlined in his/her progress report. A student on probation is making inadequate progress toward his/her degree. A student on probation will receive a letter from the faculty that explains what remedial actions he/she must take to return to good standing, and by what time each action must be taken. No student will be terminated without spending at least the preceding semester on probation.

Breadth Requirement

Students must complete at least three graduate courses from the courses listed below with an A- and with at least one coming from each category. Additionally, students must pass a written exam in the subject of algorithms, which will be offered near the end of Fall and Spring semesters. The courses and exam must be completed by their 4th semester and students have a maximum of two attempts to pass the algorithms exam (similarly to the older written qualification exams).

Artificial Intelligence

▸ CS 532 3D Computer Vision

▸ CS 541 Artificial Intelligence

▸ CS 558 Computer Vision

▸ CS 559 Machine Learning: Fundamentals and Applications

▸ CS 582 Causal Inference

▸ CS 598 Visual Information Retrieval

- CS 510 Principles of Programming Languages
- CS 516 Compiler Design
- CS 522 Mobile Systems and Applications
- CS 549 Distributed Systems and Cloud Computing
- CS 576 Secure Systems
- CS 609 Data Management and Exploration on the Web
- CS 677 Parallel Programming for Many-core Processors

Research Seminars

Ph.D. students are required to attend CS seminars and their attendance will be recorded. Students failing to meet this requirement may be put on probation at the discretion of the faculty.

Qualifying Exam

The qualifying exam is an oral examination on a syllabus consisting of research papers, prepared jointly by the student and a committee including the advisor and two tenure-track faculty members. The goal is to establish scholarship in an area of research. The exam needs to be completed by the end of the 4th semester. It consists of a presentation, followed by open-door questions from the audience and a closed-door examination from the committee. The committee can pass, fail, or request re-examination (either written or oral).

Thesis Proposal

Students must write and present a thesis proposal, where they lay out an intended course of research for their dissertation. The proposal should contain an explanation of the problem and why it is important, a sketch of the proposed solution, and background information that serves to indicate that the problem is unsolved and what prior or related approaches to this or similar problems have already been investigated. The written proposal must be distributed and read by a committee, comprising the persons that are expected to form the student's dissertation defense committee. The presentation of the thesis proposal is open to the public and it is followed by open-door questions from the audience and committee and closed-door questions from the committee. The committee can pass, fail, or request additional material from the student.

Dissertation and Thesis Defense

The department follows the Stevens-wide procedures for the dissertation defense, including committee composition. The defense must be announced at least two weeks in advance on the cs-faculty and csphd-students mailing lists as well as a Stevens-wide announcement originating with the Registrar's office. At least one manuscript based on dissertation work must be published on peer-reviewed conference proceedings or journal, at the time of the dissertation defense, and the thesis document must be in the hands of the committee at least four weeks in advance. For more information please refer to the online catalog. The committee can ask major or minor revisions, or fail the student. If major revisions are requested, at least a month of time is required for the student to make the changes and submit an updated dissertation. The amount of time given to the student to make revisions will not exceed 9 months, unless there are extenuating circumstances.

Leave

It is expected that students, once enrolled in the doctoral program, will remain enrolled full-time without interruption until graduation. However, sometimes it is necessary for a student to take a leave for a reason, such as personal difficulty, health, etc. If such a situation arises, the student must petition the faculty in writing for a leave, which, if granted, will last for one

semester. To extend the leave, a new petition must be filed. Neither indefinite leave nor excessive repetition of leave is permitted. While the student is on leave, any time limit he/she faces (e.g., completing the qualifying exam within two years) is suspended for the length of the leave.

Exceptions

The faculty reserve the right to make exceptions to any of the rules and procedures described above in order to promote and preserve the health of the doctoral program and to ensure each student's prompt and effective progress through the program.

COURSE OFFERINGS

Computer Science

CS 105   Introduction to Scientific Computing   (3 - 2 - 2)

This is a first course in computer programming for students with no prior experience. Students will learn the core process of programming: given a problem statement, how does one design an algorithm to solve that particular problem and then implement the algorithm in a computer program? The course will also introduce elementary programming concepts like basic control concepts (such as conditional statements and loops) and a few essential data types (e.g., integers and doubles). Exposure to programming will be through a self-contained user-friendly programming environment, widely used by the scientific and engineering communities, such as MATLAB. The course will cover problems from all fields of science, engineering, and business.

CS 110   Creative Problem Solving in Computing   (3 - 2 - 2)

This course is an introduction to problem solving using computers. It is specially tailored for student with no prior programming experience. CS110 offers an alternative to CS105, and prepares students for CS115. The entire course is problem driven. Programming concepts are introduced and develop as tools for creative problem solving. Only freshmen may enroll in this course.

CS 115   Introduction to Computer Science   (4 - 3 - 2)

This is an introduction to computer science with an emphasis on programming. The topics include: design; algorithmic thinking; recursion; object-oriented programming; ethics in computer science; and some basics about computer systems: machine language, interpreters, compilers, and data representation.

CS 135   Discrete Structures   (4 - 3 - 2)

The aim of this course is to integrate knowledge of basic mathematics with the problems involving specification, design, and computation. By the end of the course, the student should be able to: use sets, functions, lists, and relations in the specification and design of problems; use properties of arithmetic, modular arithmetic (sum, product, exponentiation), prime numbers, greatest common divisor, factoring, Fermat's Little Theorem; use binary, decimal, and base-b notation systems and translation methods; use induction to design and verify recursive programs; and implement in Scheme all algorithms considered during the course.

CS 146   Introduction to Web Programming and Project Development   (3 - 3 - 0)

This course introduces students to the infrastructure underlying the Web, including protocols and markup languages. It also addresses the question of how one presents large volumes of information to people who need to find out what they are looking for quickly. The scope of the course ranges from mechanics to aesthetics. Social and ethical issues are also discussed, including the concept of information ecologies for social acceptance. Networks and protocols; pervasive computing; Web protocols; markup languages and XML; defining information architecture; understanding information needs and information-seeking behaviors; organizing Web sites and intranets; navigation systems; search systems; thesauri; from research to design: strategies for information architecture; enterprise information architecture; ethics on the Web; and information ecologies.

CS 188   Seminar in Computer Science   (1 - 1 - 0)

Selected topics in Computer Science. Substantial student participation is required. May be repeated for credit. This course is offered with pass/fail grading.

CS 284   Data Structures   (4 - 2 - 2)

This is a course on standard data structures, including sorting and searching and using the Java language. The topics include: stages of software development; testing; UML diagrams; elementary data structures (lists, stacks, queues, and maps); use of elementary data structures in application frameworks; searching; sorting; and introduction to asymptotic complexity analysis. Prerequisite: CS 115 Corequisite: CS 135

CS 306   Introduction to IT Security   (4 - 3 - 1)

This course provides a basic introduction to the key concepts in security. It covers basic concepts such as authentication, confidentiality, integrity, and nonrepudiation as well as important techniques and applications. Topics include access control, security economics, ethics, privacy, software/operating system security, and security policies. Prerequisite: CS 135 or MA 134

CS 334   Automata and Computation   (3 - 3 - 0)

Introduction to recursive functional programming and equational reasoning; lists as inductive types and list induction; introduction to formal languages, automata, and the theory of computation; regular expressions, finite state machines, and pumping lemma; context free grammars and push down automata; turing machines, recursive enumerability, and unsolvable problems; and complexity and intractability. A number of models of computation are considered, as well as their relation to various problem classes (e.g. solvable problems and polynomial time solvable problems). Some experiments are performed that involve writing small Scheme programs. Prerequisites: CS 115 and CS 135

CS 347   Software Development Process   (3 - 3 - 0)

This course provides a general introduction to the essentials of the software development process, that series of activities that facilitate developing better software in less time. The course introduces software development and deployment life cycles, requirements acquisition and analysis, software architecture and design, and resource management and scheduling in the implementation phase. Students gain experience with tools and methodologies for configuration management and project management. Security engineering is considered as an essential part of the software development process, particularly from the standpoint of applied risk management. Prerequisites: CS 284, CS 135

CS 370   Creative Problem Solving and Team Programming   (3 - 3 - 0)

Gives students practice in solving challenging problems by applying algorithmic problem solving techniques learned in prior courses. Students will develop their problem-solving, algorithm-creation, and programming abilities. Problems will be complex and will require invention of an algorithm, not simply straightforward application of standard techniques. Students will work in teams. To provide a focus point and to help make the course fun, students will program their solutions in a style similar to that employed by programming competitions such as the national ACM programming contest. Prerequisite: CS 385

CS 381   Switching Theory & Logical Design   (3 - 3 - 0)

Digital systems; number systems and codes; Boolean algebra; application of Boolean algebra to switching circuits; minimization Boolean functions using algebraic, Karnaugh map, and tabular methods; design of combinational circuits; programmable logic devices; sequential circuit components; design and analysis of synchronous and asynchronous sequential circuits. Cross-listed with: CPE 358 Prerequisite: CS 115

CS 383   Computer Organization and Programming   (3 - 3 - 0)

The main aspects of computers: data (data types and formats, number bases), hardware (stored program computer concept, addressing methods and program sequencing, instruction sets and their implementation, the CPU and microprogrammed control, input/output organization, peripherals and interfacing, and main memory), communication (network protocols), software (operating systems, dispatching algorithms), and assembly language programming. Prerequisite: CS 115

CS 385   Algorithms   (4 - 4 - 0)

This is a course on more complex data structures, and algorithm design and analysis, using the C++ language. Topics include: advanced and/or balanced search trees; hashing; further asymptotic complexity analysis; standard algorithm design techniques; graph algorithms; complex sort algorithms; and other "classic" algorithms that serve as examples of design techniques. Prerequisite: CS 284

CS 392   Systems Programming   (3 - 3 - 0)

Introduction to systems programming in C on UNIX. Students will be introduced to tools for compilation, dynamic linking, debugging, editing, automatic rebuilding, and version control. Some aspects of the UNIX system call interface will be studied, drawn from this list: process creation, signals, terminal I/O, file I/O, inter-process communication, threads, network protocol stacks, programming with sockets, and introduction to RPC. Style issues to be covered include: naming, layout, commenting, portability, design for robustness and debugability, and language pitfalls. X programming and GUI design will be covered, if time allows. Prerequisite: CS 385

CS 397   Outreach Participation   (1 - 1 - 0)

Under the guidance of a faculty member, students will prepare for, participate in, then evaluate an experience in which the students represent Stevens in an off campus team outreach activity. Examples of such activities include, but are not limited to, technical competitions, cross-discipline design contests, and Ambassador programs. Course may be repeated as a free elective up to a maximum of 3 credits. Prerequisite: CS 284

CS 423   Senior Design I   (3 - 3 - 0)

Students in this course work in teams to develop real software for real clients. Topics in software engineering additional to, or more advanced than those taught in CS 347 are introduced "just in time," as needed. Prerequisites: CS 347, and CS 385 or CS 590

CS 424   Senior Design II   (3 - 3 - 0)

This course is a continuation of CS423. Prerequisite: CS 423

CS 425   Cybersecurity Capstone I   (3 - 3 - 0)

Under the guidance of a cybersecurity faculty member of the department, students will participate in a year-long cybersecurity project. The project may be conducted in a number of ways, including as a cybersecurity-only project, as a project where the cybersecurity student is integrated into the senior capstone project of another discipline like CS, QF, ECE, or as a project where the cybersecurity student interacts in a consultant role with one or more senior capstone teams of another discipline. Corequisite: CS 576

CS 426   Cybersecurity Capstone II   (3 - 3 - 0)

Continuation of CS425. Prerequisite: CS 425

CS 442   Database Management Systems   (3 - 3 - 0)

Introduction to the design and querying of relational databases. Topics include: relational schemas; keys and foreign key references; relational algebra (as an introduction to SQL); SQL in depth; Entity-Relationship (ER) database design; translating from ER models to relational schemas and from relational schemas to ER models; functional dependencies; and normalization. Cross-listed with: CPE 442 Prerequisite: CS 385

CS 465   Selected Topics in Computer Science   (3 - 3 - 0)

A participating seminar on topics of current interest and importance in computer science. Open only to undergraduates.

CS 485   Societal Impact of Information Technologies   (1 - 1 - 0)

Students explore tradeoffs posed by modern information technologies such as the Internet, mining of personal data, web tracking, and surveillance systems. Also covered are major debates about how IT technologies should be harnessed to serve the greater good, such as: Internet governance, privacy vs. openness, and laws regarding intellectual property. Students will learn how actions undertaken in their daily lives as IT professionals may have broad consequences, both planned and unplanned. Students will learn how to identify and analyze these consequences and who may be affected by them.

CS 488   Computer Architecture   (3 - 3 - 0)

An introduction to the functional level structure of modern pipelined processors and the empirical and analytic evaluation of their performance. Topics include: empirical and analytic techniques for measuring performance (use of various means, Amdahl's Law, and benchmarks); tradeoff analysis; principles of instruction set design and evaluation (memory addressing, operations, types and sizes of operands, instruction set encoding, CISC vs. RISC, and related compilation issues); pipelining (basics, data hazards, and control hazards); and memory systems. Cross-listed with: CPE 488 Prerequisite: CS 383 Corequisite: MA 222

CS 492   Operating Systems   (3 - 3 - 0)

The use and internals of modern operating systems. Lectures focus on internals whereas programming assignments focus on use of the operating system interface. Major topics include: the process concept; concurrency and how to program with threads; memory management techniques, including virtual memory and shared libraries; file system data structures; and I/O. Prerequisites: CS 383, CS 392

CS 496   Principles of Programming Languages   (3 - 3 - 0)

An introduction to programming language design and implementation, with an emphasis on the abstractions provided by programming languages. Assignments involve problem-solving issues in principles of programming languages such as Scheme and ML; recursive types and recursive functions; structural induction; abstract data types; abstract syntax; implementing languages with interpreters; static vs. dynamic scoping, closures, state; exceptions; types: type-checking, type inference, static vs. dynamic typing; object-oriented languages: classes and interfaces, inheritance and subtyping; polymorphism and genericity; and design patterns and the visitor pattern. Prerequisite: CS 334 Corequisite: CS 385

CS 497   Independent Study   (1 to 3 - TBD - TBD)

Independent study under the guidance of a full time computer science faculty member, whose prior approval is required. Independent study allows the student to participate in research, explore a topic not covered by existing courses, or continue to study in greater depth a topic introduced by a course. Scope and details of the participation must be agreed upon between student and professor before the beginning of the project. One to three credits for any BS degree offered by the computer science department. May be repeated for credit.

CS 498   Senior Research I   (3 - 0 - 8)

Individual research project under the guidance of a faculty member of the department, whose prior approval is required. Either a written report in acceptable journal format or the completion of a senior thesis, as well as an oral presentation, is required at the end of the project. Senior students only. CS 498 and CS 499 cannot be taken simultaneously.

CS 499   Senior Research II   (3 - 0 - 8)

Individual research project under the guidance of a faculty member of the department, whose prior approval is required. Either a written report in acceptable journal format or the completion of a senior thesis, as well as an oral presentation, is required at the end of the project. Senior students only. CS 498 and CS 499 cannot be taken simultaneously.

CS 501   Introduction to JAVA Programming   (3 - 3 - 0)

An introduction to the Java programming language for those students who have little or no programming background. It is intended as an elective for the Master of Science in Information Systems to be taken near the end of the program. Basic topics considered will be programs and program structure in general and Java syntax, data types, flow of control, classes, methods and objects, arrays, exception handling, and recursion. In addition, the use of Java in enterprise-wide computing and distributed systems will be introduced by considering APIs in general, and the ones specific to JDBC and the Java security features in particular. Not for credit for Computer Science department undergraduate majors. Cross-listed with: SOC 501

CS 503   Discrete Mathematics for Cryptography   (3 - 3 - 0)

Topics include basic discrete probability, including urn models and random mappings; a brief introduction to information theory; elements of number theory, including the prime number theorem, the Euler phi function, the Euclidean algorithm, and the Chinese remainder theorem; and elements of abstract algebra and finite fields including basic fundamentals of groups, rings, polynomial rings, vector spaces, and finite fields. Carries credit toward the Applied Mathematics degree only when followed by CS 579. Recommended for high-level undergraduate students. Cross-listed with: MA 503 Prerequisite: MA 502 or CS 135

CS 505   Probability and Stochastic Processes I   (3 - 3 - 0)

Axioms of probability; discrete and continuous random vectors; functions of random variables; expectations, moments, characteristic functions, and momentgenerating functions; inequalities, convergence concepts, and limit theorems; central limit theorem; and characterization of simple stochastic processes: widesense stationality and ergodicity. Cross-listed with: EE 605, CS 655

CS 506   Introduction to IT Security   (3 - 3 - 0)

This course provides a basic introduction to the key concepts in security. It covers basic concepts such as authentication, confidentiality, integrity, and non-repudiation as well as important techniques and applications. Topics include access control, security economics, ethics, privacy, software/operating system security, and security policies.

CS 510   Principles of Programming Languages   (3 - 3 - 0)

An introduction to programming language design and implementation, with an emphasis on the abstractions provided by programming languages. Assignments involve problem-solving issues in principles of programming languages such as Scheme and ML. Recursive types and recursive functions; structural induction; abstract data types; abstract syntax; implementing languages with interpreters; static vs. dynamic scoping, closures, and state; exceptions; types: type-checking, type inference, static vs. dynamic typing; object-oriented languages: classes and interfaces, inheritance, and subtyping; polymorphism and genericity; and design patterns and the visitor pattern. Prerequisites: MA 502, CS 590

CS 511   Concurrent Programming   (3 - 3 - 0)

The study of concurrency as it appears at all levels and in different types of computing systems. Topics include: models of concurrency; languages for expressing concurrency; formal systems for reasoning about concurrency; the challenges of concurrent programming; race conditions; deadlock; livelock and nondeterministic behavior; prototypical synchronization problems, such as readers-writers and dining philosophers; mechanisms for solution of these problems, such as semaphores, monitors, and conditional critical regions; important libraries for concurrent programming; message passing, both synchronous and asynchronous; and applications of multithreaded concurrent programming and parallel algorithms. Substantial programming required. Prerequisite: CS 590 or CS 392

CS 513   Knowledge Discovery and Data Mining   (3 - 3 - 0)

This course introduces fundamental and practical tools, techniques, and algorithms for Knowledge Discovery and Data Mining (KD&DM). It provides a balanced approach between methods and practice. On the methodological side, it covers several techniques for transforming corporate data into business intelligence. These include: online Analytical Processing (OLAP) Systems, Artificial Neural Networks (ANN), Rule-Based Systems (RBS), Fuzzy Logic (FL), Machine Learning (ML), Classification Trees (C4.5 Algorithm), and Classification and Regression Trees (CART Algorithm). To illustrate the practical significance of the various techniques, half of the course is devoted to case studies. The case studies, drawn from real-world applications, demonstrate application of techniques to real-world problems. Cross-listed with: SOC 550

CS 514   Computer Architecture   (3 - 3 - 0)

Measures of cost, performance, and speedup; instruction set design; processor design; hard-wired and microprogrammed control; memory hierarchies; pipelining; input/output systems; and additional topics as time permits. The emphasis in this course is on quantitative analysis of design alternatives. Cross-listed with: CPE 514, NIS 514 Prerequisites: CS 550, and CS 590 or CS 570

CS 516   Compiler Design and Implementation   (3 - 3 - 0)

In the modern software industry, there is a proliferation of programming languages, especially domain-specific languages, such as Facebook Hack, Google Go, and Mozilla Rust. Therefore, the robustness and security of the software of the future depends on these languages (i) being built from classical compilers foundations and (ii) increasingly incorporating better analysis techniques. This course introduces students to the structure and design of compilers (lexical and syntax analysis, symbol table construction, code generation, etc.) as well as semantic analyses for correctness and security. The emphasis in this course is on the integration of the various parts of a compiler. Students will build a compiler for a small language. Prerequisites: (CS334 or instructor permission) and (CS385 or CS570 or CS590)

CS 519   Introduction to E-commerce   (3 - 3 - 0)

The course provides an understanding of electronic commerce and related architectures, protocols, and technologies. It describes the e-commerce concept, objectives, and market drivers, as well as its requirements and underpinning techniques and technologies, including the Internet, WWW, multimedia, intelligent agents, client-server, and data mining. Security in e-commerce is addressed, including types of security attacks, security mechanisms, Virtual Private Networks (VPNs), firewalls, Intranets, and extranets. Implementation issues in e-commerce, including the design and management of its infrastructure and applications (ERP, CRM, and SCM), are discussed. M-commerce is addressed, electronic payment systems with their associated protocols are described, and various B2C and B2B applications are presented. Also, policy and regulatory issues in ecommerce are discussed. Cross-listed with: SOC 519

CS 520   Introduction to Operating Systems   (3 - 3 - 0)

The use and internals of modern operating systems. Lectures focus on internals, whereas programming assignments focus on use of the operating system interface. Major topics include: the process concept; concurrency and how to program with threads; memory management techniques, including virtual memory and shared libraries; file system data structures; and I/O. Prerequisites: CS 550, and CS 570 or CS 590

CS 521   TCP/IP Networking   (3 - 3 - 0)

Introduction to IP networking. Examination of all layers of the OSI stack. Detailed examination of the IP, ICMP, UDP, and TCP protocols. Basic concepts of network design: end-to-end principle, routing, encapsulation, flow control, congestion control, and security. Detailed coverage of TCP. Some treatment of important Internet applications and services. Emphasis on network layer and above. Assignments focus on protocols and software. Prerequisite: CS 520 or CS 492

CS 522   Mobile Systems and Applications   (3 - 3 - 0)

Personal computing is now mobile and cloud-based. Disconnected mobile computing challenges many of the assumptions underlying much of today's distributed systems. "Cloud computing" provides a powerful background computing facility for mobile devices, but also raises important issues of trust and privacy. Many of these issues arise in critical yet sensitive domains such as electronic healthcare delivery. Mobile computing applications are location-aware or context-aware; the privacy implications of these applications are profound. Mobile, and increasingly location aware, gaming systems are now one of the largest sectors of the world entertainment industry. The purpose of this course is to review the fundamentals of mobile systems and applications, and how they relate to services in the cloud. The course will review material from wireless communication, distributed systems, and security and privacy, as they pertain to the systems being studied. The course will involve programming mobile apps using a popular mobile computing platform, such as Android or iPhone, to get hands-on experience with the concepts being discussed in the class. Programming experience with Java or C# is required. Prerequisite: CS 385 or CS 570 or CS 590

CS 523   Programming the Internet of Things using iOS   (3 - 3 - 0)

The Internet of Things (IoT): architectures and applications, introduces both the broad range of IoT technologies, and the most recent developments in the space, using the popular iOS platform. The course explores modern IoT technologies, architectures and standards by developing key IoT concepts for popular devices (e.g., iPhones, Apple Watch, Apple TV, Amazon Echo or Fitbit or Raspberry Pi), using the iOS Swift programming language. Prerequisites: CS 385 or CS 570 or CS 590, or Under Instructor's permissions

CS 524   Introduction to Cloud Computing   (3 - 3 - 0)

This course introduces the concepts of cloud computing, using the frameworks of software as a service (SaaS), platform as a service (PaaS), and infrastructure as a service (IaaS). Fundamental concepts from each framework are introduced and related to the structure of the modern cloud. Cloud computing: economics of outsourcing. SaaS: The Web as a client-server system. Web stack: HTML and HTTP. Web data: XML and JSON. Web services and example APIs. PaaS: Introduction to databases and middleware. Data storage in the cloud. Privacy issues. IaaS: Design of server farms. Virtualization and green computing. Service discovery: DNS and content distribution networks. Batch processing in the cloud. Assignments include quizzes, examinations, and a presentation and term paper on a cloud-related topic. Cross-listed with: SOC 524 Prerequisites: CS 520 or CS 492

CS 526   Enterprise and Cloud Computing   (3 - 3 - 0)

This course is an introduction to programming and administration of mainframe computers, which are the backbone of modern enterprise computing. Introduction to z/OS and z/VM; protection and virtualization; total cost of ownership (TCO); conversational Monitoring System (CMS); initial program load (IPL) and launching new virtual machines; writing scripts in REXX; interactive z/OS facilities: TSO/E, ISPF and Unix; Unix system services; JCL and SDSF; transaction management using the Java CICS API; and network programming concepts: virtual LANs, open service adapters, and hipersockets. Prerequisite: CS 385 or CS 570 or CS 590

CS 532   3D Computer Vision   (3 - 3 - 0)

Computer vision addresses the image understanding problem; in other words, it aims to infer what was depicted in still images or video based on pixel intensity or color values. Never is the relationship between the depicted scene and images more explicit than in 3D computer vision that aims to extract 3D information from image and video data, as well as other modalities. This course will introduce students to concepts relating 2D images and 3D scenes including single and multiple-view geometry, structure from motion and 3D reconstruction. It will also cover processing of 3D data regardless of its origin starting from point sets and progressing to lines, polygons, Delaunay triangulations and Voronoi diagrams. Students will acquire in depth knowledge of 3D computer vision topics that have moved to the forefront for a broad range of applications in geospatial information systems (Google and Bing maps), robotics and driver assistance, 3D user interfaces (Microsoft Kinect), augmented reality and visual aids for people with impaired sight.

CS 537   Interactive Computer Graphics   (3 - 3 - 0)

This is an introductory-level course to computer graphics. No previous knowledge on the subject is assumed. The objective of the course is to provide a comprehensive introduction to the field of computer graphics, focusing on the underlying theory, and thus providing strong foundations for both designers and users of graphical systems. The course will study the conceptual framework for interactive computer graphics, introduce the use of OpenGL as an application programming interface (API), and cover algorithmic and computer architecture issues. Cross-listed with: CPE 537 Prerequisite: CS 385 or CS 570 or CS 590

CS 538   Visual Analytics   (3 - 3 - 0)

Visual analytics is the combination of data filtering, statistical algorithms, and visual presentation in an interactive visual interface. This course provides an introduction to both information and scientific visualization. Topics include: perception (color, space/order, and depth/occlusion), interaction (navigation, zooming, focus, and context), design studies and evaluation, and data representation (graphs, trees, volumes, and time series). Applications include: software, scientific, financial, and cartographic visualization. Junior, senior, or graduate standing is required. Prerequisite: CS 385 or CS 570 or CS 590

CS 539   Real-Time Rendering, Gaming, and Simulations Programming   (3 - 3 - 0)

The course is an introduction to the techniques for designing and building computer games and real-time graphics-oriented simulations. The topics include: 3-D game engine architecture, design, and implementation; simulation, modeling, and object control; character behavior and behaviorbased animation; human-computer interaction; and event-driven simulations. Prerequisite: CS 537

CS 541   Artificial Intelligence   (3 - 3 - 0)

An introduction to the large and diverse field of artificial intelligence. Topics include: problem-solving by search and constraint satisfaction; alpha-beta search for two-player games; and logic and knowledge representation, planning, learning, decision theory, statistical learning, and computer vision. Prerequisite: CS 385 or CS 570 or CS 590

CS 544   Health Informatics   (3 - 3 - 0)

From medical centers and individual physicians adopting electronic medical records, to patients keeping track of chronic diseases through websites and apps, we live in an era of unprecedented access to health data. These data enable inference of drug side effects, causes of disease, and new treatments, but the new terminologies, policies, and challenges in understanding the data itself can make it difficult for computational researchers to apply their techniques to this new area and for health professionals to begin using informatics to solve practical problems. This course will give both groups the foundation needed to propose, evaluate and develop projects such as secondary analysis of health data and will enable them to begin effective interdisciplinary collaborations. Students will learn how health data is collected (in both hospital and non-hospital settings), how the structure of record systems impacts the research process and interpretation of results, and how to design and evaluate studies involving secondary use of health data (while complying with HIPAA and IRB regulations) in order to gain new medical knowledge and improve healthcare delivery. Cross-listed with: SOC 552

CS 545   Human-Computer Interaction   (3 - 3 - 0)

This is an introduction to Human Computer Interaction (HCI). It covers basic concepts, principles, and frameworks in HCI; models of interaction; and design guidelines and methodologies. The course includes extensive readings and reports, as well as work on projects involving interface design and development. Cross-listed with: SOC 510 Prerequisite: CS 385 or CS 570 or CS 590

CS 546   Web Programming   (3 - 3 - 0)

This course will provide students with a first strong approach of internet programming. It will give the basic knowledge on how the Internet works and how to create advanced web sites by the use of script languages, after learning the basics of HTML. The course will teach the students how to create a complex global site through the creation of individual working modules, giving them the skills required in any business such as proper team work and coordination between groups. Prerequisite: CS 561 or CS 442

CS 548   Enterprise Software Architecture and Design   (3 - 3 - 0)

This course addresses the important engineering issues in building largescale enterprise software systems. The course emphasizes service-oriented architectures (SOA) and best practices for building service-oriented enterprises in a vendor-neutral fashion. Introduction to SOA; BPM; project management, and configuration management; Web services; mainframe services, virtualization, and data integration; application integration; legacy integration; enterprise integration; federal enterprise architecture (FEA); and case studies. Cross-listed with: SOC 542 Prerequisite: CS 385 or CS 570 or CS 590 or CS 605

CS 549   Distributed Systems and Cloud Computing   (3 - 3 - 0)

Developing robust applications in distributed environments. Coursework includes developing a fault-tolerant distributed application. RPC and RMI; Web Services; application servers (e.g., JEE and Websphere). Transactions: concurrency control and recovery, distributed transactions, nested transactions, and business transactions. Models of distributed systems, impossibility results, and Byzantine failures. Protocol design and examples (2PC and 3PC). Distributed snapshots. Logical time and vector clocks. Replication for fault tolerance: primary-backup and state machine approaches, quorum consensus, and process groups. Peer-to-peer networks. Prerequisite: CS 385 or CS 570 or CS 590

CS 550   Computer Organization and Programming   (3 - 3 - 0)

This course provides an intensive introduction to material on computer organization and assembly language programming required for entrance into the graduate program in Computer Science or Computer Engineering. The topics covered are: structure of stored program computers; linking and loading; assembly language programming, with an emphasis on translation of high-level language constructs; data representation and arithmetic algorithms; basics of logic design; processor design: data path, hardwired control and microprogrammed control. Students will be given assembly language programming assignments on a regular basis. Prerequisite: Undergraduates need permission of advisor. Cross-listed with: CPE 550

CS 553   Introduction to Text Mining and Statistical Natural Language Processing   (3 - 3 - 0)

This course will introduce statistical processing of natural language texts, particularly counting words and phrases in and of themselves as well as associations between them using correlations and other measures. Goals of text mining include document classification, information retrieval, source authentication, and stylistic categorization. Typical document sources are newspaper stories, email captures, and Internet pages, as well as collections of non-fiction and fiction such as Federalist Papers and Edgar Allan Poe short stories. Cross-listed with: SOC 553

CS 554   Web Programming II   (3 - 3 - 0)

This course focuses on teaching students the newest technologies available in Web Programming. Topics include advanced client side programming, responsive design, NoSQL databases, JQuery, AJAX, Web Site security, and the latest Frameworks. Students will be given the opportunity to suggest topics they would like to discover at the end of the semester. The course is a very hands-on course where everything taught will be practiced through in-class exercises. Prerequisite: CS 546

CS 555   Agile Methods for Software Development   (3 - 3 - 0)

In software problem areas that require exploratory development efforts, those with complex requirements and high levels of change, agile software development practices are highly effective when deployed in a collaborative, people-centered organizational culture. This course examines agile methods, including Extreme Programming (XP), Scrum, Lean, Crystal, Dynamic Systems Development Method and Feature-Driven Development to understand how rapid realization of software occurs most effectively. The ability of agile development teams to rapidly develop high quality, customer-valued software is examined and contrasted with teams following more traditional methodologies that emphasize planning and documentation. Students will learn agile development principles and techniques covering the entire software development process from problem conception through development, testing and deployment, and will be able to effectively participate in and manage agile software developments as a result of their successfully completing this course. Case studies and software development projects are used throughout. Cross-listed with: SSW 555

CS 557   Introduction to Natural Language Processing   (3 - 3 - 0)

Introduction to the basic theory and current practice for syntactic analysis of documents, written in English, for supervised and unsupervised document classification and information retrieval. The approach extends statistical machine learning to include language models and formal grammars.

CS 558   Computer Vision   (3 - 3 - 0)

An introduction to the field of Computer Vision, focusing on the underlying algorithmic, geometric, and optic issues. The course starts with a brief overview of basic image processing topics (convolution, smoothing, and edge detection). It then proceeds on various image analysis topics: binary images, moments-based shape analysis, Hough transform, image formation, depth and shape recovery, photometry, motion, classification, and special topics. Cross-listed with: CPE 558 Prerequisites: MA 232, and CS 385 or CS 570 or CS 590

CS 559   Machine Learning: Fundamentals and Applications   (3 - 3 - 0)

In many fields (e.g., computer vision, speech recognition, data mining, and bioinformatics), machine learning has become a crucial ingredient in translating research into applications. The course is intended to provide an in-depth overview of recent advances in machine learning, with applications in fields such as computer vision, data mining, natural language processing. Fundamental topics that will be covered include supervised (Bayesian) and unsupervised learning, non-parametric methods, graphical models (Bayes Nets and Markov Random Fields) and dimensionality reduction. The course will also cover several of the most important recent developments in learning algorithms, including boosting, Support Vector Machines and kernel methods, and outline the fundamental concepts behind these approaches. Prerequisite: MA 222

CS 560   Statistical Machine Learning   (3 - 3 - 0)

Machine learning aims to extract useful information from the data, and to build an accurate model on top of the extracted information for future prediction. There are two important aspects that have to be taken into account for a machine learning problem: how can we develop computationally efficient algorithms to learn useful information, and what is the prediction performance of the algorithm on unseen data. More importantly, is it possible to achieve the best of the two worlds, or there has to be some trade-off. This course will introduce students to concepts relating the computational efficiency and the statistical accuracy for a broad range of problems, including regression, classification, clustering, adaptive learning, to name a few. It will cover popular numerical methods that carry out state-of-the-art performance on the computational side, and it will also discuss possible improvement in the price of estimation accuracy and memory usage. The goal of the course is to help students understand these trade-offs from a theoretical perspective and guide them to design near-optimal algorithms for real-world problems. Prerequisites: MA 232, MA 222 and CS 559 for undergraduate students OR CS 559 for graduate students

CS 561   Database Management Systems I   (3 - 3 - 0)

Introduction to the design and querying of relational databases. Topics include: relational schemas; keys and foreign key references; relational algebra (as an introduction to SQL); SQL in depth; Entity-Relationship (ER) database design; translating from ER models to relational schemas and from relational schemas to ER models; functional dependencies; and normalization. Prerequisite: CS 590 or CS 570

CS 562   Database Management Systems II   (3 - 3 - 0)

Continuation of CS 561. Topics include UML modeling of relational databases; indexing, both static and dynamic; B-trees and B+-trees; query optimization; concurrency control; and recovery control. Prerequisite: CS 561

CS 566   Smartphone and Mobile Security   (3 - 3 - 0)

Mobile devices have evolved and experienced an immense popularity over the last few years, becoming the de-facto computing and communication devices of tomorrow. Nevertheless, this growth has exposed mobile devices to an increasing number of security threats. More specifically, sophisticated, and powerful OSs, such as Android and iOS, new wireless communication technologies, and ambiguous mobile services can bring new opportunities to attackers towards compromising both device, and data stored on it. This, along with the rise of mobile malwares is anticipated to comprise a serious threat in the near future. This course aims on the aspects of information and network security that come to light in this challenging and evolving field of mobile communication systems, focusing not only on smartphones and mobile telecommunication security, but also including aspects of mobile ad hoc, and sensor networks. Prerequisites: (CS 385 and CS 306) or ((CS 570 or CS590) and CS 506) or Under Instructor's permissions

CS 568   Software Development Project I   (3 - 3 - 0)

This course provides a conceptual framework and practical experience in a full range of software development and assessment activities from a software systems engineering approach. By examining real-world examples and employing professionally accepted techniques, students will understand issues confronting software practitioners and the wider public. Undergraduate students whose program requires CS 423 and CS 424 may not take this course for credit.

CS 569   Software Development Project II   (3 - 3 - 0)

Students will work in teams on a software development project that was begun in CS568. In this course they will re-baseline the following documents: operational concept, requirements, architecture, life cycle plan, and feasibility argument and will execute its implementation and deployment. Undergraduate students in the computer science department.

CS 570   Data Structures   (3 - 3 - 0)

This is a course on standard data structures, including sorting and searching and using the Java language. The topics include: programming; testing; recursion; elementary data structures (lists, stacks, queues, and maps); use of elementary data structures in application frameworks; searching; sorting; and introduction to asymptotic complexity analysis.

CS 571   Java   (3 - 3 - 0)

The course consists of an in-depth discussion of Java language and programming techniques. Comparison of Java to other languages, such as C/C++, is made throughout the course to emphasize various shortcomings of the language and their implications on design paradigms. Some aspects of GUI libraries, multithreading support, and Java native interface are also discussed. Not for undergraduate credit in Computer Science, Computer Engineering, Cybersecurity, and Information Systems degree programs.

CS 573   Fundamentals of CyberSecurity   (3 - 3 - 0)

This course studies the mathematical models for computer security (Bell- LaPadula, Clark-Wilson, Biba, and Gligor models). It analyzes and compares, with respect to formal and pragmatic criteria, the properties of various models for hardware, software, and database security. Topics also include: formal specification and verification of security properties, operating system security, trust management, multi-level security, security labeling, security auditing and intrusion detection, security policy, safeguards and countermeasures, risk mitigation, covert channels, identification and authentication, password schemes, access control lists, and data fusion techniques. The course includes a project. Prerequisite: CS 385 or CS 570 or CS 590

CS 574   Object-Oriented Analysis and Design   (3 - 3 - 0)

Theory of object-oriented design, classes, interfaces, inheritance hierarchy, and correctness; abstract data types, encapsulation, formal specification with preconditions, postconditions and invariants, and proofs of correctness; object-oriented software, objects and classes, genericity, inheritance, polymorphism, and overloading; single and multiple inheritance, programming by contract, subclassing as subcontract, specification, and verification; programming language examples include C+ +, Java, Smalltalk, and Eiffel. Prerequisite: CS 385 or CS 570 or CS 590

CS 576   Systems Security   (4 - 3 - 1)

This course will cover a wide range of topics in the area of Systems Security. A computer system is composed by software, hardware, policies, and practices. Systems security involves both designing and building secure systems, as well as improving and evaluating the security of exiting systems. This course is giving a particular emphasis into providing hands-on experience to students through building, attacking, and securing systems. The class is programming intensive. Those who take the class should be skill programmers and should have some experience with the C programming language and programming on a Linux environment. It is recommended that students are also familiar with the assembly language and with network and operating system basics. Prerequisites: (CS 392 and CS 306) or CS 631

CS 577   Reverse Engineering and Application Analysis   (4 - 3 - 1)

Software in binary form reveals very little about its design, inner workings, and purpose. There are many reasons for obtaining such information, such as recovering information about the software's development when it is lost, enabling interoperability, recovering data stored in obsolete encodings, analyzing software of unknown provenance, retrofitting software with additional functionality, etc. This course introduces students to the techniques involved in software reverse engineering and analysis. The course goes over multiple architectures, but mostly focuses on x86 and x86_64, and students are exposed to both static and dynamic analyses. This course is giving a particular emphasis into providing hands-on experience to students through disassembling, reverse engineering software, and programming custom analyses. Those who take the class should be skilled programmers and should not be afraid to dive deep into low-level code. Prerequisites: (CS 392 and CS 306) or CS 631

CS 578   Privacy in a Networked World   (3 - 3 - 0)

Increasing use of computers and networks in business, government, recreation, and almost all aspects of daily life has led to a proliferation of online sensitive data that, if used improperly, can harm the data subjects. As a result, concern about the ownership, control, privacy, and accuracy of these data has become a top priority. This course focuses on both the technical challenges of handling sensitive data and the policy and legal issues facing data subjects, data owners, and data users. This course is suitable for advanced undergraduate computer science majors, graduate students in computer science, and students in technology management or other majors with some computer science background. Course readings draw on a variety of sources, including both technical materials and the popular press. Cross-listed with: SOC 551 Prerequisites: CS 579 or CS 594 or CS 306 or CS 506

CS 579   Foundations of Cryptography   (3 - 3 - 0)

This course provides a broad introduction to cornerstones of security (authenticity, confidentiality, message integrity, and non-repudiation) and the mechanisms to achieve them as well as the underlying mathematical basics. Topics include: block and stream ciphers, public-key systems, key management, certificates, public-key infrastructure (PKI), digital signature, non-repudiation, and message authentication. Various security standards and protocols such as DES, AES, PGP, and Kerberos, are studied. Cross-listed with: CPE 579 Prerequisites: CS 503, and CS 385 or CS 570 or CS 590

CS 581   Online Social Networks   (3 - 3 - 0)

The technical issues involved in modern internet and online social networks. Basic social network terminology; properties of social networks: connectivity, long tail, network effects; and how these properties affect real life software systems, e.g.: blogs, wikis, social bookmarks and tagging, folksonomy, and online social networks. Students will learn programming with online social networking APIs: OpenSocial, Facebook, and Twitter. They shall also develop an appreciation of ethical, legal, and technical issues like privacy, anonymity, and authentication inherent in online social network applications. Course includes a term project resulting in a social networking application that uses the social networking APIs to operate on one of the popular social software platforms. Prerequisites: CS 392, and CS 385 or CS 570 or CS 590

CS 582   Causal Inference   (3 - 3 - 0)

This course covers what causality is, how we can infer it using automated methods, and how to use causes to predict future events, explain past occurrences and intervene on systems. Students will learn both the theory behind causal inference methods as well as how to apply them to real-world datasets such as from finance, biology, and politics. In addition to Bayesian networks, we will cover methods for causal inference in time series including dynamic Bayesian networks, Granger causality, and logic-based methods. Cross-listed with: SOC 582

CS 583   Deep Learning   (3 - 3 - 0)

Deep learning (DL) is a family of the most powerful and popular machine learning (ML) methods and has wide real-world applications such as face recognition, machine translation, self-driving car, recommender system, playing the Go game, etc. This course is designed for students either with or without ML background. The course will cover fundamental ML, computer vision, and natural language problems and DL tools for solving the problems. The students will be able to use DL methods for solving real-world ML problems. The homework is mostly implementation and programming using the Python language and popular DL frameworks such as TensorFlow and Keras. Knowledge and skills in Python programming and linear algebra are strictly required. Probability theory, statistics, and numerical analysis are recommended by not required. Knowledge in machine learning and artificial intelligence is helpful but unnecessary.

CS 584   Natural Language Processing   (3 - 3 - 0)

Natural language processing (NLP) is one of the most important technologies in the era of information. Comprehending human language is also a crucial and challenging part of artificial intelligence. People communicate almost everything in language: conferences, emails, customer service, language translation, web searches, reports, etc. There are a large variety of underlying tasks and machine learning models behind NLP applications. Recently, deep learning approaches have achieved high performance in many different NLP tasks. Instead of traditional and task-specific feature engineering, deep learning can solve tasks with single end-to-end models. The course provides an introduction to machine learning research applied to NLP. We will cover topics including word vector representations, neural networks, recurrent neural networks, convolutional neural networks, semi-supervised models, reinforcement learning for NLP, as well as some attention-based models. Prerequisites: MA 232 and MA 222 for undergraduate students OR instructor permission for graduate students.

CS 590   Algorithms   (3 - 3 - 0)

This is a course on more complex data structures, and algorithm design and analysis, using one or more modern imperative language(s), as chosen by the instructor. Topics include: advanced and/or balanced search trees; hashing; further asymptotic complexity analysis; standard algorithm design techniques; graph algorithms; complex sort algorithms; and other "classic" algorithms that serve as examples of design techniques. Cross-listed with: CPE 590 Prerequisite: CS 570

CS 593   Data Mining II: Advanced Algorithms for Mining Big Data   (3 - 3 - 0)

The recently introduced terminology of Big Data refers to data sets whose volume (amount of data collected, number of data sources), velocity (rate at which data is collected) and variety (heterogeneity of data and data sources) are so extreme that advanced data mining algorithms are needed to process and discover useful patterns in data for actionable intelligent decisions, in a reasonable amount of time. Cross-listed with: SOC 593

CS 594   Enterprise and Cloud Security   (3 - 3 - 0)

This course considers security and privacy from the perspective of enterprise and cloud applications. An underlying theme of the course is risk analysis for managing information security. The OCTAVE Allegro approach is considered as an example risk management process. Identity management, e.g., OpenID and SAML. Access control, e.g., RBAC, OAuth and XACML. Private and public key cryptography, and their use in secure Web services. WS-Security vs REST security. Multilevel and multilateral security: Bell-Lapadula, Biba, Clark-Wilson, Chinese Wall, BMA, information flow control (IFC). Network security: Firewalls, intrusion detection and honeynets, denial of service, worms and botnets. Cyber forensics: evidentiary requirements of forensics analysis after attacks have been detected. Finally, security and privacy aspects of cloud computing are considered. All security concepts are covered from first principles. Assignments involve building secure enterprise applications, including secure Web services and PKI. Cross-listed with: SOC 594 Prerequisites: CS526 or CS548 or CS549 or permission of instructor.

CS 595   Information Security and the Law   (3 - 3 - 0)

This course provides an in-depth coverage of the state and federal laws that concern information security and various areas of application. Topics include the American legal system; federal privacy regulations; information security in education, healthcare, and corporate environments; breach notification laws; intellectual property law; security governance; legal aspects of risk analysis, incident response, and contingency planning; as well as regulations in the global context. Prerequisites: CS306 or CS506 or CS594 or FIN545

CS 596   Introduction to Windows Programming   (3 - 3 - 0)

This course covers programming for the Windows system environment using current Microsoft tools and technologies. The course emphasizes inter-process communication and synchronization techniques as well as explaining advanced memory management, file handling and asynchronous I/O, multi-threaded processes, and techniques applicable to high-performance and large-scale software systems. Prerequisite: CS 392 or CS 631

CS 597   User Exp Design & Programming   (3 - 3 - 0)

This course targets how to create, design, code and evaluate effective, efficient and enjoyable user experiences using both standard and emerging techniques. It explores psychological and computational foundations, fundamental concepts, task analysis and requirements analysis. The course emphasizes design, implementation and evaluation and encourages extensive use of design patterns in the design and construction of user experiences. This is truly an interactive course in all ways with demonstrations and exercises drawn from real and virtual worlds. At the end of the course the student should have a heightened appreciation of coding and evaluating user experiences in the real and virtual worlds.

CS 598   Visual Information Retrieval   (3 - 3 - 0)

Visual information retrieval studies the processing, indexing, querying, organization, classification, search, and browsing of visual information from images, videos, and other new emerging visual media. This course will cover traditional techniques as well as recent advances in visual information retrieval, especially under the context of web-scale image and video search. Students will acquire in-depth knowledge on state-of-the-art algorithms and technologies to transform unstructured visual data into structured representation for indexing and retrieval. These algorithms and technologies have empowered a broad range of applications in internet image and video search engine mobile augmented reality, location recognition, and online shopping, etc. Prerequisite: CS 385 or CS 570 or CS 590

CS 600   Advanced Algorithm Design and Implementation   (3 - 3 - 0)

Design, implementation, and asymptotic time and space analysis of advanced algorithms, as well as analyzing worst-case and average-case complexity of algorithms. Students will be expected to run experiments to test the actual performance of the algorithms on sample inputs. Introduction to NP-complete problems and approximation algorithms. Cross-listed with: CPE 600 Prerequisites: CS 135 or MA 502, and CS 385 or CS 570 or CS 590

CS 601   Algorithmic Complexity   (3 - 3 - 0)

Analysis of algorithms: resource-bounded computation and time and space complexity. Various models of computation will be studied. Complexity classes and reducibilities, hardness, and completeness. Randomized algorithms and approximation algorithms. Prerequisite: CS 600

CS 609   Data Management and Exploration on the Web   (3 - 3 - 0)

This course is an advanced graduate course on database systems and data exploration on Web. It covers a few key current research topics in database systems and Web data exploration including: (1) information retrieval (IR) from Web, (2) semi-structured XML databases from the perspective of theory (thus accompanies the application-centric software engineering courses that uses XML), and (3) Web information integration. This course is suitable for advanced undergraduate computer science majors, graduate students in computer science, and students in technology management or other majors with some computer science background. Course readings are drawn from the recent top-tier international database conferences and journals. Prerequisite: CS 561 or CS 442

CS 615   Systems Administration   (3 - 3 - 0)

This course covers some of the most essential aspects of systems administration, giving students the opportunity to develop the skills necessary to analyze and troubleshoot problems arising in every day usage of networked computer systems, applying equally to single-user systems, as well as to large-scale installations. Some of the topics covered include: hardware configuration, operating system installation, shell programming, security policies, back-up deployment and disaster recovery, network design, software installation and maintenance, operating system tuning, and best practices for problem determination. Security topics including packet sniffers and spoofers, buffer overflow attacks and stack protection, and firewalls and intrusion detection are also covered, with an emphasis on their implementation. Students are expected to be comfortable in a Unix-like environment on a user level and have a solid understanding of TCP/IP networking and operating system concepts. Prerequisite: CS 520 or CS 492

CS 631   Advanced Programming in the UNIX Environment   (3 - 3 - 0)

In this course, students will learn to develop complex system-level software in the C programming language while gaining an intimate understanding of the UNIX family of operating systems and their programming environment. Topics covered will include the user/kernel interface, fundamental concepts of UNIX, user authentication, basic and advanced I/O, file systems, signals, process relationships, and interprocess communication. Fundamental concepts of software development and maintenance on UNIX systems (development and debugging tools such as "make" and "gdb") will also be covered. Prerequisite: CS 520

CS 638   Advanced Computer Graphics   (3 - 3 - 0)

Mathematical foundations and algorithms for advanced computer graphics. Topics include 3-D modeling, texture mapping, curves and surfaces, physics-based modeling, and visualization. Special attention will be paid to surfaces and shapes. The class will consist of lectures and discussion on research papers assigned for reading. In class, we will study the theoretical foundations and algorithmic issues. In programming assignments, we will use OpenGL as the particular API for writing graphics programs. C/C++ programming skills are essential for this course. Cross-listed with: CPE 638 Prerequisite: CS 537

CS 643   Formal Verification of Software   (3 - 3 - 0)

Formal systems for specification and verification of software; review of the first-order predicate calculus; abstract data types, formal specification, preconditions, postconditions, invariants, predicate transformers, proofs of correctness, and partial and total correctness; correctness for assignments, alternatives, iterations, and procedure calls. Tools for deductive verification, model checking, and analysis of specifications and models. Prerequisite: CS 600

CS 665   Forensic Analysis   (3 - 3 - 0)

Forensics involves the identification, preservation, and analysis of evidence of attacks in order to identify attackers and document their activity with sufficient reliability to justify appropriate technological, business, and legal responses. This course focuses on the technological and not on the legal components of the topic. The technical aspects will focus on analyzing both network and host data. This includes review of network traffic logs (pcap, flow records) and profiles and their types, identification of attack signatures and fingerprints, study of various traceback methods, application of data mining techniques, and the extraction of information (e.g., from malware, including botnet traffic) acquired through the use of network analysis tools and techniques, recovering evidence left behind, and technologies that can be used to assist in the analysis of obtained data or in obtaining more data. We will look into methodologies for recovering data from persistent storage and memory. Investigate the use of virtual machines in providing auditing capabilities to analysts and in setting traps for attackers. The class will not only cover the subjects in theory but instead also provide the students with an extensive hands-on experience. The class will involve a fair amount of programming. Prerequisites: (CS 392 and CS 306) or CS 631

CS 676   Advanced Topics in Systems Security   (3 - 3 - 0)

This course covers a wide range of advanced topics in the area of Systems Security. A computer system is composed by software, hardware, policies, and practices. Systems security involves both designing and building secure systems, as well as improving and evaluating the security of existing systems. During this course, students will study and present in the classroom recent papers in the area of systems security, write a literature survey on a particular topic, and work on a semester-long project, which will involve designing, implementing, and evaluating a system. Those who take the class should be skilled programmers and should already have some knowledge in the area of systems security. Prerequisite: CS 576

CS 677   Parallel Programming for Many-core Processors   (3 - 3 - 0)

The course covers advanced architectures and programming techniques for visual computing and machine learning and their applications in gaming, simulation, data analysis and visualization. This class covers the architecture and programming of multicore processors and graphical processing units and associated programming frameworks and languages, for example, CUDA and OpenCL. The course will cover a wide range of applications including real-time rendering of populations and scenario developments in large scale dynamic environments, machine learning and computer vision algorithms for recognition and tracking, large scale dynamic scientific visualizations. Prerequisite: CS 537

CS 691   Introduction to Systems Biology   (3 - 3 - 0)

Systems biology is a new approach to complex biological problems. It uses a combination of the most modern techniques for comprehensive measurements of cells and molecules, combined with complex computer and mathematical modeling, to build up inclusive depictions of how living systems function. This course is an integrative approach to help comprehend dynamic biological systems. True understanding of systems biology requires a cross-disciplinary approach. Topics will include both a biological and computer science perspective taught by experts in each individual discipline. The course will cover introduction to advance biological subjects in cell biology and genetics followed by introduction to computer science methods including modeling and "bio-machine" features of systems biology. In class, we will also explore critical reading of current research. Cross-listed with: CH 691

CS 693   Cryptographic Protocols   (3 - 3 - 0)

This course covers the design and analysis of security protocols, and studies different attacks and defenses against them. Topics include: signature and authentication protocols, privacy, digital rights management, security protocols for wired, wireless and distributed networks, electronic voting, payment and micropayment protocols, anonymity, broadcast encryption and traitor tracing, quantum cryptography, and visual cryptography. The course includes a project. Cross-listed with: CPE 693 Prerequisite: CS 579

CS 694   Advanced Computational Modeling in Biology and Biomaterials Science   (3 - 3 - 0)

This course introduces different modeling techniques and explores computational modeling using real lab data. The course is project based. Students will be able to design and implement a computational model using lab data, predict the behavior of the system being modeled, and use a second set of experimental results to validate the model.

CS 696   Database Security   (3 - 3 - 0)

This course is an advanced graduate course that provides an up-to-date overview of data security models, techniques, and architectures in a variety of data management applications and settings. It will cover some of the most comprehensive work on database security, with the covered topics as: (1) access control policies and mechanisms for both relational and structured databases, (2) database integrity auditing techniques, (3) database watermarking, and (4) security in distributed database management systems. Prerequisites: (CS 306 Introduction to IT Security or CS 506 Introduction to IT Security) and (CS 561 Database Management Systems I or CS 442 Database Management Systems)

CS 701   CS Co-Op Education Project   (0 - 0 - 0)

This course is for CS students who are on a Co-Op assignment.

CS 703   Curricular Practical Training   (1 or 2 - 0 - 0)

International graduate students may arrange an educationally relevant internship or paying position off campus and receive Curricular Practical Training (CPT) credit via this course. Students must maintain their full time status while receiving CPT. Prior approval of the program director is required for enrollment. To justify enrollment, the student must have a concrete commitment from a specific employer for a specific project, and must provide to the program director for his/her approval a description of the project plus a statement from the employer that he/she intends to employ the student. This information must be provided to the program director with sufficient advance notice so that the program director has time to review the materials and determine if the project is appropriate. The project must be educationally relevant; i.e., it must help the student develop skills consistent with the goals of the educational program. During the semester, the student must submit written progress reports. At the end of the semester, the student must submit for grading a written report that describes his/her activities during that semester, even if the activity remains ongoing. The student must also present his/her activities in an accompanying oral presentation that is also graded. This is a one-credit course that may be repeated for up to a total of three credits. At the discretion of the CPT director, the course may be taken for two credits. Cross-listed with: SOC 703

CS 800   Special Problems in Computer Science (M.S.)   (1 to 6 - -)

An investigation of a current research topic at the pre-master's level, under the direction of a faculty member. A written report is required, which should have the substance of a publishable article. Students with no practical experience who do not write a master's thesis are invited to take advantage of this experience. One to six credits for the degree of Master of Science (Computer Science).

CS 801   Special Problems in Computer Science (Ph.D.)   (1 to 6 - -)

An investigation of a current research topic beyond that of CS 800 level, under the direction of a faculty member. A written report is required, which should have importance in Computer Science and should have the substance of a publishable article. This course is open to students who intend to be doctoral candidates and wish to explore an area that is different from the doctoral research topic. One to six credits for the degree of Doctor of Philosophy.

CS 802   Software Engineering Examination   (6 - 0 - 0)

This will test the software engineering knowledge of students who have completed Stevens Institute of Technology-approved training programs in software engineering. Upon successful completion (graded pass/fail), students will be awarded six credits towards the Master of Quantitative Software Engineering on their study plan and three on the approval form for the certificate of Quantitative Software Engineering. To obtain a pass in this course, the student is required to demonstrate proficiency equivalent to a grade of 'B' (i.e. 3.0 out of 4.0) or higher. These credits are not transferable to other institutions.

CS 803   Special Problems in Computer Science (Engineer Degree)   (1 to 6 - -)

An investigation of a current research topic under the direction of a faculty member. One to six credits to fulfil the Engineer Degree requirements only.

CS 810   Special Topics in Computer Science   (3 - -)

A participating seminar on topics of current interest and importance in computer science. Open to both undergraduates and graduate students.

CS 900   Thesis in Computer Science (M.S.)   (1 to 10 - -)

Original research of a significant character carried out under the guidance of a member of the departmental faculty, which may serve as the basis for the dissertation, is required for the degree of Doctor of Philosophy. Credits to be arranged.

CS 950   Design Project   (1 - 1 - 0)

Design project required for the degree of Engineer in Computer Science. One to 12 credits. Course may be repeated for credit up to a total of 12 credits.

CS 960   Research in Computer Science(Ph.D.)   (- -)

Original research of a significant character carried out under the guidance of a member of the departmental faculty, which may serve as the basis for the dissertation, is required for the degree of Doctor of Philosophy. Hours and credits to be arranged.

Service Oriented Computing

SOC 501   Introduction to JAVA Programming   (3 - 3 - 0)

An introduction to the Java programming language for those students who have little or no programming background. It is intended as an elective for the Master of Science in Information Systems to be taken near the end of the program. Basic topics considered will be programs and program structure in general and Java syntax, data types, flow of control, classes, methods and objects, arrays, exception handling, and recursion. In addition, the use of Java in enterprise-wide computing and distributed systems will be introduced by considering APIs in general, and the ones specific to JDBC and the Java security features in particular. Not for credit for Computer Science department undergraduate majors. Cross-listed with: CS 501

SOC 510   Human-Computer Interaction   (3 - 3 - 0)

This is an introduction to Human Computer Interaction (HCI). It covers basic concepts, principles, and frameworks in HCI; models of interaction; and design guidelines and methodologies. The course includes extensive readings and reports, as well as work on projects involving interface design and development. Cross-listed with: CS 545 Prerequisite: CS 590 or CS 385

SOC 512   Online Social Networks for Service Oriented Computing   (3 - 3 - 0)

The objective of this course is to educate students in the design, implementation, and analysis of on-line social networks, from the viewpoint of software as a service. This course introduces basic concepts and results in graph theory and game theory, and demonstrates their application in reasoning about social networks. Privacy and security aspects of social networks are also considered. Course work includes developing a social network application and analyzing data harvested from social networks. Prerequisite: SOC 605 or permission of instructor.

SOC 519   Introduction to E-commerce   (3 - 3 - 0)

The course provides an understanding of electronic commerce and related architectures, protocols, and technologies. It describes the e-commerce concept, objectives, and market drivers, as well as its requirements and underpinning techniques and technologies, including the Internet, WWW, multimedia, intelligent agents, client-server, and data mining. Security in e-commerce is addressed, including types of security attacks, security mechanisms, Virtual Private Networks (VPNs), firewalls, Intranets, and extranets. Implementation issues in e-commerce, including the design and management of its infrastructure and applications (ERP, CRM, and SCM), are discussed. M-commerce is addressed, electronic payment systems with their associated protocols are described, and various B2C and B2B applications are presented. Also, policy and regulatory issues in ecommerce are discussed. Cross-listed with: CS 519

SOC 521   Software Requirements Acquisition and Analysis   (3 - 3 - 0)

Requirements acquisition is one of the least understood and hardest phases in the development of software products, especially because requirements are often unclear in the minds of many or most stakeholders. This course deals with the identification of stakeholders, and the elicitation and verification, with their participation, of the requirements for a new or to-be-extended software product. It deals further with the analysis and modeling of requirements, the first steps in the direction of software design. Finally, it deals with the quality assurance aspects of the software requirements phase of the software development process. This course is case-history and project-oriented, and uses industry-standard software tools. Cross-listed with: CS 564 Prerequisite: SOC 606

SOC 524   Introduction to Cloud Computing   (3 - 3 - 0)

This course introduces the concepts of cloud computing, using the frameworks of software as a service (SaaS), platform as a service (PaaS), and infrastructure as a service (IaaS). Fundamental concepts from each framework are introduced and related to the structure of the modern cloud. Cloud computing: economics of outsourcing. SaaS: The Web as a client-server system. Web stack: HTML and HTTP. Web data: XML and JSON. Web services and example APIs. PaaS: Introduction to databases and middleware. Data storage in the cloud. Privacy issues. IaaS: Design of server farms. Virtualization and green computing. Service discovery: DNS and content distribution networks. Batch processing in the cloud. Assignments include quizzes, examinations, and a presentation and term paper on a cloud-related topic. Cross-listed with: CS 524

SOC 542   Enterprise Software Architecture and Design   (3 - 3 - 0)

This course addresses the important engineering issues in building largescale enterprise software systems. The course emphasizes service-oriented architectures (SOA) and best practices for building service-oriented enterprises in a vendor-neutral fashion. Introduction to SOA; BPM; project management, and configuration management; Web services; mainframe services, virtualization, and data integration; application integration; legacy integration; enterprise integration; federal enterprise architecture (FEA); and case studies. Cross-listed with: CS 548 Prerequisites: CS 590, CS 385

SOC 550   Knowledge Discovery and Data Mining   (3 - 3 - 0)

This course introduces fundamental and practical tools, techniques, and algorithms for Knowledge Discovery and Data Mining (KD&DM). It provides a balanced approach between methods and practice. On the methodological side, it covers several techniques for transforming corporate data into business intelligence. These include: online Analytical Processing (OLAP) Systems, Artificial Neural Networks (ANN), Rule-Based Systems (RBS), Fuzzy Logic (FL), Machine Learning (ML), Classification Trees (C4.5 Algorithm), and Classification and Regression Trees (CART Algorithm). To illustrate the practical significance of the various techniques, half of the course is devoted to case studies. The case studies, drawn from real-world applications, demonstrate application of techniques to real-world problems. Cross-listed with: CS 513

SOC 551   Privacy in a Networked World   (3 - 3 - 0)

Increasing use of computers and networks in business, government, recreation, and almost all aspects of daily life has led to a proliferation of online sensitive data that, if used improperly, can harm the data subjects. As a result, concern about the ownership, control, privacy, and accuracy of these data has become a top priority. This course focuses on both the technical challenges of handling sensitive data and the policy and legal issues facing data subjects, data owners, and data users. This course is suitable for advanced undergraduate computer science majors, graduate students in computer science, and students in technology management or other majors with some computer science background. Course readings draw on a variety of sources, including both technical materials and the popular press. Cross-listed with: CS 578 Prerequisite: CS 579 or CS 594 or CS 306

SOC 552   Health Informatics   (3 - 3 - 0)

This course integrates computer science and health informatics. It is the capstone course for students in the service-oriented computing program who choose the health informatics application domain. The course covers the history of health informatics, including discussions of protocols and standards, such as OSI, UDEF, and HL7; review of information access and evaluation, health care terminology and health care economics, and looks at system selection and evaluation in the areas of telemedicine, dental informatics, consumer health informatics, and hospital/clinical informatics. Special attention is given to Web services and mobile computing as they relate to the health care industry. The course includes extensive readings. Cross-listed with: CS 544 Prerequisites: CS 548, SOC 542

SOC 553   Introduction to Text Mining and Statistical Natural Language Processing   (3 - 3 - 0)

This course will introduce statistical processing of natural language texts, particularly counting words and phrases in and of themselves as well as associations between them using correlations and other measures. Goals of text mining include document classification, information retrieval, source authentication, and stylistic categorization. Typical document sources are newspaper stories, email captures, and Internet pages, as well as collections of non-fiction and fiction such as Federalist Papers and Edgar Allan Poe short stories. Cross-listed with: CS 553 Prerequisite: SOC 605

SOC 582 Causal Inference (3 - 3 - 0)

This course covers what causality is, how we can infer it using automated methods, and how to use causes to predict future events, explain past occurrences and intervene on systems. Students will learn both the theory behind causal inference methods as well as how to apply them to real-world datasets such as from finance, biology, and politics. In addition to Bayesian networks, we will cover methods for causal inference in time series including dynamic Bayesian networks, Granger causality, and logic-based methods. Cross-listed with: CS 582

SOC 585 Introduction to Game Development (3 - 3 - 0)

The course will provide the students with: (i) A theoretical understanding of the principles, concepts, and structures underlying game designs; (ii) An analysis of game specific engineering frameworks and architectures including software and hardware architectures, game play mechanics, design documentation, and production methodology; (iii) An introduction to the innovation processes and skills neeed to formulate a viable design and take it from the idea stage to a published game. Cross-listed with: CS 585 Prerequisite: CS 385 or CS 570 or CS 590

SOC 593 Data Mining II: Advanced Algorithms for Big Data (3 - 3 - 0)

The recently introduced terminology of Big Data refers to data sets whose volume (amount of data collected, number of data sources), velocity (rate at which data is collected) and variety (heterogeneity of data and data sources) are so extreme that advanced data mining algorithms are needed to process and discover useful patterns in data for actionable intelligent decisions, in a reasonable amount of time. Cross-listed with: CS 593

CS 594 Enterprise and Cloud Security (3 - 3 - 0)

This course addresses the security of e-business and cyber environments from an end-to-end perspective, including data center security and access security. The information security phases of inspection, protection, detection, reaction, and reflection are emphasized. Topics also include: server and application security, virtual local area networks (VLANs), secure access and financial transaction techniques, and backup and disaster recovery techniques. The course also reviews financial Electronic Data Interchange (EDI) and smart card security in banking applications, and describes how the business and financial risks associated with security are estimated and managed. The course includes a project and related lab experiments. Cross-listed with: CS 594 Prerequisite: CS526 or CS548 or CS549 or permission of instructor.

SOC 605 Introduction to Service -Oriented Computing (3 - 3 - 0)

This is an introduction to the field of service-oriented computing, in the context of a first course in computer programming, for students with no prior experience. Students will learn the core process of programming: given a problem statement, how does one design an algorithm to solve that particular problem and then implement the algorithm in a computer program? The course will also introduce elementary programming concepts like basic control concepts (such as conditional statements and loops) and a few essential data types. The notions of objects and object creation will also be introduced. The course will involve programming assignments using a self-contained user-friendly programming environment.

SOC 606 Introduction to Developing Internet Applications (3 - 3 - 0)

This is a survey course of techniques and technologies for developing Internet applications, particularly for the Web. Web servers and security; three-tier client server architectures; database design and administration; and server- and client-side scripting in Web applications. The course also introduces basic software engineering principles and practices, including project management, requirements acquisition, design, testing and configuration management, reliability, security, and risk management. Prerequisite: SOC 605 Corequisite: SOC 611

SOC 611 Fundamentals of Service Oriented Computing (3 - 3 - 0)

This course introduces students to the infrastructure underlying the Web, including protocols and mark-up languages. It also addresses the question of how one presents large volumes of information to people who need to find out what they are looking for quickly. The scope of the course ranges from mechanics to aesthetics. Social and ethical issues are also discussed, including the concept of information ecologies for social acceptance. Networks and protocols; pervasive computing; Web protocols; markup languages and XML; defining information architecture; understanding information needs and information-seeking behaviors; organizing Web sites and intranets; navigation systems; search systems; thesauri; from research to design: strategies for information architecture; enterprise information architecture; ethics on the Web; and information ecologies.

SOC 703   Curricular Practical Training   (1 or 2 - 0 - 0)

International graduate students may arrange an educationally relevant internship or paying position off campus and receive Curricular Practical Training (CPT) credit via this course. Students must maintain their full time status while receiving CPT. Prior approval of the program director is required for enrollment. To justify enrollment, the student must have a concrete commitment from a specific employer for a specific project, and must provide to the program director for his/her approval a description of the project plus a statement from the employer that he/she intends to employ the student. This information must be provided to the program director with sufficient advance notice so that the program director has time to review the materials and determine if the project is appropriate. The project must be educationally relevant; i.e., it must help the student develop skills consistent with the goals of the educational program. During the semester, the student must submit written progress reports. At the end of the semester, the student must submit for grading a written report that describes his/her activities during that semester, even if the activity remains ongoing. The student must also present his/her activities in an accompanying oral presentation that is also graded. This is a one-credit course that may be repeated for up to a total of three credits. At the discretion of the CPT director, the course may be taken for two credits. Cross-listed with: CS 703

SOC 810   Special Topics in Service Oriented Computing   (3 - -)

A participating seminar on topics of current interest and importance in Service Oriented Computing.

Department of Electrical & Computer Engineering

FACULTY

MIN SONG
DEPARTMENT CHAIR

Sergul Aydore, Ph.D.
Assistant Professor

Rajarathnam Chandramouli, Ph.D.
Hattrick Chair Professor

Cristina Comaniciu, Ph.D.
Associate Professor,
Associate Department Director, Graduate Programs

Nariman Farvardin, Ph.D.
Professor, IEEE Fellow, University President

Zhou Feng, Ph.D.
Associate Professor

Yi Guo, Ph.D.
Professor

Mukundan V. Iyengar, Ph.D.
Teaching Associate Professor

Dov Kruger, Ph.D.
Teaching Associate Professor

Victor Lawrence, Ph.D.
Research Professor, IEEE Fellow,
NAE member

Hongbin Li, Ph.D.
Professor, IEEE Fellow

Hang Liu, Ph.D.
Assistant Professor

Kevin Lu, Ph.D.
Teaching Professor

Hong Man, Ph.D.
Professor,
Associate Department Director, Undergraduate Programs

Serban Sabau, Ph.D.
Assistant Professor

Elnaz Banan Sadeghian, Ph.D.
Assistant Professor

Hady Salloum, Ph.D.
Research Professor

Min Song, Ph.D.
Professor, IEEE Fellow, Department Chair

Koduvayur P. Subbalakshmi, Ph.D.
Professor

Negar Tavassolian, Ph.D.
Associate Professor

Lei Wu, Ph.D.
Associate Professor

Yu-Dong Yao, Ph.D.
Professor, IEEE Fellow

Shucheng Yu, Ph.D.
Associate Professor

EMERITUS FACULTY

Paul Chirlian, Sc.D.
Professor Emeritus

Emil Neu, Sc.D.
Professor Emeritus

Dr. Harrison Rowe, Sc.D.
Professor Emeritus

Dr. Stanley Smith, Ph.D.
Professor Emeritus

UNDERGRADUATE PROGRAMS

Electrical Engineering

Today's technological world is driven by the electronics and electronic systems, developed and advanced by electrical engineers that are found embedded in a large portion of today's commercial and consumer products. The electronic systems and subsystems (including both hardware and software components) are increasing exponentially in complexity and sophistication each year. The familiar expectation that next year's computer and communications products will be far more powerful than today's is common to all products incorporating electronics. The high (and increasing) complexity and sophistication of these electronic products may not be seen by the casual user, but they are understood, delivered, and advanced by electrical engineers. The field of electrical engineering encompasses areas such as telecommunications, data networks, signal processing, digital systems, embedded computing, intelligent systems, electronics, optoelectronics, solid state devices, and many others. The Department's program is designed to provide our electrical engineering graduates with the tools and skills necessary to understand and apply today's technologies and to become leaders in developing tomorrow's technologies and applications.

The principles and practices of electrical engineering rest upon the broad base of fundamental science and mathematics that defines the School of Engineering and Science's core program. A sequence of electrical engineering courses provides students with an understanding of the major themes defining contemporary electronic systems, as well as depth in the mathematics and principles of today's complex electronic systems. Students select elective courses to develop depth in areas of personal interest. In addition to electrical engineering elective courses, students can draw upon computer engineering and other Stevens courses to develop the skills appropriate for their career objectives. In the senior year, students complete a significant, team-based engineering design project through which they further develop their skills.

Mission and Objectives

The mission of the undergraduate electrical engineering program in the Department of Electrical and Computer Engineering (ECE) is to provide a balanced education in fundamental principles, design methodologies, and practical experiences in electrical engineering and in general engineering topics through which graduates can enter into and sustain lifelong professional careers of innovation and creativity.

The overriding objective of the electrical engineering program is to provide graduates with the skills and understanding needed to design and build innovative new products and services which balance the rival requirements of competitive performance/cost and practical constraints imposed by available technologies.

Graduates of the Electrical Engineering program will:

- ▸ Be recognized as innovative technical experts who demonstrate advanced understandings of the state-of-the-art in electrical engineering, as well as their professional, social and ethical responsibilities.

- ▸ Emerge as technical leaders through their own individual contributions and their abilities to work with and influence others.

- ▸ Function as effective entrepreneurs who nurture new technologies from concept to commercialization

Electrical Engineering Curriculum

Term I

Course #	Course Name	Lecture	Lab	Study	Credit
CH 115	General Chemistry I	3	0	6	3
CH 117	General Chemistry Laboratory I	0	3	1	1
E 101	Engineering Experiences I	1	0	0	1
E 121	Engineering Design I: Introduction to Systems Thinking	0	3	2	2
E 120	Engineering Graphics	0	2	1	1
E 115	Introduction to Programming	1	2	3	2
MA 121; MA 122	Differential Calculus; Integral Calculus	4	0	8	4
CAL 103	Writing And Communications Colloquium	3	0	6	3
	Total	**12**	**10**	**27**	**17**

Term II

Course #	Course Name	Lecture	Lab	Study	Credit
	Science Elective I[1]	3	0	6	3
E 122	Engineering Design II: Field Sustainable Systems with Sensors	0	3	3	2
MA 123; MA 124	Series, Vectors, Functions, and Surfaces; Calculus of Two Variables	4	0	8	4
PEP 111	Mechanics	3	0	6	3
CAL 105	CAL Colloquium: Knowledge, Nature, Culture	3	0	6	3
MGT 103	Introduction to Entrepreneurial Thinking	1	2	0	2
	Total	**14**	**5**	**29**	**17**

Term III

Course #	Course Name	Lecture	Lab	Study	Credit
MA 221	Differential Equations	4	0	8	4
PEP 112	Electricity and Magnetism	3	0	6	3
E 126	Mechanics of Solids	4	0	8	4
E 245	Circuits and Systems	2	2	7	3
E 231	Engineering Design III: Structural Performance and Failure	0	3	2	2
Hum	Humanities[5]	3	0	6	3
PE 200	Physical Education I	0	2	0	0
	Total	**16**	**7**	**37**	**19**

Term IV

Course #	Course Name	Lecture	Lab	Study	Credit
EE 250	Mathematics for Electrical Engineers[2]	3	0	3	3
E 232	Engineering Design IV: Systems with Analog Circuits	2	3	7	3
E 234	Thermodynamics	3	0	6	3
CPE 390	Microprocessor Systems	3	3	4	4
Hum	Humanities[5]	3	0	6	3
EE 359	Electronic Circuits	3	0	6	3
PE 200	Physical Education II	0	2	0	0
	Total	**17**	**8**	**32**	**19**

Term V

Course #	Course Name	Lecture	Lab	Study	Credit
EE 471	Transport Phenomena in Solid State Devices[2]	4	0	4	4
E 344	Materials Processing	3	0	6	3
E 321	Engineering Design V: Materials Selection and Process Optimization	0	3	2	2
E 243	Probability and Statistics for Engineers	3	0	6	3
EE 348	Signals and Systems	3	0	3	3
Hum	Humanities[5]	3	0	6	3
PE 200	Physical Education III	0	2	0	0
	Total	**16**	**5**	**27**	**18**

Term VI

Course #	Course Name	Lecture	Lab	Study	Credit
EE 345	Modeling and Simulation[3]	3	0	6	3
E 355	Engineering Economics	3	3	6	4
EE 322	Engineering Design VI[3]	1	3	2	2
S.E.	Science Elective II[1]	3	0	6	3
EE 448	Digital Signal Processing	3	0	3	3
G.E.	General Elective[4]	3	0	6	3
PE 200	Physical Education IV	0	2	0	0
IDE 400	Senior Innovation I[6]	1	0	2	1
	Total	**17**	**8**	**31**	**19**

Term VII

Course #	Course Name	Lecture	Lab	Study	Credit
T.E.	Technical Elective[3]	3	0	6	3
EE 465	Introduction to Communication Systems	3	0	3	3
G.E.	General Elective[4]	3	0	6	3
EE 423	Engineering Design VII[3]	1	7	4	3
T.E.	Technical Elective[3]	3	0	6	3
IDE 401	Senior Innovation II	1	0	2	1
	Total	**14**	**7**	**27**	**16**

Term VIII

Course #	Course Name	Lecture	Lab	Study	Credit
T.E.	Technical Elective[3]	3	0	6	3
T.E.	Technical Elective[3]	3	0	6	3
G.E.	General Elective[4]	3	0	6	3
EE 424	Engineering Design VIII[3]	1	7	4	3
Hum	Humanities[5]	3	0	6	3
IDE 402	Senior Innovation III	1	0	2	1
	Total	**14**	**7**	**30**	**16**

(1) Science electives - note: engineering programs have specific requirements. See pages 79-80 for details.

(2) Core option – specific course determined by engineering program

(3) Discipline specific courses

(4) General Electives – chosen by the student – can be used towards a minor or option – can be applied to research or approved international studies

(5) Humanities requirements can be found on pages 599-600.

(6) IDE 400 can be taken concurrently with IDE 401 in Term VII as determined by the engineering program

Computer Engineering

One of the most rapidly growing fields today is computer engineering. This includes the design, development, and application of digital and computer-based systems for the solution of modern engineering problems, as well as computer software development, data structures and algorithms, and computer communications and graphics. The department provides our computer engineering students with the tools and skills necessary to understand and apply today's technologies and to become leaders in developing tomorrow's technologies. The program prepares students to pursue professional careers in industry and government, and to continue their education in graduate school, if they choose.

Students in the computer engineering program begin by studying the scientific foundations that are the basis for all engineering. Specialized electrical engineering, computer engineering, and computer science courses follow, providing depth in the many issues related to computers, data networks, information systems, and related topics used in contemporary commercial and industrial applications. Students may direct their interests into areas such as computer and information systems, software/software engineering, and computer architectures and digital systems. In addition to computer engineering courses, students can draw upon electrical engineering and computer science courses to develop the skills appropriate for their career objectives. In the senior year, students have the opportunity to participate in an actual engineering design project which is taken directly from a current industrial or commercial application.

Mission and Objectives

The mission of the undergraduate computer engineering program in the Department of Electrical and Computer Engineering is to provide a balanced education in fundamental principles, design methodologies, and practical experiences in computer engineering, general engineering, and physical and mathematical sciences topics through which graduates can enter into and sustain lifelong professional careers of engineering innovation and creativity.

The overriding objective of the computer engineering program is to provide graduates with the skills and understanding needed to design and build innovative new products and services. They balance the rival requirements of competitive performance/cost and practical constraints imposed by available technologies.

Graduates of the computer engineering program will:

‣ Be recognized as innovative technical experts who demonstrate advanced understandings of the state-of-the-art in computer engineering, as well as their professional, social and ethical responsibilities.

‣ Emerge as technical leaders through their own individual contributions and their abilities to work with and influence others.

‣ Function as effective entrepreneurs who nurture new technologies from concept to commercialization

Computer Engineering Curriculum

Term I

Course #	Course Name	Lecture	Lab	Study	Credit
CH 115	General Chemistry I	3	0	6	3
CH 117	General Chemistry Laboratory I	0	3	1	1
E 101	Engineering Experiences I	1	0	0	1
E 121	Engineering Design I: Introduction to Systems Thinking	0	3	2	2
E 120	Engineering Graphics	0	2	1	1
E 115	Introduction to Programming	1	2	3	2
MA 121; MA 122	Differential Calculus; Integral Calculus	4	0	8	4
CAL 103	Writing And Communications Colloquium	3	0	6	3
	Total	**12**	**10**	**27**	**17**

Term II

Course #	Course Name	Lecture	Lab	Study	Credit
	Science Elective I[1]	3	0	6	3
E 122	Engineering Design II: Field Sustainable Systems with Sensors	0	3	3	2
MA 123; MA 124	Series, Vectors, Functions, and Surfaces; Calculus of Two Variables	4	0	8	4
PEP 111	Mechanics	3	0	6	3
CAL 105	CAL Colloquium: Knowledge, Nature, Culture	3	0	6	3
MGT 103	Introduction to Entrepreneurial Thinking	1	2	0	2
	Total	**14**	**5**	**29**	**17**

Term III

Course #	Course Name	Lecture	Lab	Study	Credit
MA 221	Differential Equations	4	0	8	4
PEP 112	Electricity and Magnetism	3	0	6	3
E 126	Mechanics of Solids	4	0	8	4
E 245	Circuits and Systems	2	2	7	3
E 231	Engineering Design III: Structural Performance and Failure	0	3	2	2
Hum	Humanities[5]	3	0	6	3
PE 200	Physical Education I	0	2	0	0
	Total	**16**	**7**	**37**	**19**

Term IV

Course #	Course Name	Lecture	Lab	Study	Credit
MA 134	Discrete Mathematics[2]	3	0	6	3
E 232	Engineering Design IV: Systems with Analog Circuits	2	3	7	3
E 234	Thermodynamics	3	0	6	3
CPE 360	Computational Data Structures and Algorithms	3	0	6	3
CPE 390	Microprocessor Systems	3	3	4	4
Hum	Humanities[5]	3	0	6	3
PE 200	Physical Education II	0	2	0	0
	Total	**17**	**8**	**35**	**19**

Term V

Course #	Course Name	Lecture	Lab	Study	Credit
EE 471	Transport Phenomena in Solid State Devices[2]	4	0	4	4
E 344	Materials Processing	3	0	6	3
E 321	Engineering Design V: Materials Selection and Process Optimization	0	3	2	2
E 243	Probability and Statistics for Engineers	3	0	6	3
CPE 490	Information System Engineering[3]	3	0	6	3
Hum	Humanities[5]	3	0	6	3
PE 200	Physical Education III	0	2	0	0
	Total	**16**	**5**	**30**	**18**

Term VI

Course #	Course Name	Lecture	Lab	Study	Credit
CPE 345	Modeling and Simulation[3]	3	0	6	3
E 355	Engineering Economics	3	3	6	4
CPE 322	Engineering Design VI[3]	1	3	2	2
CPE 462	Introduction to Image Processing and Coding	3	0	3	3
S.E.	Science Elective II[1]	3	0	6	3
G.E.	General Elective[4]	3	0	6	3
PE 200	Physical Education IV	0	2	0	0
IDE 400	Senior Innovation I[6]	1	0	2	1
	Total	**17**	**8**	**31**	**19**

Term VII

Course #	Course Name	Lecture	Lab	Study	Credit
T.E.	Technical Elective[3]	3	0	6	3
CPE 487	Digital System Design	2	1	3	3
G.E.	General Elective[4]	3	0	6	3
CPE 423	Engineering Design VII[3]	1	7	4	3
T.E.	Technical Elective[3]	3	0	6	3
IDE 401	Senior Innovation II	1	0	2	1
	Total	**13**	**8**	**27**	**16**

Term VIII

Course #	Course Name	Lecture	Lab	Study	Credit
T.E.	Technical Elective[3]	3	0	6	3
T.E.	Technical Elective[3]	3	0	6	3
G.E.	General Elective[4]	3	0	6	3
CPE 424	Engineering Design VIII[3]	1	7	4	3
Hum	Humanities[5]	3	0	6	3
IDE 402	Senior Innovation II	1	0	2	1
	Total	14	7	30	16

(1) Science electives – note: engineering programs have specific requirements - one elective must have a laboratory component - two electives from the same science field cannot be selected
(2) Core option – specific course determined by engineering program
(3) Discipline specific courses
(4) General Electives – chosen by the student – can be used towards a minor or option - can be applied to research or approved international studies
(5) Humanities requirements can be found on pages 599-600.
(6) IDE 400 can be taken concurrently with IDE 401 in Term VII as determined by the engineering program

Areas of Concentration for Electrical Engineering and Computer Engineering

Electrical and computer engineering students can select their elective courses among four technical electives and three general electives in various ways. Some of them may wish to cluster those electives in ways that would help them gain expertise in an area of specialization within electrical and computer engineering. The following groupings are possible specialty (concentration) areas that students can select from within the electrical and computer engineering program:

Computer Architectures

▶ CPE 517 Digital and Computer Systems Architecture

▶ CPE/CS 550 Computer Organization and Programming

Electronics and Embedded Systems

▶ EE 359 Electronic Circuits

▶ CPE 487 Digital System Design

▶ CPE 555 Real-Time and Embedded Systems

▶ CPE 556 Computing Principles of Embedded Systems

Software Engineering and Design

▶ CPE 360 Computational Data Structures and Algorithms

▶ CPE/CS 442 Database Management Systems

▶ CPE 492 Computer and Operating Systems

▶ CPE 545 Communication Software and Middleware

▶ CPE 593 Applied Data Structure and Algorithm

Networks and Security

▶ CPE 490 Information Systems Engineering I

▶ CPE 579 Foundations of Cryptography

▸ EE 582 Wireless Networking: Architectures, Protocols, and Standards

▸ EE 584 Wireless Systems Security

▸ CPE 592 Computer and Multimedia Network Security

Power Engineering

▸ EE 589 Introduction to Power Engineering

▸ EE 590 Smart Grid

Robotics and Control

▸ EE 478 Control Systems

▸ CPE 521 Introduction to Autonomous Robots

▸ EE 575 Introduction to Control Theory

Image Processing and Multimedia

▸ CPE 462 Introduction to Image Processing and Coding

▸ CPE 536 Integrated Services - Multimedia

▸ CPE 537 Interactive Computer Graphics I

▸ CPE 558 Computer Vision

▸ CPE 591 Introduction to Multimedia Networking

▸ CPE 592 Computer and Multimedia Network Security

Wireless Communications

▸ EE 441 Introduction to Wireless Systems

▸ EE 568 Software Defined Radio

▸ EE 582 Wireless Networking: Architectures, Protocols, and Standards

▸ EE 583 Wireless Communications

▸ EE 584 Wireless Systems Security

▸ EE 585 Physical Design of Wireless Systems

Graduation Requirements for Electrical Engineering and Computer Engineering

Physical Education Requirements

▸ All undergraduate students must complete a minimum of four semesters of Physical Education (P.E.). A large number of activities are offered in lifetime, team and wellness areas.

▸ All P.E. courses must be completed by the end of the sixth semester. Students can enroll in more than the minimum required P.E. for graduation and are encouraged to do so.

▸ Participation in varsity sports can be used to satisfy up to three semesters of the P.E. requirement.

▸ Participating in club sports can be used to satisfy up to two of the PE requirements.

Note: Student may repeat Physical Education class but the repeated course (excluding varsity and club sports) will not count toward the graduation requirement.

All undergraduate students are required to fulfill certain Humanities requirements in order to graduate. Please see pages 599-600 for a breakdown of specific requirements by program.

Electives

"Technical electives" are generally selected from among the courses (EE or CPE) listed among the ECE course descriptions. Under special circumstances, students may be allowed to use courses from other departments to satisfy the technical elective requirement. Approval by the course instructor, the student's advisor, and the ECE Director is required.

"General Electives" are free electives, and can be selected from among any courses (including ECE courses) at Stevens Institute of Technology. Students can use 500-level ECE courses to satisfy an elective requirement, with the permission of the course instructor and the students' advisor. If a student satisfies the conditions established by the Stevens Graduate School for admission into 600-level graduate courses, ECE 600-level courses may also be used as electives or technical electives. Students interested in using a 500-level or 600-level course from other departments as a free elective must satisfy the conditions for admission into the course by the offering department.

Minors

A student may qualify for a minor in Electrical Engineering or Computer Engineering by taking the required courses indicated below. Completion of a minor indicates proficiency beyond that provided by the Stevens curriculum in the basic material of the selected area. Enrollment in a minor program means that the student must also meet Stevens' requirements for minor programs.

Requirements for a Minor in Electrical Engineering

- CPE 390 Microprocessor Systems
- E 250 Math for Electrical Engineers
- EE 348 Systems Theory
- EE 448 Digital Signal Processing
- EE 465 Introduction to Communications
- EE 359 Electronic Circuits

Requirements for a Minor in Computer Engineering

- CPE 360 Computational Data Structures and Algorithms
- CPE 390 Microprocessor Systems
- CPE 462 Image Processing and Coding
- CPE 487 Digital Systems Design
- CPE 490 Information Systems Eng. I
- MA 134 Discrete Math

Requirements for a Minor in Media Engineering (for EE and CPE students)

- CPE462 Introduction to Image Processing and Coding
- CPE591 Introduction to Multimedia Networking

- Cloud computing, choose one of the following
    - CS524 Introduction to Cloud Computing
    - CS526 Enterprise & Cloud Computing
- CS546 Web Programming
- EM357 Elements of Operations Research
- SYS581 Introduction to System Engineering
- In addition to these six courses, students taking this Media Engineering minor are required to complete their senior design EE/CPE423-424 on a media engineering related topic.

GRADUATE PROGRAMS

The mission of the Department of Electrical and Computer Engineering is to provide students with the tools and skills necessary to understand and apply today's technologies and to become leaders in developing tomorrow's technologies and applications. To this end, programs have been developed to ensure that students receive both fundamental knowledge in basic concepts and an understanding of current and emerging/future technologies and applications.

The Electrical and Computer Engineering department offers the degrees of Master of Engineering - Electrical Engineering, Master of Science - Electrical Engineering, Master of Engineering - Computer Engineering, Master of Science - Computer Engineering, Master of Engineering - Applied Artificial Intelligence, Master of Science - Applied Artificial Intelligence, the degree of Electrical Engineer, and the degree of Computer Engineer. In addition, the degree of Doctor of Philosophy is offered in Electrical Engineering and in Computer Engineering.

Master of Engineering- Electrical Engineering

In general, a bachelor's degree in electrical engineering or computer engineering with a minimum grade point average of 3.0 on a 4.0 scale is required for graduate study in electrical engineering. Outstanding applicants with degrees in other engineering disciplines, physics, or mathematics may be conditionally admitted subject to the completion of appropriate ramp courses or their equivalents with a grade of "B" or better. The special requirements will be determined on an individual basis depending on the student's background. Submission of GRE scores is recommended, but not required.

The master's degree requires completion of a total of 30 hours of credit. Each student must complete a mathematical foundations course, four core courses and must complete the course requirements for one of the electrical engineering concentrations. Elective courses are to be chosen from the EE, CPE or AAI numbered graduate courses in this catalog. An elective course not in the EE, CPE or AAI numbered courses may be taken, with the approval of the student's academic advisor. A maximum of two elective courses not listed in the ECE program may be taken with the approval of the academic advisor.

Master of Science - Electrical Engineering

The Master of Science degree requires completion of a master's thesis or 6 credits project course. In the Master of Engineering degree, the completion of a master's thesis or project course is optional. All other requirements are the same for the Master of Science and Master of Engineering degrees.

Requirements

Students seeking a Master of Engineering (ME) or Master of Science (MS) in Electrical Engineering are required to complete:

- One (1) mathematical foundation course
- Four (4) core courses in their majors/programs

▸ Three (3) concentration courses in a chosen concentration

▸ Two (2) additional courses

- A student in an ME program is required to take two (2) elective courses

- A student in an MS program is required to take six (6) credits of research project or a master's thesis (equivalent to two courses)

List of Mathematical Foundation Courses (select one)

▸ EE 602 Analytical Methods in Electrical Engineering

▸ EE 605 Probability and Stochastic Processes I

List of Core Courses (select four)

▸ EE 548 Digital Signal Processing

▸ EE 575 Introduction to Control Theory

▸ EE 603 Linear Systems Theory

▸ EE 608 Applied Modeling & Optimization

▸ EE 609 Communication Theory

List of Concentrations (select three from one concentration)

▸ Communications

▸ Power Engineering

▸ Robotics and Automation Systems

▸ Microelectronics and Photonics

▸ Artificial Intelligence

List of Concentrations and Concentration Courses

Concentration 1: Communications

▸ EE 510 Introduction to Radar Systems

▸ EE 568 Software-Defined Radio

▸ EE 582 Wireless Networking: Architecture, Protocols and Standards

▸ EE 583 Wireless Communications

▸ EE 584 Wireless Systems Security

▸ EE 585 Physical Design of Wireless Systems

Concentration 2: Power Engineering

▸ EE 575 Introduction to Control Theory

▸ EE 589 Introduction to Power Engineering

▸ EE 590 Smart Grid

▸ EE 629 Internet of Things

▸ CPE 679 Computer and Information Networks

▸ CPE 691 Information Systems Security

Concentration 3: Robotics and Automation Systems

- EE 553 Engineering Programming C++

- EE 575 Introduction to Control Theory

- EE 621 Nonlinear Control

- EE/CPE 631 Cooperating Autonomous Mobile Robots

- CPE 521 Introduction to Autonomous Mobile Robots

- CPE 645 Image Processing and Computer Vision

Concentration 4: Microelectronics and Photonics

- CPE 690 Introduction to VLSI Design

- EE/PEP 503 Introduction to Solid State Physics

- EE/PEP 507 Introduction to Microelectronics and Photonics

- EE/PEP 509 Intermediate Waves and Optics

- EE/PEP 561 Solid State Electronics for Engineering I

- EE/PEP 562 Solid State Electronics for Engineering II

Concentration 5: Artificial Intelligence

- EE 551 Engineering Programming: Python

- EE 627 Data Acquisition and Processing I (Big Data)

- EE 628 Data Acquisition and Processing II (Deep Learning)

- EE 672 Applied Game Theory and Evolutionary Algorithms

- CPE 646 Pattern Recognition and Classification

- CPE 695 Applied Machine Learning

Master of Engineering - Computer Engineering

In general, a bachelor's degree in electrical engineering or computer engineering with a minimum grade point average of 3.0 on a 4.0 scale is required for graduate study in computer engineering. Outstanding applicants in other areas may be conditionally admitted subject to the completion of appropriate ramp courses or their equivalents with a grade of "B" or better. The specific requirements will be determined on an individual basis depending upon the student's background. Submission of GRE scores is recommended, but not required.

The master's degree requires completion of a total of 30 hours of credit. Each student must complete a mathematical foundations course, four core courses and must complete the course requirements for one of the computer engineering concentrations. Elective courses are to be chosen from the CPE, EE or AAI numbered graduate courses in this catalog. An elective course not in the CPE, EE or AAI numbered courses may be taken, with the approval of the student's academic advisor. A maximum of two elective courses not listed in the ECE program may be taken with the approval of the academic advisor.

Master of Science - Computer Engineering

The Master of Science degree requires completion of a master's thesis or 6 credits project course. In the Master of Engineering degree, the completion of a master's thesis or project course is optional. All other requirements are the same for the Master of Science and Master of Engineering degrees.

Requirements

Students seeking a Master of Engineering (ME) or Master of Science (MS) in Computer Engineering are required to complete:

▸ One (1) mathematical foundation course

▸ Four (4) core courses in their majors/programs

▸ Three (3) concentration courses in a chosen concentration

▸ Two (2) additional courses

- A student in an ME program is required to take two (2) elective courses

- A student in an MS program is required to take six (6) credits of research project or a master's thesis (equivalent to two courses)

List of Mathematical Foundation Courses (select one)

▸ CPE 602 Applied Discrete Mathematics

▸ EE 605 Probability and Stochastic Processes I

List of Core Courses (select four)

▸ CPE 517 Digital and Computer Systems Architecture

▸ CPE 555 Real-Time and Embedded Systems

▸ CPE 593 Applied Data Structures & Algorithms

▸ CPE 690 Introduction to VLSI Design

▸ EE 608 Applied Modeling & Optimization

List of Concentrations (select three from one concentration)

▸ Embedded Systems

▸ Software and Data Engineering

▸ Networks and Security

▸ Artificial Intelligence

List of Concentrations and Concentration Courses

Concentration 1: Embedded Systems

▸ CPE 517 Digital and Computer Systems Architecture

▸ CPE 545 Communication Software and Middleware

▸ CPE 555 Real-Time and Embedded Systems

▸ CPE 556 Computing Principles for Embedded Systems

▸ CPE 690 Introduction to VLSI Design

▸ EE 629 Internet of Things

Concentration 2: Software and Data Engineering

▸ CPE 545 Communication Software and Middleware

▸ CPE 593 Applied Data Structures & Algorithms

‣ EE 551 Engineering Programming: Python

‣ EE 552 Engineering Programming: Java

‣ EE 553 Engineering Programming: C++

‣ EE 627 Data Acquisition and Processing I (Big Data)

‣ EE 628 Data Acquisition and Processing II (Deep Learning)

‣ EE 629 Internet of Things

Concentration 3: Networks and Security

‣ CPE/CS 579 Foundations of Cryptography

‣ CPE 604 Analytical Methods for Networks

‣ CPE 654 Design and Analysis of Network Systems

‣ CPE 679 Computer and Information Networks

‣ CPE 691 Information Systems Security

‣ EE 552 Engineering Programming: Java

‣ EE 584 Wireless Systems Security

Concentration 4: Artificial Intelligence

‣ EE 551 Engineering Programming: Python

‣ EE 627 Data Acquisition and Processing I (Big Data)

‣ EE 628 Data Acquisition and Processing II (Deep Learning)

‣ EE 672 Applied Game Theory and Evolutionary Algorithms

‣ CPE 646 Pattern Recognition and Classification

‣ CPE 695 Applied Machine Learning.

Master of Engineering - Applied Artificial Intelligence

The Master of Engineering in Applied Artificial Intelligence educates students to acquire state-of-the-art knowledge and skills in artificial intelligence and its applications across a broad range of engineering domains. The program prepares students to develop a strong background in understanding the theoretical foundations of artificial intelligence and deep learning, together with the understanding of a variety of engineering applications including intelligent communication networks, autonomous robotics, image processing and computer vision, smart Internet of Things, smart health, information systems security, biomedical and bio-engineering, civil and environmental engineering, mechanical engineering, data engineering, and software engineering. The program prepares students to enter careers in engineering fields that require advanced artificial intelligence knowledge and skills.

Master of Science - Applied Artificial Intelligence

The Master of Science in Applied Artificial Intelligence educates students to acquire state-of-the-art knowledge and skills in artificial intelligence and its applications across a broad range of engineering domains. The program prepares students to develop a strong background in understanding the theoretical foundations of artificial intelligence and deep learning, together with the understanding of a variety of engineering applications including intelligent communication networks, autonomous robotics, image processing and computer vision, smart Internet of Things, smart health, information systems security, biomedical and bio-engineering, civil and environmental engineering, mechanical engineering, data engineering,

and software engineering. The program prepares students to enter careers in engineering fields that require advanced artificial intelligence knowledge and skills.

Requirements

In general, a bachelor's degree in electrical engineering or computer engineering (or a closely related discipline) with a minimum grade point average of 3.0 on a 4.0 scale is required for graduate study in Applied Artificial Intelligence. Outstanding applicants with degrees in other disciplines such as computer science, engineering, management, or mathematics may be admitted subject to demonstration of the technical background expected. Such applicants, as well as applicants with significant career experiences but not satisfying the primary requirements, will be admitted on an individual basis depending on the student's background. Submission of GRE scores is recommended, but not required. The master's degree requires completion of a total of 30 hours of credit. Each student must complete the three core courses and must complete the course requirements for one of the artificial intelligence for electrical and computer engineering concentrations. Elective courses are to be chosen from among the CPE and EE numbered graduate courses in this catalog. Under special circumstances, an elective course not in the CPE or EE numbered courses may be taken, with the approval of the student's academic advisor. A maximum of two elective courses not listed in the ECE program may be used for the master's degree with approval of the academic advisor.

Students seeking a Master of Engineering (ME) or Master of Science (MS) in Applied Artificial Intelligence are required to complete:

- One (1) mathematical foundation course,

- Four (4) core courses in their majors/programs,

- Three (3) concentration courses in a chosen concentration,

- Two (2) skill courses

  - A student in an ME program is required to take two (2) software/hardware skill

  - A student in an MS program is required to take two (2) analytical skill courses

List of Mathematical Foundation Courses (select one)

- EE 602 Analytical Methods in Electrical Engineering

- EE 605 Probability and Stochastic Processes I

- EE 608 Applied Modeling & Optimization

List of Core Courses (select four)

- CPE 695 Applied Machine Learning

- EE 551 Engineering Programming: Python

- CPE 646 Pattern Recognition and Classification

- EE 627 Data Acquisition and Processing I (Big Data)

- EE 628 Data Acquisition and Processing II (Deep Learning)

- EE 672 Applied Game Theory and Evolutionary Algorithms

List of Concentrations (select three from one concentration)

- Electrical Engineering

- Computer Engineering

▸ Data Engineering

▸ Software Engineering

▸ Biomedical Engineering

▸ Systems Biology

▸ Mechanical Engineering

▸ Artificial Intelligence in Design and Construction

List of Analytical Skill Courses (MS students select two)

▸ EE 602 Analytical Methods in Electrical Engineering

▸ EE 608 Applied Modeling and Optimization

▸ EE 672 Applied Game Theory and Evolutionary Algorithms

▸ CPE 646 Pattern Recognition and Classification

▸ CPE 695 Applied Machine Learning

List of Software/Hardware Skill Courses (ME students select two)

▸ CPE 555 Real-Time and Embedded Systems

▸ CPE 556 Computing Principles for Embedded Systems

▸ CPE 593 Applied Data Structures & Algorithms

▸ EE 553 Engineering Programming: C++

▸ EE 552 Engineering Programming: Java

▸ EE 551 Engineering Programming: Python

List of Concentrations and Concentration Courses

Concentration 1: Electrical Engineering

The Electrical Engineering concentration will provide students with fundamental knowledge and background on electrical engineering and will allow students to apply Artificial Intelligence algorithms to a wide array of topics including but not limited to communications, smart grids, and digital systems design.

▸ EE 548 Digital Signal Processing

▸ EE 575 Introduction to Control Theory

▸ EE 583 Wireless communications

▸ EE 584 Wireless Systems Security

▸ EE 585 Physical Design of Wireless Systems

▸ EE 586 Wireless Networking: Architecture, Protocols and Standards

▸ EE 589 Introduction to Power Engineering

▸ EE 590 Smart Grid

▸ EE 609 Communication Theory

▸ EE 621 Nonlinear Control

▸ EE 626 Optical Communication Systems

▸ EE 631 Cooperating Autonomous Mobile Robots

▸ EE 664 Advanced Digital Signal Processing

▸ EE 670 Information Theory and Coding

▸ EE 690 Introduction to VLSI Design

Concentration 2: Computer Engineering

The Computer Engineering concentration will provide students with fundamental knowledge and background on computer engineering and will allow students to apply Artificial Intelligence algorithms to a wide array of topics including but not limited to communications, networking, information networks, image processing and computer vision, security, real time and embedded systems, and robotics and control.

▸ CPE 517 Digital and Computer Systems Architecture

▸ CPE 521 Introduction to Autonomous Robots

▸ CPE 545 Communication Software and Middleware

▸ CPE/CS 550 Computer Organization and Programming

▸ CPE 555 Real-Time and Embedded Systems

▸ CPE/CS 579 Foundations of Cryptography

▸ CPE 604 Analytical Methods for Networks

▸ CPE 645 Image Processing and Computer Vision

▸ CPE 646 Pattern Recognition and Classification

▸ CPE 654 Design and Analysis of Network Systems

▸ CPE 679 Computer and Information Networks

▸ CPE 691 Information Systems Security

Concentration 3: Data Engineering

The Data Engineering concentration will provide students with fundamental knowledge and background necessary for analysis, management and classification of Big Data for a variety of application domains, including information systems security, and data management for web applications.

▸ EE 608 Applied Modeling and Optimization

▸ EE 627 Data Acquisition, Modeling, and Analysis

▸ CPE 646 Pattern Recognition and Classification

▸ CPE 691 Information Systems Security

▸ CPE 695 Applied Machine Learning

▸ CS 609 Data Management and Exploration on the Web

Concentration 4: Software Engineering

The Software Engineering concentration will provide students with fundamental knowledge and background on software development with an emphasis on developing software for AI applications.

▸ EE 551 Engineering Programming: Python

▸ EE 552 Engineering Programming: Java

▸ EE 553 Engineering Programming: C++

▸ CPE 545 Communication Software and Middleware

▸ CPE/CS 550 Computer Organization and Programming

▸ CPE 640 Software Engineering I

Concentration 5: Biomedical Engineering

The Biomedical Engineering concentration will provide students with the engineering skills needed to extract and process biomedical signals, compute and analyze medical data, and build new user friendly healthcare applications.

▸ BME 810: Biomedical Digital Signal Processing

▸ BME 558: Introduction to Brain Computer Interface

▸ BME 504/CPE 585: Medical Instrumentation and Imaging

Concentration 6: Systems Biology

The Systems Biology concentration will provide students with sufficient knowledge and background to perform mathematical and computational modeling of complex biological systems in a wide range of areas including genetics and bioinformatics.

▸ BIO 687: Molecular Genetics

▸ CH 580 Biochemistry I

▸ BIO 668 Computational Biology

Concentration 7: Mechanical Engineering

The Mechanical Engineering concentration will provide students with fundamental knowledge and background in design and manufacturing to perform mathematical and computational modeling of complex mechanical systems including but not limited to robotics.

▸ ME 598 Introduction to Robotics

▸ ME 621: Introduction to Modern Control

▸ ME 644: Computer-Integrated Design and Manufacturing

Concentration 8: Artificial Intelligence in Design and Construction

Students who complete this concentration will acquire a practical grounding in artificial intelligence as applied to the Design and Construction Industry, including its potential to transform organizations by increasing productivity and efficiency while enhancing safety and profitability. By evaluating current trends and applications, students will be able to investigate and conclude the capital investments and project-specific feasibility necessary to incorporate AI throughout the design and construction process.

▸ OE 511 Urban Oceanography

▸ CM 521 Construction Organizations

▸ CM 530 Strategic Responses to Cyclical Environments

▸ CM 560 Sustainable Design

Dual MS/ME degree in Electrical Engineering or Computer Engineering and MBA Degree

The dual MS/ME-MBA degree is designed for students that seek to have a deep technical knowledge in Electrical Engineering and Computer Engineering as well as strong management skills and qualifications. An engineering degree coupled with an MBA provides a great mixture of education and creates a well-rounded employee. This joint degree will give engineering students strong business management skills to complement their Engineering degree, accelerating their growth into management positions and opening a more diverse selection of career choices. The students will earn two separate master's degrees at completion of this dual degree program.

This dual program offers an exceptional combination of management skills with deep and practical knowledge of the technical aspects of electrical and computer engineering. The MBA program is particularly suited for engineers, as it incorporates a unique blend of courses on management skills, technology and analytics skills, and human skills.

Students in this program benefit from close interaction with an internationally recognized faculty body with diverse educational and professional backgrounds both in the School of Engineering and Science and in the School of Business; from the hybrid format of many classes; summer classes; and networking opportunities with alumni from both schools.

This dual degree program requires completion of a total of 57 credits, including 10 courses (30 credits) from the MS/ME degree program and additional 9 courses (27 credits) from the MBA degree program.

Requirements for MS/ME degree in Electrical Engineering or Computer Engineering (with Business Operations for ECE concentration) in the dual degree program

- One (1) EE or CPE math foundation course

- Two (2) EE or CPE core courses according to the major of the student

- Two (2) EE or CPE skill courses according to the major and the degree program of the student

- Two (2) EE or CPE elective courses

- Three (3) concentration courses from Business Operations for ECE concentration, including

    - BIA 600, Business Analytics: Data, Models, and Decisions

    - BIA 610, Applied Analytics

    - MGT 657, Operations Management

Additional requirements for MBA degree (with ECE concentration) in the dual degree program

- MGT 606, Economics for Managers

- FIN 600, Financial and Managerial Accounting

- FIN 623, Financial Management

- MGT 612, Leader Development

- MGT 635, Managerial Judgment and Decision Making

- MGT 641, Marketing Management

- MGT 663, Discovering and Exploiting Entrepreneurial Opportunities

- MGT 699, Strategic Management

- MGT 810, Field Consulting Project or Entrepreneurial Project

Doctoral Programs

Admission requirements to the Ph.D. program are naturally more stringent than those for the lesser degrees. More attention is paid to the student's background and potential to perform independent research. All applications are considered individually. In general, admissions are granted to students with a master's degree in electrical engineering or computer engineering who have achieved a minimum GPA of 3.5 on a 4.0 scale. Exceptional students may be accepted after receiving the bachelor's degree. Submission of GRE scores is recommended, but not required.

The Ph.D. degree requires 84 credits. A maximum of 30 credits can be applied toward the 84-credit requirement of the Ph.D. from a previous master's degree or from any other graduate courses subject to the approval of the advisor. All Ph.D. candidates must take at least 30 credits of thesis work and at least 20 credits of course work at Stevens beyond the master's degree. Courses counting towards the Ph.D. degree are expected to be taken from the ECE catalog courses (approval by the student's advisor is required to apply courses outside the ECE program to the Ph.D. degree).

All Ph.D. candidates must pass the written Ph.D. qualifying examination. Students may take the qualifying examination only twice. Failure to pass the qualifying examination in the second attempt will result in dismissal from the Ph.D. program.

After the student has successfully completed the qualifying examination, (s)he must arrange for an advisor to assist in the development of a thesis proposal. The advisor must be a full-time ECE professor or professor emeritus. Once a suitable topic has been found and agreed upon with the advisor, the student must prepare a thesis proposal. This thesis proposal should be completed and defended within one year of passing the Ph.D. qualifying examination. The proposal must indicate the direction that the thesis will take and procedures that will be used to initiate the research. Ordinarily, some preliminary results are included in the proposal. In addition, the proposal must indicate that the student is familiar with the research literature in his/her area. To this end, the proposal must include the results of a thorough literature search. A committee of at least three faculty members must accept the written thesis proposal. The committee chairperson is the thesis advisor. The other two members should be ECE department faculty. After the written proposal has been accepted, the examination committee conducts an oral defense. At this defense, the student presents his/her proposal.

All Ph.D. candidates who are working on a thesis must have a thesis committee chaired by the thesis advisor and consisting of at least four members. The thesis advisor and at least two other members must be full-time faculty members or professors emeritus of the ECE department. In addition, there must be one member who is a regular faculty member within another department at Stevens. It is permissible and desirable to have as a committee member a highly-qualified person from outside of Stevens. The committee must approve the completed thesis unanimously. After the thesis has been completed, it must be publicly defended.

Degree of Electrical Engineer and Degree of Computer Engineer

These programs provide opportunities for the student to proceed with professional development beyond the master's level. The course work may be directed toward depth in the area of the master's degree or toward depth in a new area related to that of the master's degree. A design project of significance is required.

To be admitted to the Electrical Engineer or Computer Engineer program, the student must have a master's degree in electrical engineering or computer engineering with a minimum grade point average of 3.0 on a 4.0 scale and the agreement of at least one regular faculty member in the department who expresses a willingness to serve as project advisor. Outstanding applicants with degrees in other disciplines may be admitted subject to demonstration of the technical background expected (perhaps with the requirement for completion of appropriate ramp courses or their equivalents with a grade of "B" or better). Such applicants, as well as applicants with significant career experiences but not satisfying the primary requirements, will be determined on an individual basis depending on the student's background.

At least 30 credits beyond the master's degree are required for the Engineer Degree. At least eight, but not more than fifteen, credits must be in the design project. The project courses for EE and CPE are EE 950 and CPE 950, respectively. An ECE faculty advisor and at least two faculty members must supervise the project; one must be a regular member of the faculty in the ECE department. A written report and oral presentation are required.

Graduate Certificate Programs

The Department of Electrical and Computer Engineering offers several graduate certificate programs to students meeting the regular admission requirements for the master's program. Each graduate certificate is self-contained and highly focused, carrying 12 or more graduate credits. All of the courses may be used toward the master's degree, as well as for the graduate certificate.

Artificial Intelligence for Engineering

Choose four from the following list:

- CPE 646 Pattern Recognition and Classification
- CPE 695 Applied Machine Learning
- EE 551 Engineering Program: Python
- EE 627 Data Acquisition and Processing I
- EE 628 Data Acquisition and Processing II

Autonomous Robotics

Required:

- CPE 521 Autonomous Mobile Robotic Systems
- EE 631 Cooperating Autonomous Mobile Robots

Choose two from the following list with approval from an ECE advisor:

- CPE 555 Real-Time and Embedded Systems
- CPE 645 Image Processing and Computer Vision
- EE 583 Wireless Communications
- EE 621 Nonlinear Control

Digital Signal Processing

- EE 613 Digital Signal Processing for Communications
- EE 616 Signal Detection and Estimation for Communications
- EE 663 Digital Signal Processing I
- EE 666 Multidimensional Signal Processing

Digital Systems and VLSI Design

- CPE 514 Computer Architecture
- CPE 621 Analysis and Design of Real-Time Systems
- CPE 643 Logical Design of Digital Systems I
- CPE 644 Logical Design of Digital Systems II
- CPE 690 Introduction to VLSI Systems Design

Microelectronics

▶ EE/MT/PEP 507 Introduction to Microelectronics and Photonics

▶ EE/MT/PEP 561 Solid State Electronics I

▶ EE/MT/PEP 562 Solid State Electronics II

▶ CPE/MT/PEP 690 Introduction to VLSI Design

Photonics

▶ EE/MT/PEP 507 Introduction to Microelectronics and Photonics

▶ EE/MT/PEP 515 Photonics I

▶ EE/MT/PEP 516 Photonics II

▶ EE/MT/PEP 626 Optical Communication Systems

Multimedia Technology

▶ CPE 536 Integrated Services - Multimedia

▶ CPE 592 Multimedia Network Security

▶ CPE 612 Principles of Multimedia Compression

▶ CPE 645 Image Processing and Computer Vision

Networked Information Systems

Select four of the following courses:

▶ CPE 563 Networked Applications Engineering

▶ EE 584 Wireless Systems Security

▶ NIS 565 Management of Local Area Networks

▶ NIS 591 Introduction to Multimedia Networking

▶ NIS 678 Information Networks I

▶ NIS 691 Information Systems Security

Real-Time and Embedded Systems

Required:

▶ CPE 555 Real-Time and Embedded Systems

▶ CPE 690 Introduction to VLSI Design

Choose two from the following list:

▶ CPE 621 Analysis and Design of Real-Time Systems

▶ CPE 623 Applied Machine Learning

▶ CPE 643 Logical Design of Digital Systems

▶ CPE 645 Image Processing and Computer Vision

Secure Network Systems Design

Select four of the following courses:

▶ CPE 560 Introduction to Networked Information

▶ CPE 592 Multimedia Network Security

▶ CPE 654 Design and Analysis of Intelligent Network Systems

▶ CPE 691 Information Systems Security

▶ EE 584 Wireless Systems Security

Software Design for Embedded and Information Systems

Select four of the following courses:

▶ CPE 545 Communication Software and Middleware

▶ CPE 555 Real-Time and Embedded Systems

▶ CPE 556 Computing Principles for Mobile and Embedded Systems

▶ NIS 593 Applied Data Structures & Algorithms

▶ CPE 640 Software Engineering I

Wireless Communications

▶ EE 583 Wireless Communications (required)

(Select 3 of the following courses)

▶ EE 582 Wireless Networking: Architectures, Protocols and Standards

▶ EE 584 Wireless Systems Security

▶ EE 585 Physical Design of Wireless Systems

▶ EE 651 CDMA and Spread Spectrum

▶ EE 653 Cross-Layer Design for Wireless Networks

COURSE OFFERINGS

Electrical Engineering

EE 181   Seminar in Electrical Engineering   (1 - 1 - 0)

Introduction to electrical and computer engineering, addressing theoretical foundation, systems, and applications. Topics include information theory, control theory, power systems, wireless systems, information networks, sensor networks, and internet of things. Cross-listed with: CPE 181

EE 250   Mathematics for Electrical Engineers   (3 - 3 - 0)

Introduction to logic, methods of proof, proof by induction and the pigeonhole principle with applications to logic design. Analytic functions of a complex variable, Cauchy-Riemann equations, Taylor series. Integration in the complex plane, Cauchy Integral formula, Liouville's theorem, maximum modulus theorem. Laurent series, residues, the residue theorem. Applications to system theory, Laplace transforms, and transmission lines. Prerequisite: MA 221

EE 291   Supplemental Topics in Circuits and Systems I   (3 - 1 - 0)

Additional work for transfer students to cover topics omitted from Circuits and Systems courses taken elsewhere. This additional work is usually specified as completion of particular PSI modules.

EE 322   Engineering Design VI   (2 - 1 - 3)

This course addresses the general topic of selection, evaluation and design of a project concept, emphasizing the principles of team-based projects and the stages of project development. Techniques to acquire information related to the state-of-the-art concepts and components impacting the project, evaluation of alternative approaches and selection of viable solutions based on appropriate cost factors, presentation of proposed projects at initial, intermediate and final stages of development and related design topics. Students are encouraged to use this experience to prepare for the senior design project courses. Prerequisite: E 321 Corequisite: EE 345

EE 333   Electronics & Instrumentation Lab   (2 - 0 - 3)

Experimental investigations of the characteristics of networks, and integrated electronics with application to analog and digital instrumentation and control. Students are required to design, breadboard and test their circuits.

EE 345   Modeling and Simulation   (3 - 3 - 0)

Development of deterministic and non-deterministic models for physical systems, engineering applications and simulation tools for deterministic and non-deterministic systems. Case studies and projects.

EE 348   Signals and Systems   (3 - 3 - 0)

An introduction to the mathematical methods used in the study of communications systems with practical applications. Discrete and fast Fourier transforms. Functions of a complex variable. Laplace and Z transforms. Prerequisites: E 245, and EE 250

EE 359   Electronic Circuits   (3 - 3 - 0)

Design of differential amplifiers using BJTs or FETs, design of output stages (class B and class AB), output and input impedance of differential amplifiers, frequency response. Feedback amplifiers, Nyquist criteria, Nyquist plots and root loci, bode plots, gain/phase margins and application in compensation for operational amplifiers, oscillators, tuned amplifiers and filters (passive and active). A suitable circuit analysis package is used for solving many of the problems. Prerequisite: Corequisites: E 232, and EE 250

EE 423   Engineering Design VII   (3 - 1 - 7)

Senior design course. The development of design skills and engineering judgment, based upon previous and current course and laboratory experience, is accomplished by participation in a design project. Projects are selected in areas of current interest such as communication and control systems, signal processing and hardware and software design for computer-based systems. To be taken during the student's last fall semester as an undergraduate student. Prerequisite: EE 322

EE 424   Engineering Design VIII   (3 - 0 - 8)

A continuation of EE 423 in which the design is implemented and demonstrated. This includes the completion of a prototype (hardware and/or software), testing and demonstrating performance and evaluating the results. To be taken during the student's last spring semester as an undergraduate student. Prerequisite: EE 423

EE 440   Current Topics in Electrical and Computer Engineering   (3 - 3 - 0)

This course consists of lectures designed to explore a topic of contemporary interest from the perspective of current research and development. In addition to lectures by the instructors and discussions led by students, the course includes talks by professionals working in the topic being studied. When appropriate, team-based design projects are included. Cross-listed with: CPE 440

EE 441   Introduction to Wireless Systems   (3 - 3 - 0)

Review of history, concepts, and technologies of wireless communications; explanations and mathematical models for analyzing and designing wireless systems; description of various wireless systems, including cellular systems, wireless local area networks, and satellite-based communication systems; and wireless design projects using Matlab, LabView, and software-defined radio. Cross-listed with: CPE 441

EE 448   Digital Signal Processing   (3 - 3 - 0)

Introduction to the theory and design of digital signal processing systems. Include sampling, linear convolution, impulse response, and difference equations; discrete-time Fourier transform, DFT/FFT, circular convolution, and Z-transform; frequency response, magnitude, phase and group delays; ideal filters, linear-phase FIR filters, all-pass filters, minimum-phase and inverse systems; digital processing of continuous-time signals. Prerequisite: EE 348

EE 465   Introduction to Communication Systems   (3 - 3 - 0)

Review of probability, random processes, signals and systems; continuous-wave modulation including AM, DSB-SC, SSB, FM and PM; superheterodyne receiver; noise analysis; pulse modulation including PAM, PPM, PDM and PCM; quantization and coding; delta modulation, linear prediction and DPCM; baseband digital transmission, matched filter and error rate analysis; passband digital transmission including ASK, PSK and FSK. Prerequisites: E 243, EE 348

EE 471   Transport Phenomena in Solid State Devices   (4 - 4 - 0)

Introduction to the underlying phenomena and operation of solid state electronic, magnetic and optical devices essential in the functioning of computers, communications and other systems currently being designed by engineers and scientists. Charge carrier concentrations and their transport are analyzed from both microscopic and macroscopic viewpoints, carrier drift due to electric and magnetic fields in solid state devices is formulated and optical energy absorption and emission are related to the energy levels in solid-state materials. Diffusion, generation and recombination of charge carriers are combined with carrier drift to produce a continuity equation for the analysis of solid state devices. Explanations and models of the operation of PN, metal-oxide, metal-oxide-semiconductor and heterostructure junctions are used to describe diode, transistor, photodiode, laser, integrated circuit and other device operation. Prerequisite: E 232

EE 473   Electromagnetic Fields   (3 - 3 - 0)

Introduction to electromagnetic fields and applications. Vector calculus: orthogonal coordinates, gradient, divergence, curl, and Stokes' and divergence theorems. Electrostatics: charge, Coulomb's and Gauss' laws, potential, conductors and dielectrics, dipole fields, stored energy and power dissipation, resistance and capacitance, polarization, boundary conditions, and LaPlace's and Poisson's equations. Magnetostatics: Biot-Savart's and Ampere's laws, scalar and vector potentials, polarization, magnetic materials, stored energy, boundary conditions, inductance, magnetic circuits, and force. Time-dependent Maxwell's equations: displacement current, constitutive relations, isotropic and anisotropic media, force, boundary conditions, and the time-dependent Poynting vector and power. Circuit theory of transmission lines, transient response, and multiple reflections. Prerequisite: EE 250

EE 474   Microwave Systems   (3 - 3 - 0)

Complex scalars and vectors, sinusoidal steady-state, complex Maxwell's equations, and complex Poynting's theorem. Propagation of plane waves: complex vector wave equation, loss-less transmission line analogy, sinusoidal steady-state, frequency, wavelength and velocity, polarity, lossy media, radiation pressure, group velocity, and reflection and refraction. Snell's law, Brewster angle, field theory of transmission lines, TEM waves, sinusoidal steady-state transmission line theory, traveling and standing waves, Smith Chart, matching power flow, lossy lines, and circuit and field theory. Waveguides: TE and TM modes in general guides, propagation constant and wave impedance, separation of variables, rectangular and cylindrical guides, representation of wavelength fields by plane wave components, propagation and cutoff (evanescent) modes, the Poynting vector, dielectric guides, and losses. Waveguide resonators. Antennas: scalar and vector potentials, wave equations, spherical coordinates, electric and magnetic dipole antennas, and aperture antennas. Microwave electronics and traveling wave tubes. Prerequisite: EE 473

EE 475   Advanced Communication Systems   (3 - 3 - 0)

Information theory and coding. Error control coding: CRCs, trellis codes, convolutional codes, and Viterbi decoding. Quantization and digitization of speech: PCM, ADPCM, DM, LPC, and VSELP algorithms. Carrier recovery and synchronization. Multiplexers: TDM and FDM hierarchies. Echo cancelers, equalizers, and scrambler/unscramblers. Spread spectrum communication systems. Mobile communications: digital cellular communication systems and PCS Encryption techniques. Introduction to computer communications networks. Prerequisite: EE 465

EE 478   Control Systems   (3 - 3 - 0)

Introduction to the theory and design of linear feedback and control systems in both digital and analog form, review of z-transform and Laplace transforms, time domain performance error of feedback systems, PID controller, frequency domain stability, including Nyquist stability in both analog and digital form, frequency domain performance criteria and design, such as via the gain and phase plots, state variable analysis of linear dynamical systems, elementary concepts of controllability, observability and stability via state space methods, and pole placement and elements of state variable design for single-input single-output systems. Prerequisite: EE 348

EE 480   Optical Fiber Communication Systems   (3 - 3 - 0)

Relevant characteristics of optical fibers, sources (LED and laser diodes), and photodetectors (PIN, APD) are introduced to provide the background for optical fiber communication system design. Subsystems design deals with optical transmitters, optical receivers, and optical components (switches, couplers, multiplexers, and demultiplexers). Optical fiber systems design and applications include long-haul optical transmission systems, local area networks, coherent optical communication, and future trends.

EE 485   Research in Electrical Engineering I   (- -)

Individual investigation of a substantive character taken at the undergraduate level under the guidance of a faculty advisor leading to a thesis with a public defense. The student's thesis committee consists of the faculty advisor and one or more readers. Prior approval from the faculty advisor and the Department Director is required. Hours to be arranged with the faculty advisor. For information regarding a Degree with Thesis, see the "Academic Procedures, Requirements, and Advanced Degrees" section of this catalog.

EE 486   Research in Electrical Engineering II   (- -)

Individual investigation of a substantive character taken at the undergraduate level under the guidance of a faculty advisor leading to a thesis with a public defense. The student's thesis committee consists of the faculty advisor and one or more readers. Prior approval from the faculty advisor and the Department Director is required. Hours to be arranged with the faculty advisor. For information regarding a Degree with Thesis, see the "Academic Procedures, Requirements, and Advanced Degrees" section of this catalog.

EE 493   Data and Computer Communications   (3 - 3 - 0)

Introduction to information networks, data transmission and encoding; digital communication techniques, circuit switching and packet switching, OSI protocols, switched networks and LANs, introduction to ISDN and ATM/SONET networks, system architectures.

EE 503   Introduction to Solid State Physics   (3 - 3 - 0)

Description of simple physical models which account for electrical conductivity and thermal properties of solids. Basic crystal lattice structure, X-ray diffraction and dispersion curves for phonons and electrons in reciprocal space. Energy bands, Fermi surfaces, metals, insulators and semiconductors, superconductivity and ferromagnetism. Cross-listed with: PEP 503, MT 503, PEP 501

EE 507   Introduction to Microelectronics and Photonics   (3 - 3 - 0)

An overview of microelectronics and photonics science and technology. It provides the student who wishes to specialize in their application, physics or fabrication with the necessary knowledge of how the different aspects are interrelated. It is taught in three modules: design and applications, taught by EE faculty; operation of electronic and photonic devices, taught by Physics faculty; fabrication and reliability, taught by the materials faculty. Cross-listed with: MT 507, PEP 507

EE 509   Intermediate Waves and Optics   (3 - 3 - 0)

The general study of field phenomena; scattering and vector fields and waves; dispersion, phase, and group velocity; interference, diffraction, and polarization; coherence and correlation; and geometric and physical optics. Cross-listed with: PEP 509

EE 510   Introduction to Radar Systems   (3 - 3 - 0)

The radar equation for pulses, signal to noise ratio, target cross section, and antenna parameters; Doppler radar, CW radar, multifrequency CW radar, FM radar, and chirp radar; tracking and acquisition radar, radar wave propagation; transmitter and receiver design;and interference considerations.

EE 515 **Photonics I** (3 - 3 - 0)

This course will cover topics encompassing the fundamental subject matter for the design of optical systems. Topics will include optical system analysis, optical instrument analysis, applications of thin-film coatings and opto-mechanical system design in the first term. The second term will cover the subjects of photometry and radiometry, spectrographic and spectrophotometric systems, infrared radiation measurement and instrumentation, lasers in optical systems and photon-electron conversion. Cross-listed with: PEP 515, MT 515 Prerequisite: EE 509

EE 516 **Photonics II** (3 - 3 - 0)

This course will cover topics encompassing the fundamental subject matter for the design of optical systems. Topics will include optical system analysis, optical instrument analysis, applications of thin-film coatings and opto-mechanical system design in the first term. The second term will cover the subjects of photometry and radiometry, spectrographic and spectrophotometric systems, infrared radiation measurement and instrumentation, lasers in optical systems and photon-electron conversion. Cross-listed with: PEP 516, MT 516 Prerequisite: EE 509 or PEP 509 or PEP 209

EE 517 **Digital and Computer Systems Architecture** (3 - 3 - 0)

This course covers the design and architecture of computer and digital systems in the system design region starting from the transistor/logic gate level to below the device driver level/system monitor level. The systems considered in the course will go beyond the computer chips or CPUs discussed in a typical computer architecture course, but will include complex logic devices such as application specific integrated circuits (ASICs), the core-designs for field programmable gate arrays (FPGAs), system-on-a-chip (SoC) designs, ARM, and other application-specific architectures. Printed circuit board-level architectural considerations for multiple complex digital circuits will also be discussed. Cross-listed with: CPE 517

EE 541 **Physics of Gas Discharges** (3 - 3 - 0)

Charged particle motion in electric and magnetic fields; electron and ion emission; ion-surface interaction; electrical breakdown in gases; dark discharges and DC glow discharges; confined discharge; AC, RF, and microwave discharges; arc discharges, sparks, and corona discharges; non-thermal gas discharges at atmospheric pressure; and discharge and low-temperature plasma generation. Typical texts: J.R. Roth, Industrial Plasma Engineering: Principles, Vol. 1 and Y.P. Raizer, Gas discharge Physics. Cross-listed with: PEP 541

EE 542 **Electromagnetism** (3 - 3 - 0)

Electrostatics; Coulomb-Gauss law; Poisson-Laplace equations; boundary value problems; image techniques, and dielectric media; magnetostatics; multipole expansion, electromagnetic energy, electromagnetic induction, Maxwell's equations, electromagnetic waves, waves in bounded regions, wave equations and retarded solutions, simple dipole antenna radiation theory, and transformation law of electromagnetic fields. Spring semester. Typical text: Reitz, Milford and Christy, Foundation of Electromagnetic Theory. Cross-listed with: PEP 542

EE 548 **Digital Signal Processing** (3 - 3 - 0)

Review of mathematics of signals and systems including sampling theorem, Fourier transform, z-transform, Hilbert transform; algorithms for fast computation: DFT, DCT computation, convolution; filter design techniques: FIR and IIR filter design, time and frequency domain methods, window method and other approximation theory based methods; structures for realization of discrete time systems: direct form, parallel form, lattice structure and other state-space canonical forms (e.g., orthogonal filters and related structures); roundoff and quantization effects in digital filters: analysis of sensitivity to coefficient quantization, limit cycle in IIR filters, scaling to prevent overflow, role of special structures. Cross-listed with: CPE 548

EE 551 **Engineering Programming: Python** (3 - 3 - 0)

This course presents tool, techniques, algorithms, and programming techniques using the Python programming language for data intensive applications and decision making. The course formally introduces techniques to: (i) gather,(ii) store, and (iii) process large volumes of data to make informed decisions. Such techniques find applicability in many engineering application areas, including communications systems, embedded systems, smart grids, robotics, Internet, and enterprise networks, or any network where information flows and alters decision making. Cross-listed with: CPE551

EE 552   Engineering Programming: Java   (3 - 3 - 0)

This course is a hands-on intensive introduction to solving engineering problem using Java. The focus is on building real applications including an electrical CAD package, molecular modelers, and controlling network communications. In the process, Java and object-oriented programming are mastered in order to implement efficient solutions to the target applications. Cross-listed with: CPE552

EE 553   Engineering Programming: C++   (3 - 3 - 0)

This course teaches a deep knowledge of C++ by focusing on common engineering problems. The focus is on engineering applications. In the beginning, the course covers computational goals to including statistics, smoothing data, numerical integration and calculation of volumes to teach/review basic programming logic, loops and function calls. Then we focus on more complex tasks such as simulation, localization and path planning for robotics, and teach object-oriented programming as part of an efficient solution to these engineering problems. By the end of the course, students will have a thorough knowledge of C++.

EE 556   Computing Principles for Mobile and Embedded Systems   (3 - 3 - 0)

Embedded systems have emerged as a primary application area, highlighting the co-integration of application-specific hardware components with programmable, flexible, adaptable, and versatile software components. Such systems have been one of the drivers of important new computing principles that play an important role in achieving optimal performance of the overall system. This course will provide the student with a background in these new computing principles and their application to embedded systems. Representative topics include emerging computing paradigms in the areas of context-aware pervasive systems, spatio-temporal access control with distributed software agents, vehicular computing, information systems cryptography, trust and privacy in mobile environments, location-aware services, RFID systems, wireless medical networks, and urban sensing. Cross-listed with: CPE 556

EE 560   Fundamentals of Remote Sensing   (3 - 3 - 0)

This course exposes the student to the physical principles underlying remote sensing of ocean, atmosphere, and land by electromagnetic and acoustic passive and active sensors: radars, lidars, infrared and microwaves thermal sensors, sonars, sodars, infrasound/seismic detectors. Topics include fundamental concepts of electromagnetic and acoustic wave interactions with oceanic, atmospheric, and land environment, as well as with natural and man-made objects. Examples from selected sensors will be used to illustrate the information extraction process, and applications of the data for environmental monitoring, oceanography, meteorology, and security/military objectives. Cross-listed with: OE 560, EN 560, CE 561, PEP 560 Prerequisites: PEP 201, PEP 112, E 246

EE 561   Solid State Electronics for Engineering I   (3 - 3 - 0)

This course introduces fundamentals of semiconductors and basic building blocks of semiconductor devices that are necessary for understanding semiconductor device operations. It is for first-year graduate students and upper-class undergraduate students in electrical engineering, applied physics, engineering physics, optical engineering and materials engineering who have no previous exposure to solid state physics and semiconductor devices. Topics covered will include description of crystal structures and bonding; introduction to statistical description of electron gas; free-electron theory of metals; motion of electrons in periodic lattice-energy bands; Fermi levels; semiconductors and insulators; electrons and holes in semiconductors; impurity effects; generation and recombination; mobility and other electrical properties of semiconductors; thermal and optical properties; p-n junctions; metal-semiconductor contacts. Cross-listed with: PEP 561, MT 561

EE 562   Solid State Electronics for Engineering II   (3 - 3 - 0)

This course introduces operating principles and develops models of modern semiconductor devices that are useful in the analysis and design of integrated circuits. Topics covered include: charge carrier transport in semiconductors; diffusion and drift; injection and lifetime; p-n junction devices; bipolar junction transistors; metal-oxide-semiconductor field effect transistors and high electron mobility transistors; microwave devices; light-emitting diodes, semiconductor lasers, and photodetectors; and integrated devices. Cross-listed with: MT 562, PEP 562

EE 568   Software-Defined Radio   (3 - 3 - 0)

This course offers an introduction to software-defined radios, devices that can be programmed to work with a variety of different radios. The course covers the following topics: software radio architectures, existing software radio efforts, a review of basic receiver design principles, and application to software radios. Basic questions, design tradeoffs, and architectural issues are also discussed. Several case studies of software radios will be discussed throughout the course.

EE 575   Introduction to Control Theory   (3 - 3 - 0)

An introduction to classic and modern feedback control that does not presume an undergraduate background in control. Transfer function and state space modeling of linear dynamic systems, closed-loop response, root locus, proportional, integral, and derivative control, compensators, controllability, observability, pole placement, linear–quadratic cost controllers, and Lyapunov stability. MATLAB simulations in control system design.

EE 582   Wireless Networking: Architecture, Protocols and Standards   (3 - 3 - 0)

This course addresses the fundamentals of wireless networking, including architectures, protocols and standards. It describes concepts, technology and applications of wireless networking as used in current and next-generation wireless networks. It explains the engineering aspects of network functions and designs. Issues such as mobility management, wireless enterprise networks, GSM, network signaling, WAP, mobile IP and 3G systems are covered. Cross-listed with: NIS 582, TM 582

EE 583   Wireless Communications   (3 - 3 - 0)

This courses serves as a broad introduction to the several technologies and applications of wireless communications systems. The emphasis is on providing a reasonable mixture of information leading to a broad understanding of the technical issues involved, with modest depth in each of the topics. As an integrating course, the topics range from the physics of wave generation/propagation/reception through the circuit/component issues, to the signal processing concepts, to the techniques used to impress the information (voice or data) on a wireless channel, to overviews of representative applications including current generation systems and next generation systems. Upon completion of this course, the student shall understand the manner in which the more detailed information in the other three courses is integrated to create a complete system. Cross-listed with: NIS 583

EE 584   Wireless Systems Security   (3 - 3 - 0)

Wireless systems and their unique vulnerabilities to attack; system security issues in the context of wireless systems, including satellite, terrestrial microwave, military tactical communications, public safety, cellular and wireless LAN networks; security topics: confidentiality/privacy, integrity, availability and control of fraudulent usage of networks. Issues addressed include jamming, interception and means to avoid them. Case studies and student projects are important components of the course. Cross-listed with: NIS 584, TM 584

EE 585   Physical Design of Wireless Systems   (3 - 3 - 0)

Physical design of wireless communication systems, emphasizing present and next generation architectures. Impact of non-linear components on performance; noise sources and effects; interference; optimization of receiver and transmitter architectures; individual components (LNAs, power amplifiers, mixers, filters, VCOs, phase-locked loops, frequency synthesizers, etc.); digital signal processing for adaptable architectures; analog-digital converters; new component technologies (SiGe, MEMS, etc.); specifications of component performance; reconfigurability and the role of digital signal processing in future generation architectures; direct conversion; RF packaging; minimization of power dissipation in receivers. Cross-listed with: MT 585, PEP 585, PEP 685

EE 587   Microwave Engineering I   (3 - 3 - 0)

A study of microwave techniques at both the component and system level. Topics include wave propagation and transmission, uniform and non-uniform transmission lines, rectangular and circular waveguide, losses, microstrip, waveguide excitation, modal expansion of waveguide fields, perturbation theory, ferrites, scattering parameters for lumped and distributed systems, general theory of microwave junctions waveguide components including tee's, circulators, isolators, phase shifters, splitters, and directional couplers.

EE 588   Microwave Engineering II   (3 - 3 - 0)

A more advanced treatment of microwave systems. Topics include coupled mode theory, periodic structures, cavities, cavity excitation and perturbation, circuit representations, broadband matching, microwave filter theory, antenna theory, including various types of wire antennas, horns, dishes, antenna arrays, phased arrays, sources, detectors, modulators, limiters, optical-microwave interaction, and microwave signal processing. Topics may vary to accommodate specific interests.

EE 589   Introduction to Power Engineering   (3 - 3 - 0)

Electric power systems provide the essential infrastructure upon which the modern industrial society is built. This course deals with the fundamental concepts in Power Systems. Topics covered will describe how electrical power is created, transmitted, and effectively used, including generators, transmission lines, transformers, and protection devices.

EE 590   Smart Grid   (3 - 3 - 0)

The course will cover the evolution of the smart grid, overview of energy production, the role of telecommunication technologies in efficient transmission, self healing networks that can withstand a failure in its transmission paths, flow of electricity in the system through intelligent metering and sensors networks, which are the true enablers of smart grid. The course will also explain risks to smart grid and protective measures to ensure system integrity while supplying energy at greater reliability and economy.

EE 595   Reliability and Failure of Solid State Devices   (3 - 3 - 0)

This course deals with the electrical, chemical, environmental and mechanical driving forces that compromise the integrity and lead to the failure of electronic materials and devices. Both chip and packaging level failures will be modeled physically and quantified statistically in terms of standard reliability mathematics. On the packaging level, thermal stresses, solder creep, fatigue and fracture, contact relaxation, corrosion and environmental degradation will be treated. Cross-listed with: MT 595, PEP 595 Prerequisites: EE 507, PEP 507 MT 507

EE 596   Micro-Fabrication Techniques   (3 - 3 - 0)

Deals with aspects of the technology of processing procedures involved in the fabrication of microelectronic devices and microelectromechanical systems (MEMS). Students will become familiar with various fabrication techniques used for discrete devices as well as large-scale integrated thin-film circuits. Students will also learn that MEMS are sensors and actuators that are designed using different areas of engineering disciplines and they are constructed using a microlithographically-based manufacturing process in conjunction with both semiconductor and micromachining microfabrication technologies. Cross-listed with: MT 596, PEP 596, NANO 596 Prerequisites: PEP 507, PEP 501, MT 501, EE 507 Corequisites: EE 507, MT 507, PEP 507, PEP 501, MT 501

EE 599   Curricular Practical Training   (1 to 3 - 0 - 0)

This course involves an educationally relevant practical industry project experience that augments the academic content of the student's program. Students engage in a project in industry that is relevant to the focus of their academic program. This project is conducted under the supervision of a faculty advisor and an industry mentor. During the semester, the student must submit written progress reports. At the end of the semester, the student must submit a final written report, and present a summary of his/her activities by means of a powerpoint presentation that will both be graded. This is a one-credit course that may be repeated up to a total of three credits.

EE 602   Analytical Methods in Electrical Engineering   (3 - 3 - 0)

The theory of linear algebra with application to state space analysis. Topics include Cauchy-Binet and Laplace determinant theorems, system of linear equations; linear transformations, basis and rank; Gaussian elimination; LU and congruent transformations; Gramm-Schmidt; eigenvalues, eigenvectors and similarity transformations; canonical forms; functions of matrices; singular value decomposition; generalized inverses; norm of a matrix; polynomial matrices; matrix differential equations; state space; controllability and observability.

EE 603   Linear System Theory   (3 - 3 - 0)

Fourier transforms; distribution theory; Gibbs phenomena; Shannon sampling; Poisson sums; discrete and fast Fourier transforms; Laplace transforms; z-transforms; the uncertainty principle; Hilbert transforms; computation of inverse transforms by contour integration; stability and realization theory of linear, time invariant, continuous and discrete systems.

EE 605   Probability and Stochastic Processes I   (3 - 3 - 0)

Axioms of probability; discrete and continuous random vectors; functions of random variables; expectations, moments, characteristic functions, and momentgenerating functions; inequalities, convergence concepts, and limit theorems; central limit theorem; and characterization of simple stochastic processes: widesense stationality and ergodicity. Cross-listed with: NIS 605, CS 505

EE 606   Probability and Stochastic Processes II   (3 - 3 - 0)

Introduction and review of probability as a measure, measure theoretic notions of random variables and stochastic processes, discrete time and continuous time Markov chains, renewal processes, delayed renewal processes, convergence of random sequences, martingale processes, stationarity and ergodicity. Applications of these topics with examples from networked communications, wireless communications, statistical signal processing and game theory.

EE 608   Applied Modeling and Optimization   (3 - 3 - 0)

Engineering, computational science and business students tackle various kinds of real-life optimization problems occurring in areas such as information theory, wireless communications, VLSI design, design and analysis of networks, optimal decision making etc. This course will provide a comprehensive coverage of several aspects of applied modeling and optimization. Complexity issues and numerical techniques (classical and non-classical techniques) to solve optimization problems will be the main thrust. Example problems arising in electrical engineering, computer engineering and business will be extensively used to illustrate the different optimization algorithms. This course will be computer projects based. Software packages such as MAPLE, MATLAB, CPLEX etc. will be used. Cross-listed with: NIS 608

EE 609   Communication Theory   (3 - 3 - 0)

Review of probability theory with applications to digital communications, digital modulation techniques, receiver design, bit error rate calculations, bandwidth efficiency calculations, convolutional encoding, bandwidth efficient coded modulation, wireless fading channel models, and shannon capacity, software simulation of communication systems. Cross-listed with: NIS 609

EE 610   Error Control Coding for Networks   (3 - 3 - 0)

Error-control mechanisms; Elements of algebra; Linear block codes; Linear cyclic codes; fundamentals of convolutional codes; Viterbi decoding codes in mobile communications; Trellis-coded modulation; concatenated coding systems and turbo codes; BCH codes; Reed-Solomon codes; implementation architectures and applications of RS codes; ARQ and interleaving techniques. Cross-listed with: NIS 610

EE 611   Digital Communications Engineering   (3 - 3 - 0)

Waveform characterization and modeling of speech/image sources; quantization of signals; uniform, nonuniform and adaptive quantizing; Pulse Code Modulation (PCM) systems; Differential PCM (DPCM); linear prediction theory, adaptive prediction; Deltamodulation and sigma-delta modulation systems; subband coding with emphasis on speech coding; data compression methods like Huffman coding, Ziv-Lempel coding and run length coding. Cross-listed with: NIS 611

EE 612   Principles of Multimedia Compression   (3 - 3 - 0)

Brief introduction to Information Theory; entropy and rate; Kraft-McMillan inequality; entropy codes - Huffman and arithmetic codes; scalar quantization-quantizer design issues, the Lloyd quantizer and the Lloyd-Max quantizer; vector quantization - LBG algorithm, other quantizer design algorithms; structured VQs; entropy constrained quantization; bit allocation techniques: generalized BFOS algorithm; brief overview of linear algebra; transform coding: KLT, DCT, LOT; subband coding; wavelets; wavelet based compression algorithms (third generation image compression schemes)- EZW algorithm, the SPIHT algorithm and the EBCOT algorithm; video compression: motion estimation and compensation; image and video coding standards: JPEG/ JPEG 2000, MPEG, H.263, H.263+; Source coding and error resilience. Cross-listed with: NIS 612

EE 613   Digital Signal Processing for Communications   (3 - 3 - 0)

This course teaches digital signal processing techniques for wireless communications. It consists of two parts. Part 1 covers basic DSP fundamentals, such as DFT, FFT, IIR and FIR filters and DSP algorithms (ZF, ML, MMSE). Part 2 covers DSP applications in wireless communications. Various physical layer issues in wireless communications are addressed, including channel estimation, adaptive equalization, synchronization, interference cancellation, OFDM, multi-user detection and rake receiver in CDMA, space-time coding and smart antennae.

EE 615   OFDM and Multicarrier Communications   (3 - 3 - 0)

This course reviews multicarrier modulation (MCM) methods which offer several advantages over conventional single carrier systems for broadband data transmission. Topics include fundamentals of MCM, where the data stream is divided into several parallel bit streams, each of which has a much lower bit rate, to exploit multipath diversity and practical applications. It will cover new advances, as well as the present core technology. Hands-on learning with computer-based approaches will include simulation in MATLAB and state-of-the-art high level software packages to design and implement modulation, filtering, synchronization, and demodulation.

EE 616   Signal Detection and Estimation for Communications   (3 - 3 - 0)

Introduction to signal detection and estimation principles with applications in wireless communication systems. Topics include optimum signal detection rules for simple and composite hypothesis tests, Chernoff bound and asymptotic relative efficiency, sequential detection and nonparametric detection; optimum estimation including Bayesian estimation and maximum likelihood, Fisher information and Cramer-Rao bound, linear estimation, least squares and weight least squares.

EE 617   Statistical Signal Processing   (3 - 3 - 0)

Mathematical modeling of signal processing; Wiener-Kalman filters, LP, and LMS methods; estimation and detection covering minimum-variance-unbiased (MVUB) and maximum likelihood (ML) estimators, Cramer-Rao bound, Bayes and Neyman-Pearson detectors, and CFAR detectors; methods of least squares (LS): batch mode, weighted LS, total LS (TLS), and recursive LS (RLS); SVD and high resolution spectral estimation methods including MUSIC, modified FBLP, and Min-Norm; higher order spectral analysis (HOSA) with applications of current interest; PDA and JPDA data association trackers with MultiDATTM; and applied computer projects on major topics.

EE 619   Solid State Devices   (3 - 3 - 0)

Operating principle, modeling and fabrication of solid state devices for modern optical and electronic system implementation; recent developments in solid state devices and integrated circuits; devices covered include bipolar and MOS diodes and transistors, MESFET, MOSFET transistors, tunnel, IMPATT and BARITT diodes, transferred electron devices, light emitting diodes, semiconductor injection and quantum-well lasers, PIN and avalanche photodetectors. Cross-listed with: PEP 619 Prerequisites: EE 503, MT 503, PEP 503

EE 620   Reliability Engineering   (3 - 3 - 0)

Combinatorial reliability including series, parallel, cascade, and multistage networks; Markov, Weibull, and exponential failure models; redundancy; repairability; marginal and catastrophic failures; and parameter estimation.

EE 621   Nonlinear Control   (3 - 3 - 0)

Methods for analysis and design of nonlinear control systems emphasizing Lyapunov theory. Second order systems, phase plane descriptions of ononlinerar phenomena, limit cycles, stability, direct and indirect method of Lyapunov, linearization, feedback linearization, Lyapunov-based design, and backstepping.

EE 626   Optical Communication Systems   (3 - 3 - 0)

Components for and design of optical communication systems; propagation of optical signals in single mode and multimode optical fibers; optical sources and photodetectors; optical modulators and multiplexers; optical communication systems: coherent modulators, optical fiber amplifiers and repeaters; transcontinental and transoceanic optical telecommunication system design; optical fiber LANs. Cross-listed with: NIS 626, MT 626, PEP 626

EE 627   Data Acquisition and Processing III   (3 - 3 - 0)

The application of electronic principles and analog and digital integrated circuits to the design of industrial and scientific instrumentation, process control, and robotics and automation. Topics include sensors and transducers, analog and digital signal conditioning and processing, data conversion, data transmission and interface standards, machine vision, control, and display. Microcomputers, microprocessors, and their support components are applied as system elements.

EE 628   Data Acquisition and Processing II   (3 - 3 - 0)

The application of electronic principles and analog and digital integrated circuits to the design of industrial and scientific instrumentation, process control, and robotics and automation. Topics include sensors and transducers, analog and digital signal conditioning and processing, data conversion, data transmission and interface standards, machine vision, control, and display. Microcomputers, microprocessors, and their support components are applied as system elements.

EE 631   Cooperating Autonomous Mobile Robots   (3 - 3 - 0)

Advanced topics in autonomous and intelligent mobile robots, with emphasis on planning algorithms and cooperative control. Robot kinematics, path and motion planning, formation strategies, cooperative rules, and behaviors. The application of cooperative control spans from natural phenomena of groupings, such as fish schools, bird flocks, and deer herds, to engineering systems such as mobile sensing networks and vehicle platoon. Cross-listed with: NIS 651

EE 647   Analog and Digital Control Theory   (3 - 3 - 0)

State space description of linear dynamical systems; canonical forms; solutions of state equations; controllability, observability, and minimality; Lyapunov stability; pole placement; asymptotic observer and compensator design andquadratic regulator theory; extensions to multivariable systems; matrix fraction description approach; and elements of time-varying systems.

EE 651   Spread Spectrum and CDMA   (3 - 3 - 0)

Basic concepts, models and techniques; direct sequence frequency hopping, time hopping, chirp and hybrid systems, jamming game, anti-jam systems, analysis of coherent and non-coherent systems; synchronization and demodulation; multiple access systems; ranging and tracking; pseudo-noise generators. Cross-listed with: NIS 651

EE 653   Cross-Layer Design for Wireless Networks   (3 - 3 - 0)

Introduction to wireless networks and layered architecture, principles of cross-layer design, impact of cross-layer interactions for different architectures: cellular and ad hoc networks, model abstractions for layers in cross-layer design for different architectures (cellular and ad hoc networks), quality of service (QoS) provisioning at different layers of the protocol stack with emphasis on physical layer, medium access control (MAC) and network layers, examples of cross-layer design in the literature: joint optimizations involving beamforming, interference cancellation techniques, MAC protocols, admission control, power control, routing and adaptive modulation. Cross-listed with: NIS 653

EE 663   Digital Signal Processing I   (3 - 3 - 0)

Review of mathematics of signals and systems including sampling theorem, Fourier transform, z-transform, Hilbert transform; algorithms for fast computation: DFT, DCT computation, convolution; filter design techniques: FIR and IIR filter design, time and frequency domain methods, window method and other approximation theory based methods; structures for realization of discrete time systems: direct form, parallel form, lattice structure and other state-space canonical forms (e.g., orthogonal filters and related structures); roundoff and quantization effects in digital filters: analysis of sensitivity to coefficient quantization, limit cycle in IIR filters, scaling to prevent overflow, role of special structures.

EE 664   Advanced Digital Signal Processing   (3 - 3 - 0)

Implementation of digital filters in high speed architectures; multirate signal processing: Linear periodically time varying systems, decimators and expanders, filter banks, interfacing digital systems operating at multiple rates, elements of subband coding and wavelet transforms; signal recovery from partial data: from zero crossing, level crossing, phase only, magnitude only data; elements of spectral estimation: MA, R & ARMA models. lattice, Burg methods, MEM.

EE 666   Multidimensional Signal Processing   (3 - 3 - 0)

Mathematics of multidimensional (MD) signals and systems; frequency and state space description of MD systems; multidimensional FFT; MD recursive and nonrecursive filters, velocity and isotropic filters, their stability and design; MD spectral estimation with applications in array processing; MD signal recovery from partial information such as magnitude, phase, level crossing etc.; MD subband coding for image compression; selected topics from computer aided tomography and synthetic aperture radar.

EE 670   Information Theory and Coding   (3 - 3 - 0)

An introduction to information theory methods used in the analysis and design of communication systems. Typical topics include: entropy, relative entropy and mutual information; the asymptotic equipartition property; entropy rates of stochastic process; data compression; Kolmogorov complexity; channel capacity; differential entropy; the Gaussian channel; maximum entropy and mutual information; rate distortion theory; network information theory; algebraic codes.

EE 672   Applied Game Theory and Evolutionary Algorithms   (3 - 3 - 0)

Part I: Introduction to game theory: games in strategic form and Nash equilibrium, Existence and properties of Nash equilibrium, Pareto efficiency, Extensive form games, repeated games, Bayesian games and Bayesian equilibrium, types of games and equilibrium properties, learning in games. Part II: Applications for wireless networks: resource allocation, enforcing cooperation in ad hoc networks, cognitive radios. Cross-listed with: NIS 672

EE 673　　　　Wireless Communications　　　　　　　　　　　　　　(3 - 3 - 0)

Introduction to wireless communication systems; the concept of frequency reuse; basic planning of a cellular system, elements of cellular radio design system; propagation characteristics of cellular radio channels; frequency management, channel allocation and handoff mechanisms; specifications of digital cellular systems in USA and Europe; Spread spectrum cellular communications; elements of cordless communication systems.

EE 674　　　　Satellite Communications　　　　　　　　　　　　　(3 - 3 - 0)

Overview of communication theory, modulation techniques, conventional multiple access schemes, and SS/TDMA; satellite and frequency allocation, analysis of satellite link, and identification of the parameters necessary for the link calculation; modulation and coding; digital modulation methods and their comparison; error correction coding for the satellite channel, including Viterbi decoding and system performance; synchronization methods and carrier recovery; and effects of impairment on the channel.

EE 681　　　　Fourier Optics　　　　　　　　　　　　　　　　　(3 - 3 - 0)

An introduction to two-dimensional linear systems, scalar diffraction theory, and Fresnel and Fraunhofer diffraction. Applications of diffraction theory to thin lenses, optical imaging systems, spatial filtering, optical information processing, and holography.

EE 683　　　　Wireless Systems Overview　　　　　　　　　　　　　(3 - 3 - 0)

This courses serves as a broad introduction to the several technologies and applications of wireless communications systems. The emphasis is on providing a reasonable mixture of information leading to a broad understanding of the technical issues involved, with modest depth in each of the topics. As an integrating course, the topics range from the physics of wave generation/propagation/reception through the circuit/component issues, to the signal processing concepts, to the techniques used to impress the information (voice or data) on a wireless channel, to overviews of representative applications including current generation systems and next generation systems. Upon completion of this course, the student shall understand the manner in which the more detailed information in the other three courses is integrated to create a complete system.

EE 684　　　　Spread Spectrum and CDMA　　　　　　　　　　　　(3 - 3 - 0)

Provides depth in the several topics related to signal processing and data processing that appear within wireless communications systems. The treatment is mathematical, providing depth in the analytic formulations and analysis techniques. Digital signal processing techniques will be given particular emphasis, recognizing their considerable influence on present and emerging designs. However, these digital signal processing techniques will be supplemented by analog signal processing techniques will be supplemented by analog signal processing techniques, which continue to be important for front-ends of receivers (and will remain important as carrier frequencies continue to migrate to higher frequencies). In addition to covering the mathematical principles of digital and analog signal processing, the course will cover contemporary digital signal processors. The data processing issue arises in the coding of data for improved communications performance. Compression algorithms, reducing the amount of data that must be transmitted, coding techniques to provide error detection/protection, and encryption techniques to improve security are representative examples of data processing.

EE 685　　　　Physical Design of Wireless Systems　　　　　　　　　(3 - 3 - 0)

The emphasis will be on the design of the transmitter and receiver sections of a wireless system, but antenna design will also be covered to provide an understanding of the techniques used to achieve directional and steerable antennas when appropriate for the given wireless system. The wide range of carrier frequencies seen in wireless systems leads to a variety of semiconductor and other technologies being required at different carrier frequencies. In addition, the bandwidth of the signal leads to substantially different issues arising in the packaging used for the transmitter and receiver ends. For lower carrier frequencies, advanced silicon IC technologies are preferred, given the maturity of the technology and the considerable density of both analog and digital circuitry that can be integrated on a single IC. At higher frequencies, the limits of contemporary silicon technologies are encountered, leading to use of specialized semiconductor technologies such as GaAs and SiGe circuits. In addition, the difficulty of realizing high accuracy analog/digital conversions at multi-GHz frequencies leads to a preference, at this time, for analog for analog circuitry at the higher frequencies. On the other hand, analog/digital conversions are becoming possible at sufficiently high sampling rates that digital processing is being strongly pursued directly at the front end of a receiver, allowing a variety of new techniques to be considered for the overall receiver design. In cases where front-end digital signal processing cannot be achieved, such digital processing is increasingly used at intermediate frequencies (i.e., the IF section). In the case of data communications, digital techniques are almost certainly used at baseband, for example to separate the data signal from the received analog signal, to perform data decoding, etc. The course will include material related to contemporary digital signal processor technologies, supplementing the discussions in Course 2 by considering in greater depth the physical design and performance limitations of technologies and architectures.

EE 686   High-Level Operation, Performance, Standards, and   (3 - 3 - 0)
                Control of Wireless Communications Systems

Provides the student with depth in the overall understanding of the high-level definition and operation of a contemporary wireless system. Since many wireless systems involve connections among hardware developed by different commercial manufacturers, national and international standards play a major role in the evolution of wireless systems. Earlier first generation systems evolved to today's second generation systems, with third generation systems expected shortly. One component of this course relates to these important standards. There are several fundamentally different wireless systems applications simultaneously evolving. Some relate to personal communications services (e.g., cellular telephony, wireless modems, etc.). Others relate to LANs, implemented in wireless rather than wired technologies to allow mobility or ease of access but providing data rates competitive with wired systems. Satellite communications systems (e.g., the Iridium system) are emerging and promise to provide a particularly interesting means of extending communication services. GPS systems provide an important means of determining one's position to high accuracy. Digital and software radios exploit the familiar concept of radio transmissions to provide digital information (and draw upon channel assignment schemes related to the radio metaphor). In addition to the commercial development of separate (and non-integrated) wireless systems of the various types above, there are important military applications in which the various systems are integrated to provide a versatile communications systems designed for battlefield applications. Upon completion of this course, the student will have depth of understanding in the high-level, systems-oriented view of wireless systems.

EE 689   Applied Antenna Theory   (3 - 3 - 0)

Brief review of electromagnetic theory; Maxwell's equations; the wave equations; plane waves and spherical waves; explanation of phenomenon of radiation; the incremental dipole antenna; dipole antennas including half-wave dipole and grounded monopole. Linear-antenna arrays such as Yagi-Uda array and log-periodic array. Radiation from an aperture such as rectangular and circular apertures. Prime-focus fed paraboloidal reflector antennas; far-field patterns, directivity, effects of scanning and effects of random surface imperfections. Shaped-reflector paraboloidal reflector antennas, Cassegrain and Gregorian paraboloidal antennas. Offset para-boloidal reflectors, spherical reflectors. Tracking antennas, types of monopulse patterns, antenna noise, concept of G/T.

EE 690   Introduction to VLSI Design   (3 - 3 - 0)

This course introduces students to the principles and design techniques of Very Large Scale Integrated Circuits (VLSI). Topics include: MOS transistor characteristics, DC analysis, resistance, capacitance models, transient analysis, propagation delay, power dissipation, CMOS logic design, transistor sizing, layout methodologies, clocking schemes, case studies. Students will use VLSI CAD tools for layout, and simulation. Selected class projects may be sent for fabrication. Cross-listed with: MT 690, PEP 690

EE 693   Heterogeneous Computing Architecture and Hardware   (3 - 3 - 0)

This course presents tools, techniques and algorithms to accelerate compute intensive applications, via a combination of computing devices such as the GPU, FPGA and multi-core CPU on a heterogeneous platform. Computationally intensive problems present various challenges in terms of tasks with different characteristics and features. With the exponential growth of data from sensors, biological sequencing, financial transactions, multimedia and user generated content; there is a strong need to accelerate the processing involved at various levels. Such applications benefit highly from heterogeneous computing architecture. The basics of GPU architecture, programming tools, such as CUDA and OpenCL, real-world applications that benefit from GPU computing will be presented. This is followed by the techniques for multi-core CPU programming, hardware design via Verilog as well as advantages of FPGA for various low latency applications and a combination of the two architectures to accelerate scientific applications.

EE 695   Applied Machine Learning   (3 - 3 - 0)

An introduction course for machine learning theory, algorithms and applications. This course aims to provide students with the knowledge in understanding key elements of how to design algorithms/systems that automatically learn, improve and accumulate knowledge with experience. Topics covered in this course include decision tree learning, neural networks, Bayesian learning, reinforcement learning, ensembling multiple learning algorithms, and various application problems. The students will have chances to simulate their algorithms in a programming language and apply them to solve real-world problems. Cross-listed with: CPE 695

EE 700   Seminar in Electrical Engineering   (0 - -)

An ECE seminar on topics of current interest.

EE 701   EE Co-Op Education Project   (0 - 0 - 0)

This course is for EE graduate students who are on Co-Op assignment.

EE 710   Selected Topics in Multicarrier Communications   (3 - 3 - 0)

This course reviews multicarrier modulcation (MCM) methods that offer several advantages over conventional single carrier systems for broadband data transmission. Topics include fundamentals of MCM, where the data stream is divided up into several parallel bit streams, each of which has a much lower bit rate, to exploit multipath diversity and the practical applications. It will cover new advances as well as the core technology. Hands on learning with computer based learning approaches will include simulation in MATLAB and state of the art high level software packages to design and implement modulation, filtering, synchronization and demodulation.

EE 740   Selected Topics in Communication Theory   (3 - 3 - 0)

A participating seminar in the area of modern communications. Typical topics include high-resolution spectral estimation, nonparametric and robust signal processing, CFAR radars, diversity techniques for fading multipath channels, and adaptive nonlinear equalizers of optical communications.

EE 775   Selected Topics in Information Theory and Coding   (3 - 3 - 0)

Current topics in information theory and coding. Typical topics include: basic theorems of information theory, entropy, channel capacity, and error bounds. Rate distortion theory: discrete source with a fidelity criterion, minimum distortion quantization, bounds on rate-distortion functions, error control codes: review of prerequisite linear algebra and field theory, linear block codes, cyclic algebraic codes, convolutional codes, and sequential decoding.

EE 800   Special Problems in Electrical Engineering   (3 - -)

An investigation of a current research topic at the pre-master's level, under the direction of a faculty member. A written report is required, which should have the substance of a publishable article. Students with no practical experience who do not write a master's thesis are invited to take advantage of this experience.

EE 801   Special Problems in Electrical Engineering   (3 - -)

An investigation of a current research topic beyond that of EE 800 level, under the direction of a faculty member. A written report, which should have the substance of a publishable article, is required. It should have importance in modern electrical engineering. This course is open to students who intend to be doctoral candidates and wish to explore an area that is different from the doctoral research topic.

EE 810   Special Topics in Electrical Engineering   (3 - -)

A participating seminar on topics of current interest and importance in Electrical Engineering.

EE 900   Thesis in Electrical Engineering (ME)   (1 to 10 - -)

A thesis of significance to be filed in libraries, demonstrating competence in a research area of electrical engineering. For the degree of Master of Engineering (Electrical Engineering). Credits to be arranged.

EE 950   Electrical Engineering Design Project (Deg EE)   (3 - 0 - 0)

An investigation of a current engineering topic or design. A written report is required.

EE 960   Research in Electrical Engineering   (- -)

Original research of a significant character, undertaken under the guidance of a member of the departmental faculty, which may serve as the basis for the dissertation required for the degree of Doctor of Philosophy. Hours and credits to be arranged.

Computer Engineering

CPE 181   Seminar in Computer Engineering   (1 - 1 - 0)

Introduction to electrical and computer engineering, addressing theoretical foundation, systems, and applications. Topics include information theory, control theory, power systems, wireless systems, information networks, sensor networks, and internet of things. Cross-listed with: EE 181

CPE 322   Engineering Design VI   (2 - 1 - 3)

This course addresses the general topic of selection, evaluation, and design of a project concept, emphasizing the principles of team-based projects and the stages of project development. Techniques to acquire information related to the state-of-the-art concepts and components impacting the project, evaluation of alternative approaches and selection of viable solutions based on appropriate cost factors, presentation of proposedprojects at initial, intermediate and final stages of development, and related design topics. Students are encouraged to use this experience to prepare for the senior design project courses. Prerequisite: E 321 Corequisite: CPE 345

CPE 345   Modeling and Simulation   (3 - 3 - 0)

Development of deterministic and non-deterministic models for physical systems, engineering applications, and simulation tools for deterministic and non-deterministic systems. Case studies and projects.

CPE 358   Switching Theory and Logical Design   (3 - 3 - 0)

Digital systems, number systems and codes, Boolean algebra, application of Boolean algebra to switching circuits, minimization of Boolean functions using algebraic, Karnaugh map and tabular methods, design of combinational circuits, programmable logic devices, sequential circuit components, design and analysis of synchronous and asynchronous sequential circuits. Cross-listed with: CS 381, CS 381

CPE 360   Computational Data Structures and Algorithms   (3 - 3 - 0)

The role of data structures and algorithms in the real world; principles of programming including the topics of control flow, recursion and I/O; principles of computational intelligence; topics from elementary data structures including arrays, lists, stacks, queues, pointers, strings; searching and sorting; data structures for concurrent execution; topics from elementary algorithms including analysis of algorithms and efficiency, computational complexity, empirical measurements of computational complexity of algorithms, proof techniques including induction; selected topics from advanced algorithms including distributed algorithms; programming laboratory exercises and projects. Prerequisite: E 115

CPE 384   Data Structures and Algorithms I   (3 - 3 - 0)

An introduction to basic data structures and algorithms. Emphasis will be placed on programming in C++ and debugging skills. Topics include: control flow, loops,recursion, elementary data structures (lists, stacks, queues) and their implementation via arrays and pointers, primitive sorting algorithms, binary trees and searching. Prerequisites: CS 115, CS 181

CPE 385   Data Structures and Algorithms II   (3 - 3 - 0)

A continuation of CS384/CPE360, this course focuses on algorithm development including running time analysis and correctness arguments. Topics include: asymptotic notation and running time analysis, program verification using loop invariants, advanced sorting algorithms, linear sorting algorithms, lower bounds, general trees, priority queues and heaps, set implementations, elementary graph algorithms. Prerequisite: CPE 360 or CS 384 Corequisite: MA 334

CPE 390   Microprocessor Systems   (4 - 3 - 3)

A study of the implementation of digital systems using microprocessors. The architecture and operation of microprocessors is examined in detail along with I/O interfacing, interrupts, DMA and software design techniques. Specialized controller chips for interrupts, DMA, arithmetic processing, graphics and communications are discussed. The laboratory component introduces hardware and software design of digital systems using microprocessors. Design experiments include topics such as bus interfacing, memory decoding, serial communications and programmable ports. Cross-listed with: E 115 Prerequisite: E 115

CPE 423   Engineering Design VII   (3 - 0 - 8)

Senior Design course. The development of design skills and engineering judgment, based upon previous and current course and laboratory experience, is accomplished by participation in a design project. Projects are selected in areas of current interest such as communication and control systems, signal processing, and hardware and software design for computer-based systems. To be taken during the student's last fall semester as an undergraduate student. Prerequisite: CPE 322

CPE 424   Engineering Design VIII   (3 - 0 - 8)

A continuation of CPE423 in which the design is implemented and demonstrated. This includes the completion of a prototype (hardware or software), testing and demonstrating the performance, and the evaluation of results. To be taken during the student's last spring semester as an undergraduate student. Prerequisite: CPE 423

CPE 437   Interactive Computer Graphics   (3 - 3 - 0)

Introduction to computer graphics. Designing a complete 2-D graphics package with an interface. Graphics hardware overview. Drawing of 2-D primitives (polylines, polygons, and ellipses). Character generation. Attribute primitives (line styles, color and intensity, area filling, and character attributes). 2D transformations (translation, general scaling, general rotation, shear, reflection). Windowing and clipping. 3-D concepts (3-D transformations, 3-D viewing, and 3-D modeling). Selected topics. Cross-listed with: CS 437

CPE 440   Current Topics in Electrical Engineering & Computer Engineering   (3 - 3 - 0)

This course consists of lectures designed to explore a topic of contemporary interest from the perspective of current research and development. In addition to lectures by the instructors and discussions led by students, the course includes talks by professionals working in the topic being studied. When appropriate, team-based design projects are included. Cross-listed with: EE 440

CPE 441   Introduction to Wireless Systems   (3 - 3 - 0)

Review of history, concepts and technologies of wireless communications; Explanations and mathematical models for analyzing and designing wireless systems; Description of various wireless systems, including cellular systems,wireless local area networks and satellite-based communication systems; Wireless design projects using Matlab, LabView and software defined radio. Cross-listed with: EE 441

CPE 442   Database Management Systems   (4 - 4 - 0)

Introduction to the design and querying of relational databases. Topics include: relational schemas; keys and foreign key references; relational algebra (as an introduction to SQL); SQL in depth; Entity-Relationship (ER) database design; translating from ER models to relational schemas and from relational schemas to ER models; functional dependencies; and normalization. Cross-listed with: CS 442 Prerequisite: CPE 385

CPE 450   Real-Time Embedded Systems   (3 - 3 - 0)

Unlike typical software-based systems, real-time systems must complete their tasks within specified timeframes. Unlike general purpose computing platforms, embedded systems must perform their tasks while minimizing tightresource constraints. This course addresses the considerations in designing real-time embedded systems, both from a hardware and software perspective. The primary emphasis is on real-time processing for communications and signal processing systems, but applications to seismic and environmental monitoring,process control, and biomedical systems will be addressed. Programming projects in a high level language like C/C++ will be an essential component of the course, as well as hardware design with modern design tools.

CPE 460   Software Design and Development   (3 - 3 - 0)

Theory of software design, with emphasis on large systems. Models of the software process, specifications development, designing, coding and testing. Program abstraction with functional abstraction and with abstract data types. Top-down and bottom-up development methods. Common software architecture models. Specification Validation, design verification, testing strategies, test coverage issues. Prerequisite: CPE 385

CPE 462   Introduction to Image Processing and Coding   (3 - 3 - 0)

Image acquisition, storage, image formation, sampling, basic relationship between pixels, imaging geometry, segmentation: edge detection, edge linking and boundary detection, Hough transform, region growing, thresholding, split and merge, histogram matching, representation: chain code, polygonal approximation and skeletonization, thinning algorithms, texture, image compression: elementary discussion of motion vectors for compression, discussion of industry standards such as JEPG and MPEG. Prerequisite: E 245

CPE 470   Parallel Processing   (3 - 3 - 0)

Learn how multiple computational threads may be detected in ordinary code, and how such threads may be tailored for execution on parallel and superscalar architectures. Topics include: introduction to the architecture of parallel and superscalar machines, lexical and syntax analysis, data dependence analysis, control dependence anlysis, generation of code for parallel and superscalar architecture. Students are required to complete a significant programming project. Prerequisites: CPE 390, CPE 385

CPE 485 Research in Computer Engineering I (- -)

Individual investigation of a substantive character taken at the undergraduate level under the guidance of a faculty advisor leading to a thesis with a public defense. The student's thesis committee consists of the faculty advisor and one or more readers. Prior approval from the faculty advisor, a faculty member who has agreed to supervise the research, and the Department Director is required. Hours to be arranged with the faculty advisor. For information regarding a Degree with Thesis, see the "Academic Procedures, Requirements, and Advanced Degrees" section of this catalog. The thesis option is a two-semester program requiring completion of CPE 485 and CPE 486. Continuation into CPE 486 is contingent on demonstrating adequate progress in CPE 485.

CPE 486 Research in Computer Engineering II (- -)

Individual investigation of a substantive character taken at the undergraduate level under the guidance of a faculty advisor leading to a thesis with a public defense. The student's thesis committee consists of the faculty advisor and one or more readers. Prior approval from the faculty advisor, a faculty member who has agreed to supervise the research, and the Department Director is required. Hours to be arranged with the faculty advisor. For information regarding a Degree with Thesis, see the "Academic Procedures, Requirements, and Advanced Degrees" section of this catalog. The thesis option is a two-semester program requiring completion of CPE 485 and CPE 486. Continuation into CPE 486 is contingent on demonstrating adequate progress in CPE 485. Prerequisite: CPE 485

CPE 487 Digital System Design (3 - 2 - 1)

Design of complex digital CMOS/VLSI circuits. Introduction to MOS transistor characteristics and fabrication, digital circuit design and layout for integrated circuits, major categories of VLSI circuit functions, design methodologies including use of Hardware Description Languages (HDL), FPGA, verification, simulation, testability. The course includes a project using VHDL for the design of a significant system function. Prerequisite: E 245

CPE 488 Computer Architecture (3 - 3 - 0)

An introduction to the functional level structure of modern pipelined processors and the empirical and analytic evaluation of their performance. Topics include: empirical and analytic techniques for measuring performance (use of various means, Amdahl's Law, and benchmarks); tradeoff analysis; principles of instruction set design and evaluation (memory addressing, operations, types and sizes of operands, instruction set encoding, CISC vs. RISC, and related compilation issues); pipelining (basics, data hazards, and control hazards); and memory systems. Cross-listed with: CS 488 Prerequisite: CS 383

CPE 490 Information Systems Engineering I (3 - 3 - 0)

The focus of the course is on data networks and end-user software environments for information systems. Topics include the TCP/IP protocols, organization of large-scale data networks, end-to-end operation over heterogeneous networks and the software foundation of client-server application programs. The students complete a project using TCP/IP protocols to create a basic client-server application. Prerequisite: MA 134

CPE 491 Information Systems Engineering II (3 - 3 - 0)

This course emphasizes a major component of contemporary networked information systems, namely visually rich information, including multimedia, virtual reality, human-machine interactions and related topics. The students complete a project in which they demonstrate competency in creating and manipulating the information and the resources used to store, transfer and present the information.

CPE 493 Data and Computer Communications (3 - 3 - 0)

Introduction to information networks, data transmission and encoding, digital communication techniques, circuit switching and packet switching, OSI protocols, switched networks and LANs, introduction to ISDN and ATM/SONET networks, system architectures. Prerequisite: E 234

CPE 494 Networked Systems Design: Principles and Practices (3 - 3 - 0)

Basic elements in local and wide-area network infrastructures, architecture and protocols at all layers; client-server systems programming using sockets and remote procedure cells; concurrency and coordination issues and techniques; concepts and tools for fault tolerance, failure detection, checkpointing, disaster recovery and rejuvenation in networked applications; overview of network systems middleware facilities such as .NET and Weblogic to illustrate the above principles and techniques.

CPE 514   Computer Architecture   (3 - 3 - 0)

Measures of cost, performance, and speedup; instruction set design; processor design; hard-wired and microprogrammed control; memory hierarchies; pipelining; input/output systems; and additional topics as time permits. The emphasis in this course is on quantitative analysis of design alternatives. Cross-listed with: NIS 514, CS 514 Prerequisite: CPE 550

CPE 517   Digital and Computer Systems Architecture   (3 - 3 - 0)

This course covers the design and architecture of computer and digital systems in the system design region starting from the transistor/logic gate level to below the device driver level/system monitor level. The systems considered in the course will go beyond the computer chips or CPUs discussed in a typical computer architecture course, but will include complex logic devices such as application specific integrated circuits (ASICs), the core-designs for field programmable gate arrays (FPGAs), system-on-a-chip (SoC) designs, ARM, and other application-specific architectures. Printed circuit board-level architectural considerations for multiple complex digital circuits will also be discussed. Cross-listed with: EE 517

CPE 521   Autonomous Mobile Robotic Systems   (3 - 3 - 0)

This course will offer the students an overview of the technology of autonomous mobile robotic systems the mechanisms that allow a mobile robot to move through a real-world environment to perform its tasks. Since the design of any successful mobile robot involves the integration of many different disciplines -- among them kinematics, signal analysis, information theory, artificial intelligence, and probability theory -- the course will discuss all facets of mobile robotic system, including hardware design, wheel design, kinematics analysis, sensors and perception, localization, mapping, motionplanning, navigation, and robot control architectures. Multi-robot systems will also be introduced due to their broader applications, such as search and rescue tasks, and exploring tasks.

CPE 533   Cost Estimation and Metrics   (3 - 3 - 0)

An objective cost model is necessary for planning and executing software projects. A cost model provides a framework for communicating business decisions among the stakeholders of a software effort; it supports contract negotiations, process improvement analysis, tool purchases, architecture changes, component make/buy tradeoffs, and several other return-on-investment decisions. This course provides the student with a through introduction to software estimation and to industry standard tools, like COCOMOII, used in cost estimation. Cross-listed with CS533 .

CPE 536   Integrated Services - Multimedia   (3 - 3 - 0)

Types of multimedia information: voice, data video facsimile, graphics, and their characterization; modeling techniques to represent multimedia information; analysis and comparative performances of different models; detection techniques for multimedia signals; specification of multimedia representation based on service requirements; and evaluation of different multimedia representations to satisfy user applications and for generating test scenarios for standardization. Cross-listed with: NIS 536, CS 536

CPE 537   Interactive Computer Graphics   (3 - 3 - 0)

This is an introductory-level course to computer graphics. No previous knowledge on the subject is assumed. The objective of the course is to provide a comprehensive introduction to the field of computer graphics, focusing on the underlying theory, and thus providing strong foundations for both designers and users of graphical systems. The course will study the conceptual framework for interactive computer graphics, introduce the use of OpenGL as an application programming interface (API), and cover algorithmic and computer architecture issues. Cross-listed with: CS 537 Prerequisite: CPE 590

CPE 540   Fundamentals of Quantitative Software Engineering I   (3 - 3 - 0)

This course introduces the subject of software engineering, also known as software development process or software development best practice from a quantitative, analytic- and metrics-based point of view. Topics include introductions to: software life-cycle process models from the heaviest weight, used on very large projects, to the lightest weight, such as, extreme programming; industry-standard software engineering tools; teamwork; project planning and management; object-oriented analysis and design. The course is case-history and project oriented. Cross-listed with: CS 540, SSW 540

CPE 542   Fundamentals of Quantitative Software Engineering II   (3 - 3 - 0)

This course is a project-oriented continuation of CS540. It is intended for computer science majors interested in learning software development process, but not interested in the full MS program in QSE or the Graduate Certificate in QSE. Prerequisite: CS540

CPE 545   Communication Software and Middleware   (3 - 3 - 0)

Communications in computer networks are not only enabled by physical links and hardware, but are also enabled by software and middleware. This course provides an understanding of software techniques in communications. It explores development models that address a broad range of issues in the design of communication software, including hardware and software partitioning, layering, and protocol stacks. Other topics are configuration techniques, buffer and timer management, task and table managements, and multi-board communications software design. Communication middleware and agent technologies as enabling technology in networking will also be covered.

CPE 548   Digital Signal Processing   (3 - 3 - 0)

Review of mathematics of signals and systems including sampling theorem, Fourier transform, z-transform, Hilbert transform; algorithms for fast computation: DFT, DCT computation, convolution; filter design techniques: FIR and IIR filter design, time and frequency domain methods, window method and other approximation theory based methods; structures for realization of discrete time systems: direct form, parallel form, lattice structure and other state-space canonical forms (e.g., orthogonal filters and related structures); roundoff and quantization effects in digital filters: analysis of sensitivity to coefficient quantization, limit cycle in IIR filters, scaling to prevent overflow, role of special structures. Cross-listed with: EE 548

CPE 550   Computer Organization and Programming   (3 - 3 - 0)

This course provides an intensive introduction to material on computer organization and assembly language programming required for entrance into the graduate program in Computer Science or Computer Engineering. The topics covered are: structure of stored program computers; linking and loading; assembly language programming, with an emphasis on translation of high-level language constructs; data representation and arithmetic algorithms; basics of logic design; processor design: data path, hardwired control and microprogrammed control. Students will be given assembly language programming assignments on a regular basis. Cross-listed with: CS 550 Prerequisite: CS 580

CPE 551   Engineering Programming: Python   (3 - 3 - 0)

This course presents tool, techniques, algorithms, and programming techniques using the Python programming language for data intensive applications and decision making. The course formally introduces techniques to: (i) gather,(ii) store, and (iii) process large volumes of data to make informed decisions. Such techniques find applicability in many engineering application areas, including communications systems, embedded systems, smart grids, robotics, Internet, and enterprise networks, or any network where information flows and alters decision making. Cross-listed with: EE 551.

CPE 552   Engineering Programming: Java   (3 - 3 - 0)

This course is a hands-on intensive introduction to solving engineering problem using Java. The focus is on building real applications including an electrical CAD package, molecular modelers, and controlling network communications. In the process, Java and object-oriented programming are mastered in order to implement efficient solutions to the target applications. Cross-listed with: EE 552.

CPE 555   Real-Time and Embedded Systems   (3 - 3 - 0)

The miniaturization of electronics and increasingly sophisticated software environments has enabled the realization of systems that embed intelligence within a wide variety of systems interacting in real time with the environment. Such systems are characterized by hardware/software integration along with integration of both analog and digital electronics. Representative topics include specification of the overall system, real-time operating system, embedded network protocols, tradeoffs between hardware and software, etc. The lectures will be complemented by projects related to design of such systems.

CPE 556   Computing Principles for Mobile and Embedded Systems   (3 - 3 - 0)

Embedded systems have emerged as a primary application area, highlighting the co-integration of application-specific hardware components with programmable, flexible, adaptable, and versatile software components. Such systems have been one of the drivers of important new computing principles that play an important role in achieving optimal performance of the overall system. This course will provide the student with a background in these new computing principles and their application to embedded systems. Representative topics include emerging computing paradigms in the areas of context-aware pervasive systems, spatio-temporal access control with distributed software agents, vehicular computing, information systems cryptography, trust and privacy in mobile environments, location-aware services, RFID systems, wireless medical networks, and urban sensing. Cross-listed with: EE 556

CPE 558   Computer Vision   (3 - 3 - 0)

An introduction to the field of Computer Vision, focusing on the underlying algorithmic, geometric, and optic issues. The course starts with a brief overview of basic image processing topics (convolution, smoothing, and edge detection). It then proceeds on various image analysis topics: binary images, moments-based shape analysis, Hough transform, image formation, depth and shape recovery, photometry, motion, classification, and special topics. Cross-listed with: CS 558 Prerequisites: CS 590, CS 385 Corequisites: MA 115, MA 112

CPE 560   Introduction to Networked Information Systems   (3 - 3 - 0)

An overview of the technical and application topics encountered in contemporary networked information systems including the overall architecture of such systems, data networked architectures, secure transmission of information, data representations including visual representations, information coding/compression for storage and transmission, management of complex heterogeneous networks, and integration of next-generation systems with legacy systems. Cross-listed with: NIS 560

CPE 563   Networked Applications Engineering   (3 - 3 - 0)

Introduction to the engineering principles and practices to build networked applications, such as e-mail and www; programming networked applications using Web Services; coordinating the execution of application components on different computers on the network; ensuring consistency of data among the components in online banking-like applications; monitoring, recovery, and rejuvenation capabilities to handle component failures; authentication among components for eCommerce-like applications; application quality of service; middleware platforms that address these issues in practice; and large-scale networked application examples. Cross-listed with: NIS 563

CPE 565   Management of Local Area Networks   (3 - 3 - 0)

Principles and practices of managing local area networks are presented from the perspective of a network systems engineer, including hands-on projects working with a real local area network (Cisco routers, switches, firewalls, etc.). The SNMP protocols and network management using SNMP are presented in terms of the general organization of information regarding network components and from the perspective of creating basic network management functions using SNMP. Techniques for troubleshooting practical networks, along with setting up and maintaining an IP network are covered. The course includes a project-based learning experience. Cross-listed with: NIS 565

CPE 579   Foundations of Cryptography   (3 - 3 - 0)

This course provides a broad introduction to cornerstones of security (authenticity, confidentiality, message integrity and non-repudiation) and the mechanisms to achieve them as well as the underlying mathematical basics. Topics include: block and stream ciphers, public-key systems, key management, certificates, public-key infrastructure (PKI), digital signature, non-repudiation, and message authentication. Various security standards and protocols such as DES, AES, PGP and Kerberos, are studied. Cross-listed with: CS 579 Prerequisites: CS 590 or CS 385, CS 503

CPE 580   The Logic of Program Design   (3 - 3 - 0)

Introduction to the rigorous design of functional and procedural programs in modern language (C++). The main theme is that programs can be reliably designed, proven and refined if one pays careful attention to their underlying logic, and the emphasis of this course is on the logical evolution of programs from specifications. Programs are developed in the UNIX environment. The necessary background in logic, program syntax and UNIX is developed as needed, though at a fast pace. Cross-listed with: CS 580 Corequisite: MA 502

CPE 585   Medical Instrumentation and Imaging   (3 - 3 - 0)

Imaging plays an important role in both clinical and research environments. This course presents both the basic physics together with the practical technology associated with such methods as X-ray computed tomography (CT), magnetic resonance imaging (MRI), functional MRI (f-MRI) and spectroscopy, ultrasonics (echocardiography, Doppler flow), nuclear medicine (Gallium, PET and SPECT scans) as well as optical methods such as bioluminescence, optical tomography, fluorescent confocal microscopy, two-photon microscopy and atomic force microscopy. Cross-listed with: BME 504

CPE 590   Algorithms   (3 - 3 - 0)

This is a course on more complex data structures, and algorithm design and analysis, using one or more modern imperative language(s), as chosen by the instructor. Topics include: advanced and/or balanced search trees; hashing; further asymptotic complexity analysis; standard algorithm design techniques; graph algorithms; complex sort algorithms; and other "classic" algorithms that serve as examples of design techniques. Cross-listed with: CS 590 Prerequisites: MA 502, and CS 570

CPE 591   Introduction to Multimedia Networking   (3 - 3 - 0)

The objective of this course is to introduce current techniques in multimedia communications especially as applied to wireless networks. The course will introduce the basic issues in multimedia communications and networking. Topics covered include: multimedia information representation - text, images, audio, video; introduction to information theory - information of a source, average information of a discrete memoryless source, source coding for memoryless sources; multimedia compression - text, image, audio, video; standards for multimedia communications; transmissions and protocols; circuit switched networks; the Internet; broadband ATM networks; packet video in the network environment; transport protocols - TCP/IP; TCP; UDP; RTP and RTCP; wireless networks - models, characteristics; error resilience for wireless networks. Cross-listed with: NIS 591

CPE 592   Computer and Multimedia Network Security   (3 - 3 - 0)

The objective of this course is to introduce current techniques in securing IP and multimedia networks. Topics under IP security will include classic cryptography, Diffie-Hellman, RSA, end-to-end authentication, Kerberos, viruses, worms and intrusion detection. Topics from multimedia will include steganography, digital watermarking, covert channels, hacking, jamming, security features in MPEG-4, secure media streaming, wireless multimedia, copy control and other mechanisms for secure storage and transfer of audio, image and video data. Cross-listed with: NIS 592

CPE 593   Applied Data Structures & Algorithms   (3 - 3 - 0)

The course provides the student with an integrated presentation of (i) the formalisms of data structures, graphs and algorithms, (ii) the development of efficient and reliable software using these formalisms, and (iii) theapplications of the data structures, graphs and algorithms topics (including appropriate elements of graph theory) within representative computing, information, and communications engineering applications. Principles will be applied through programming projects solving representative problems drawn from data networking and other applications. Cross-listed with: NIS 593

CPE 599   Curricular Practical Training   (1 - 0 - 0)

This course involves an educationally relevant practical industry project experience that augments the academic content of the student's program. Students engage in a project in industry that is relevant to the focus of their academic program. This project is conducted under the supervision of a faculty advisor and an industry mentor. During the semester, the student must submit written progress reports. At the end of the semester, the student must submit a final written report, and present a summary of his/her activities by means of a powerpoint presentation that will both be graded. This is a one-credit course that may be repeated up to a total of three credits.

CPE 600   Advanced Algorithm Design and Implementation   (3 - 3 - 0)

Design, implementation, and asymptotic time and space analysis of advanced algorithms, as well as analyzing worst-case and average-case complexity of algorithms. Students will be expected to run experiments to test the actual performance of the algorithms on sample inputs. Introduction to NP-complete problems and approximation algorithms. Cross-listed with: CS 600 Prerequisites: CPE 590, CS 385

CPE 602   Applied Discrete Mathematics   (3 - 3 - 0)

This is an introductory course for engineers. Topics that will be covered include principles of counting, set theory, mathematical induction, analysis of algorithms and complexity, relations, recurrent relations, graph algorithms, combinatorial design, software tools, applications to coding theory, network optimization, data compression, security, etc. Cross-listed with: NIS 602

CPE 604   Analytical Methods for Networks   (3 - 3 - 0)

This course is an introduction on modern information networks with an emphasis on providing the student with the mathematical background and required analytical skills for performance analysis of information networks protocols. The material concentrates mostly on the bottom three layers of the protocol stack, focusing on delay and throughput analysis. Topics covered include an overview of the OSI layering model, data link layer issues, medium access control, queueing analysis, mathematical models for routing in broadcast and point-to-point networks, and flow and congestion control. Cross-listed with: NIS 604

CPE 608   Applied Modeling and Optimization   (3 - 3 - 0)

This course will deal with the main aspects of applied modeling and optimization suitable for engineering, science, and business students. Sample applications to be used as case studies include channel capacity computation (information theory), statistical detection and estimation (signal processing), sequential decision making/revenue maximization (business), and others. Topics will include introduction to convex and non-linear optimization and modeling; linear, quadratic, and geometric program models and applications; stochastic modeling; combinatorial issues; gradient techniques; machine learning algorithms; stochastic approximation; genetic algorithms; and ant colony optimization. Cross-listed with: NIS 608

CPE 610   Introduction to Bioinformatics Engineering   (3 - 3 - 0)

This is an introductory course. Topics that will be covered in this course include an introduction to the basic concepts in biology such as DNA and RNA, biological data in digital symbol sequences, genomes—diversity, size and structure, genome, proteome, protein function, alignment versus prediction, consensus sequences and sequence logos, graphical models, secondary encoding and output interpretation, prediction of protein secondary structure, phylogenetic trees, Shannon model of a biological system and its implications, data analysis using BLAST tool, and probabilistic evolutionary models.

CPE 612   Principles of Multimedia Compression   (3 - 3 - 0)

Modeling of image signals; 2D prediction theory and application to DPCM/ADM coding of images; subband coding of images; filters for subband coding; transform coding of images; comparison of various transforms like KLT, DCT, LOT; vector quantizing theory, vector quantizing algorithms like the LBG algorithm; VQ for image coding.

CPE 619   E-Commerce Technologies   (3 - 3 - 0)

The course provides an understanding of electronic commerce and related architectures, protocols and technologies. The course introduces the E-commerce concept, objectives, and market drivers, and identifies its requirements, underpinning techniques, and technologies. These include Internet techniques like tunneling and Telnet and WWW techniques like Forms, and Common Gateway Interface (CGI). Other related topics such as multimedia, intelligent agents and their applications in E-commerce, the client/server model, and Commitment, Concurrency and Recovery (CCR) are also presented. Network, service, and application management, which are important aspects of E-commerce, are discussed. Quality of Service (QoS) management, Service Level Agreement (SLA) management, Application Programming Interface (APIs), and the role of Application Service Providers (ASPs) are discussed. There will be strong emphasis on the important topic of security management. Topics here include security concepts and technologies, types of security attacks, encryption techniques, public key systems, Data Encryption Standard (DES), and authentication techniques. Virtual Private Networks (VPNs), secure tunneling techniques, firewalls, Intranets, extranets, and VPN management are covered. The policy and regulatory issues in E-commerce are discussed. Finally, various E-commerce applications in the areas of finance, securities, trading, auctions, and travel are described. The course includes some E-commerce case studies and demonstrations. Cross-listed with: NIS 619, CS 619, TM 619, CS 619

CPE 625   Systems Operational Effectiveness and Life-Cycle Analysis   (3 - 3 - 0)

This course presents the fundamental principles and process for designing effective and reliable, supportable, and maintainable systems. The participants will also understand the concept of system operational effectiveness, and the inherent "cause and effect" relationship between design decisions and system operation, maintenance and logistics. Furthermore, the course will also discuss system life cycle cost modeling as a strategic design decision making methodology and present illustrative case studies.

CPE 631   Cooperating Autonomous Mobile Robots   (3 - 3 - 0)

Advanced topics in autonomous and intelligent mobile robots, with emphasis on planning algorithms and cooperative control. Robot kinematics, path and motion planning, formation strategies, cooperative rules and behaviors. The application of cooperative control spans from natural phenomena of groupings such as fish schools, bird flocks, deer herds, to engineering systems such as mobile sensing networks, vehicle platoon.

CPE 636   Integrated Services - Multimedia   (3 - 3 - 0)

Types of multimedia information: voice, data video facsimile, graphics and their characterization; modeling techniques to represent multimedia information; analysis and comparative performances of different models; detection techniques for multimedia signals; specification of multimedia representation based on service requirements; evaluation of different multimedia representations to satisfy user applications and for generating test scenarios for standardization. Cross-listed with: CS 636

CPE 638   Advanced Computer Graphics   (3 - 3 - 0)

Mathematical foundations and algorithms for advanced computer graphics. Topics include 3-D modeling, texture mapping, curves and surfaces, physics-based modeling, and visualization. Special attention will be paid to surfaces and shapes. The class will consist of lectures and discussion on research papers assigned for reading. In class, we will study the theoretical foundations and algorithmic issues. In programming assignments, we will use OpenGL as the particular API for writing graphics programs. C/C++ programming skills are essential for this course. Cross-listed with: CS 638 Prerequisite: CPE 537

CPE 640   Software Engineering I   (3 - 3 - 0)

This course covers the principles and theory of programming-in-the-large. The phases of software development, requirements development, software design software coding, and module testing, and software verification will be discussed in detail. Documents, rapid phototyping, top down, bottom up, successive refinement, functional and data abstraction will be discussed. Black and white box testing methods will be covered. Hierarchical and democratic term organization structures and the effects of personalizing and group dynamics will be discussed.

CPE 642   Software Engineering II   (3 - 3 - 0)

Types of multimedia information: voice, data video facsimile, graphics and their characterization; modeling techniques to represent multimedia information; analysis and comparative performances of different models; detection techniques for multimedia signals; specification of multimedia representation based on service requirements; evaluation of different multimedia representations to satisfy user applications and for generating test scenarios for standardization. Cross-listed with: CS 642

CPE 643   Logical Design of Digital Systems I   (3 - 3 - 0)

Design concepts for combinational and sequential (synchronous and asynchronous) logic systems; the design processes are described algorithmically and are applied to complex function design at the gate and register level; the designs are also implemented using software development tools, logic compilers for programmable logic devices and gate arrays. Cross-listed with: CS 527

CPE 644   Logical Design of Digital Systems II   (3 - 3 - 0)

The design of complex digital logic systems using processor architectures. The architectures are implemented for reduced instruction set computers (RISC) and extended to complex instruction set computers (CISC). The emphasis in the course is the design of high-speed digital systems and includes processors, sequencer/controllers, memory systems and input/output.

CPE 645   Image Processing and Computer Vision   (3 - 3 - 0)

The goal is to acquaint the students with the fundamental techniques of image processing. Specific topics include: Digital imaging fundamentals; neighborhood operators; clustering, region growing; split and merge, segmentation; edge and line linking; degradation model, restoration, inverse filtering; zero-crossing methods, gradient edge detectors; gray level co-occurrence, texture analysis; morphological operations; image registration and enhancement; scale space filtering; motion estimation; 3D image recognition and estimation. Cross-listed with: NIS 645

CPE 646   Pattern Recognition and Classification   (3 - 3 - 0)

Introduction and general pattern recognition concerns and statistical pattern recognition: introduction to statistical pattern recognition, supervised learning (training) using parametric and nonparametric approaches, parametric estimation and supervised learning, maximum likelihood (ML) estimation, the Bayesian parameter estimation approach, supervised learning using nonparametric approaches, Parzen windows, nonparametric estimation, unsupervised learning and clustering, and formulation of unsupervised learning problems; syntactic pattern recognition: quantifying structure in pattern description and recognition, grammar-based approach and applications, elements of formal grammars, syntactic recognition via parsing and other grammars, graphical approaches, and learning via grammatical inference; neural pattern recognition: the artificial neural network model, introduction to neural pattern associators and matrix approaches, multilayer, feed-forward network structure, and content addressable memory approaches. The Hopfield approach to pattern recognition, unsupervised learning, and self-organizing networks.

CPE 654   Design and Analysis of Intelligent Network Systems   (3 - 3 - 0)

Analysis of current networks including classic telephone, ISDN, IP and ATM. Attributes and characteristics of high-speed networks. Principles of network design including user-network interface, traffic modeling, buffer architectures, buffer management techniques, call processing, routing algorithms, switching fabric, distributed resource management, computational intelligence, distributed network management, measures of network performance, quality of service, self-healing algorithms, hardware and software issues in future network design. Cross-listed with: NIS 654

CPE 655   Queuing Systems with Computer Applications I   (3 - 3 - 0)

Queuing models will be developed and applied to current problems in telecommunication networks and performance analysis of networked computer systems. Topics include elementary queuing theory, birth-death processes, open and closed networks of queues, priority queues, conservation laws, models for time-shared computer systems and computer communication networks. Cross-listed with: NIS 655, CS 655, CS 655

CPE 656   Queuing Systems with Computer Applications II   (3 - 3 - 0)

This course is a continuation of CPE 655. Cross-listed with: NIS 656, CS 656 Prerequisites: CPE 655, CS 655 NIS 655

CPE 658   Image Analysis and Wavelets   (3 - 3 - 0)

The course emphasizes two main themes. The first is the study of wavelets as a newly emerging tool in signal analysis. The second is its applications in image processing and computer vision. In the first category, the following topics will be covered: time-frequency localization, windowed Fourier transform, continuous and discrete wavelet transforms, orthogonal and biorthogonal families of wavelets, and multiresolution analysis and its relation to subband coding schemes and use of wavelets in analysis of singularities. In the second category, applications of wavelets in problems of compact coding of images, edge and boundary detection, zero-crossing based representation, motion estimation, and other problems relevant to image processing and transmission will be considered.

CPE 664   Advanced Digital Signal Processing   (3 - 3 - 0)

Implementation of digital filters in high speed architectures; multirate signal processing: linear periodically time varying systems, decimators and expanders, filter banks, interfacing digital systems operating at multiple rates, elements of subband coding and wavelet transforms; signal recovery from partial data: from zero crossing, level crossing, phase only, magnitude only data; elements of spectral estimation: MA, AR and ARMA models. Lattice, Burg methods, MEM. Prerequisites: EE 548, CPE 548

CPE 668   Foundations of Cryptography   (3 - 3 - 0)

This course provides a broad introduction to cornerstones of security (authenticity, confidentiality, message integrity and non-repudiation) and the mechanisms to achieve them. Topics include: block and stream ciphers, secret-key and public-key systems, key management, public-key infrastructure (PKI), digital envelope, integrity and message authentication, digital signature and non-repudiation, trusted third party and certificates. Various security standards and protocols such as DES, PGP and Kerberos will be studied. The course includes a project and some lab experiments related to running, analyzing and comparing various security algorithms. Cross-listed with: CS 669

CPE 671   High-Speed Signal and Image Processing with VLSI   (3 - 3 - 0)

The design of ASCA (Application Specific Computer Architectures) for signal and image processing; topics include an overview of VLSI architectural design principles, signal and image processing algorithms, mapping algorithms onto array structures, parallel architectures and implementation, and systolic design for neural network processing.

CPE 678   Information Networks I   (3 - 3 - 0)

The first of a two-course sequence on modern computer networks. Focus is on the physical and data link levels of the OSI layers. Trace the evolution of client/server computing to the Internet. Topics covered include OSI layering, TCP/IP overview, the application of Shannon's and Nyquist's bandwidth theorems, Discrete Wave Division Multiplexing, wireless transmission, local loops, QAM, TDM, SONET/SDH, circuit switching, ATM switching, knockout switch, ISDN, STM, framing, error detection and correction, CRC, ARQ protocol, sliding window protocols, finite state machines, Universal Modeling Language, PPP, ALOHA, CSMA, LANs, fast and gigabit Ethernet, bridges and FDDI. A significant amount of time is spend on designing 802.3 LANs. Cross-listed with: NIS 678

CPE 679   Computer and Information Networks   (3 - 3 - 0)

Learn the technologies that make the Internet work. You will understand the TCP and IP protocols and their interaction. You will study the TCP slow start in low noise and high noise environments, the use of proxy servers, web caching, and gain understanding of the technologies used to make routers perform well under load. These include shortest path routing, new routing protocols, TCP congestion control, leaky bucket and token bucket admission control, weighted fair queueing and random early detection of congestion. Networks are described in terms of their architecture, transport, routing and management. Quality of Service (QoS) models are integrated with communication models. The course requires problem solving and extensive reading on network technology. After an introduction to bridges, gigabit ethernet, routing and the Internet Protocol, a fundamental understanding of shortest path and distance vector routing is taught. A "problem/solution" approach is used to develop how and why the technology evolved to keep engineering tradeoffs in focus. Continuation of Information Networks I with a focus on the network and transport layers of the OSI layers. Protocol definitions for distributed networks and performance analysis of various routing protocols including Bellman-Ford, BGP and OSPF. TCP over IP is discussed. Other topics include pipelining, broadcast routing, congestion control and reservations, Leaky and Token Bucket algorithms, weighted fair queuing, tunneling, firewalls, Ipv4 and IPv6. Network layers in SAN including the different service categories are discussed. The TCP and UDP transport protocols are discussed in depth along with network security, DNS, SAN, SLIP, firewalls and naming. Cross-listed with: NIS 679

CPE 680   Ad Hoc Networks   (3 - 3 - 0)

Ad hoc networking relates to a collection of network components that can self-organize and manage communications in a manner largely transparent to the user. Such networks have grown in importance as wireless network technologies have advanced, leading to dynamically changing network topologies. Representative topics, presented from the perspective of ad hoc networks, include routing protocols, performance metrics, implementations, applications such as sensor and peer-to-peer networks, and security are presented from the perspective of ad hoc networks.

CPE 682   Fuzzy Logic Systems   (3 - 3 - 0)

The geometry of fuzzy sets; the universe as a fuzzy set; fuzzy relational algebra; fuzzy systems; the fuzzy entropy theorem; the subsethood theorem; the fuzzy approximation theorem (FAT); fuzzy associative memories (FAM); adaptive FAMs (AFAM); fuzzy learning methods; approximate reasoning (linguistic modeling); different integration of neural networks and fuzzy systems; neuro-fuzzy controller and their applications; expert systems: knowledge acquisition, knowledge representation, and inference engines; hybrid expert systems (soft computing): knowledge-based systems, fuzzy systems, and neural networks; and applications: image processing, data compression, pattern recognition, computer vision, qualitative modeling, retrieval from fuzzy database, process control, robotics, and some industrial applications.

CPE 685   Computational Systems Biology   (3 - 3 - 0)

This is an introductory course on computational modeling of biological systems. Topics that will be covered include biological modeling, representing biochemical networks, chemical and biochemical kinetics, case studies, Bayes inference and Monte Carlo methods, stochastic simulation of biological networks. Prerequisite: EE 606

CPE 686   Software Tools in Bioinformatics   (3 - 3 - 0)

This is an introductory course on computational software tools and methods used in bioinformatics and computational genomics. Software tools, websites, databases, hardware and programming languages used in the analysis of biological information will be introduced. Prerequisite: CPE 610

CPE 690   Introduction to VLSI Design   (3 - 3 - 0)

This course introduces students to the principles and design techniques of very large scale integrated circuits (VLSI). Topics include: MOS transistor characteristics, DC analysis, resistance, capacitance models, transient analysis, propagation delay, power dissipation, CMOS logic design, transistor sizing, layout methodologies, clocking schemes, case studies. Students will use VLSI CAD tools for layout and simulation. Selected class projects may be sent for fabrication. Cross-listed with: MT 690, PEP 690

CPE 691   Information Systems Security   (3 - 3 - 0)

History of network security; classical information security; cryptosecurity; kerberos for IP networks; private and public keys; nature of network security; fundamental framework for network security; analysis and performance impact of network topology; vulnerabilities and security attack models in ATM, IP, and mobile wireless networks; security services, policies, and models; trustworthy systems; intrusion detection techniques - centralized and distributed; emulation of attack models and performance assessment through behavior modeling and asynchronous distributed simulation; principles of secure network design in the future; and projects in network security and student seminar presentations. Cross-listed with: NIS 691

CPE 693   Cryptographic Protocols   (3 - 3 - 0)

This course covers the design and analysis of security protocols, and studies different attacks and defenses against them. Topics include: signature and authentication protocols, privacy, digital rights management, security protocols for wired, wireless and distributed networks, electronic voting, payment and micropayment protocols, anonymity, broadcast encryption and traitor training, quantum cryptography and visual cryptography. The course includes a project and some related lab experiments. Cross-listed with: CS 693 Prerequisite: CPE 668

CPE 695   Applied Machine Learning   (3 - 3 - 0)

n introduction course for machine learning theory, algorithms and applications. This course aims to provide students with the knowledge in understanding key elements of how to design algorithms/systems that automatically learn, improve and accumulate knowledge with experience. Topics covered in this course include decision tree learning, neural networks, Bayesian learning, reinforcement learning, ensembling multiple learning algorithms, and various application problems. The students will have chances to simulate their algorithms in a programming language and apply them to solve real-world problems. Cross-listed with: EE 695

CPE 700   Seminar in Computer Engineering (ECE Seminar)   (0 - -)

An ECE Department seminar on topics of current interest.

CPE 701   CPE Co-Op Education Project   (0 - 0 - 0)

This course is for CPE students who are on a Co-Op assignment.

CPE 702   Selected Topics in Imaging and Pattern Recognition   (3 - 3 - 0)

Current topics in image processing and pattern recognition. Topics may include Bayes decision theroy, parameter estimation, feature selection, non-parametric techniques, linear discriminate functions, unsupervised learning, clustering, applications of pattern recognition, and biomedical problems. Cross-listed with: CS 702

CPE 732   Selected Topics VLSI Design and Simulation   (3 - 3 - 0)

Current topics in VLSI, VHSIC, and ASIC design, simulation, and verification. Electronic design automation (EDA) tools. Design physics and processing and basic CMOS and bipolar circuit structures. Top-down design methods; formal specifications of circuits; simulation as an aid to circuit design and verification; and principles of functional and logical simulation before layout. Bottom-up circuit construction; hierarchical layout circuits; floor plan organization and routing of subcircuit interconnections; extraction of circuit from layout; critical path analysis. Class project and design, simulation, and layout of medium size circuit.

CPE 765   Selected Topics in Computer Engineering   (3 - 3 - 0)

A participating seminar on topics of current interest and importance in computer engineering.

CPE 800   Special Problems in Computer Engineering (M.Eng.)   (3 - -)

An investigation of current research topic at the pre-master's level, under the direction of a faculty member. A written report is required, which should have the substance of a publishable article. Students with no practical experience who do not write a master's thesis are invited to take advantage of this experience.

CPE 801   Special Problems in Computer Engineering (Ph.D.)   (3 - -)

An investigation of a current research topic beyond that of CPE 800 level, under the direction of a faculty member. A written report is required, which should have importance in modern computer engineering and have the substance of a publishable article. This course is open to students who intend to be doctoral candidates and wish to explore an area that is different from the doctoral research topic.

CPE 810   Special Topics in Computer Engineering   (3 - -)

A participating seminar on topics of current interest and importance in Computer Engineering.

CPE 900   Thesis in Computer Engineering (M.Eng.)   (1 to 10 - -)

A thesis of significance to be filed in libraries, demonstrating competence in a research area of computer engineering. Credits to be arranged.

CPE 950 Computer Engineer Design Project   (1 - 1 - 0)

An investigation of current a engineering topic or design. A written report is required.

CPE 960   Research in Computer Engineering (Ph.D.)   (- -)

Original research of a significant character undertaken under the guidance of a member of the departmental faculty that may serve as the basis for the dissertation required for the degree of Doctor of Philosophy. Hours and credits to be arranged.

Information and Data Engineering

NIS 505   Probability for Telecommunications Managers   (3 - 3 - 0)

This course provides a background in probability and stochastic processes necessary for the analysis of telecommunications systems. Topics include axioms of probability, combinatorial methods, discrete and continuous random variables, expectation, Poisson processes, birth-death processes, and Markov processes. Cross-listed with: TM 605

NIS 514 Computer Architecture   (3 - 3 - 0)

Measures of cost, performance, and speedup; instruction set design; processor design; hard-wired and microprogrammed control; memory hierarchies; pipelining; input/output systems; and additional topics as time permits. The emphasis in this course is on quantitative analysis of design alternatives. Cross-listed with: CPE 514, CS 514

NIS 521 Communication Software and Middleware   (3 - 3 - 0)

Communications in computer networks are not only enabled by physical links and hardware, but are also enabled by software and middleware. This course provides an understanding of software techniques in communications. It explores development models that address a broad range of issues in the design of communication software, including hardware and software partitioning, layering, and protocol stacks. Other topics are configuration techniques, buffer and timer management, task and table managements, and multi-board communications software design. Communication middleware and agent technologies as enabling technology in networking will also be covered.

NIS 536   Integrated Services - Multimedia   (3 - 3 - 0)

Types of multimedia information: voice, data video facsimile, graphics, and their characterization; modeling techniques to represent multimedia information; analysis and comparative performances of different models; detection techniques for multimedia signals; specification of multimedia representation based on service requirements; and evaluation of different multimedia representations to satisfy user applications and for generating test scenarios for standardization. Cross-listed with: CPE 536, CS 536

NIS 545   Communication Software and Middleware   (3 - 3 - 0)

Communications in computer networks are not only enabled by physical links and hardware, but are also enabled by software and middleware. This course provides an understanding of software techniques in communications. It explores development models that address a broad range of issues in the design of communication software, including hardware and software partitioning, layering, and protocol stacks. Other topics are configuration techniques, buffer and timer management, task and table managements, and multi-board communications software design. Communication middleware and agent technologies as enabling technology in networking will also be covered.

NIS 560   Introduction to Networked Information Systems   (3 - 3 - 0)

An overview of the technical and application topics encountered in contemporary networked information systems including the overall architecture of such systems, data network architectures, secure transmission of information, data representations including visual representations, information coding/compression for storage and transmission, management of complex heterogeneous networks and integration of next-generation systems with legacy systems. Cross-listed with: CPE 560

NIS 561   Database Management Systems I   (3 - 3 - 0)

Introduction to the use of relational database systems; the relational model; the entity-relationship model; translation of entity-relationship diagrams into relational schemes; relational algebra; SQL; normalization of relational schemes. Students who have had a previous course in database systems must obtain permission of the instructor to enroll in this course. Cross-listed with: CS 561

NIS 563   Networked Applications Engineering   (3 - 3 - 0)

Introduction to the engineering principles and practices to build networked applications, such as e-mail and www; programming networked applications using Web Services; coordinating the execution of application components on different computers on the network; ensuring consistency of data among the components in online banking-like applications; monitoring, recovery, and rejuvenation capabilities to handle component failures; authentication among components for eCommerce-like applications; application quality of service; middleware platforms that address these issues in practice; and large-scale networked application examples. Cross-listed with: CPE 563

NIS 564   Design & Analysis of Network Systems   (3 - 3 - 0)

Analysis of current networks including classic telephone, ISDN, IP and ATM. Attributes and characteristics of high-speed networks. Principles of network design including user-network interface, traffic modeling, buffer architectures, buffer management techniques, call processing, routing algorithms, switching fabric, distributed resource management, computational intelligence, distributed network management, measures of network performance, quality of service, self-healing algorithms, hardware and software issues in future network design.

NIS 565   Management of Local Area Networks   (3 - 3 - 0)

Principles and practices of managing local area networks are presented from the perspective of a network systems engineer, including hands-on projects working with a real local area network (Cisco routers, switches, firewalls, etc.). The SNMP protocols and network management using SNMP are presented in terms of the general organization of information regarding network components and from the perspective of creating basic network management functions using SNMP. Techniques for troubleshooting practical networks, along with setting up and maintaining an IP network are covered. The course includes a project-based learning experience. Cross-listed with: CPE 565

NIS 582   Wireless Networking: Architecture, Protocols and Standards   (3 - 3 - 0)

This course addresses the fundamentals of wireless networking, including architectures, protocols and standards. It describes concepts, technology and applications of wireless networking as used in current and next-generation wireless networks. It explains the engineering aspects of network functions and designs. Issues such as mobility management, wireless enterprise networks, GSM, network signaling, WAP, mobile IP and 3G systems are covered. Cross-listed with: EE 582, TM 582

NIS 583   Wireless Communications   (3 - 3 - 0)

This courses serves as a broad introduction to the several technologies and applications of wireless communications systems. The emphasis is on providing a reasonable mixture of information leading to a broad understanding of the technical issues involved, with modest depth in each of the topics. As an integrating course, the topics range from the physics of wave generation/propagation/reception through the circuit/component issues, to the signal processing concepts, to the techniques used to impress the information (voice or data) on a wireless channel, to overviews of representative applications including current generation systems and next generation systems. Upon completion of this course, the student shall understand the manner in which the more detailed information in the other three courses is integrated to create a complete system. Cross-listed with: EE 583

NIS 584   Wireless Systems Security   (3 - 3 - 0)

Wireless systems and their unique vulnerabilities to attack; system security issues in the context of wireless systems, including satellite, terrestrial microwave, military tactical communications, public safety, cellular and wireless LAN networks; security topics: confidentiality/privacy, integrity, availability, and control of fraudulent usage of networks. Issues addressed include jamming, interception and means to avoid them. Case studies and student projects are an important component of the course. Cross-listed with: EE 584, TM 584

NIS 591   Introduction to Multimedia Networking   (3 - 3 - 0)

The objective of this course is to introduce current techniques in multimedia communications especially as applied to wireless networks. The course will introduce the basic issues in multimedia communications and networking. Topics to be covered include: multimedia information representation - text, images, audio, video; iIntroduction to information theory - information of a source, average information of a discrete memoryless source, source coding for memoryless sources; multimedia compression - text, image, audio, video; standards for multimedia communications; transmissions and protocols; circuit switched networks; the Internet; broadband ATM networks; packet video in the network environment; transport protocols - TCP/IP; TCP; UDP; RTP and RTCP; wireless networks - models, characteristics; error resilience for wireless networks. Cross-listed with: CPE 591

NIS 592   Multimedia Network Security   (3 - 3 - 0)

The objective of this course is to introduce current techniques in securing IP and multimedia networks. Topics under IP security will include classic cryptography, Diffie-Hellman, RSA, end-to-end authentication, Kerberos, viruses, worms and intrusion detection. Topics from multimedia will include steganography, digital watermarking, covert channels, hacking, jamming, security features in MPEG-4, secure media streaming, wireless multimedia, copy control and other mechanisms for secure storage and transfer of audio, image and video data. Cross-listed with: CPE 592

NIS 593   Applied Data Structures & Algorithms   (3 - 3 - 0)

The course provides the student with an integrated presentation of (i) the formalisms of data structures, graphs and algorithms, (ii) the development of efficient and reliable software using these formalisms, and (iii) the applications of the data structures, graphs and algorithms topics (including appropriate elements of graph theory) within representative computing, information, and communications engineering applications. Principles will be applied through programming projects solving representative problems drawn from data networking and other applications. Cross-listed with: CPE 593

NIS 599   Curricular Practical Training   (1 to 3 - 0 - 0)

This course involves an educationally relevant practical industry project experience that augments the academic content of the student's program. Students engage in a project in industry that is relevant to the focus of their academic program. This project is conducted under the supervision of a faculty advisor and an industry mentor. During the semester, the student must submit written progress reports. At the end of the semester, the student must submit a final written report, and present a summary of his/her activities by means of a powerpoint presentation that will both be graded. This is a one-credit course that may be repeated up to a total of three credits.

NIS 602   Applied Discrete Mathematics for Engineers   (3 - 3 - 0)

This is an introductory course for engineers. Topics that will be covered include principles of counting, set theory, mathematical induction, analysis of algorithms and complexity, relations, recurrent relations, graph algorithms, combinatorial design, software tools, applications to coding theory, network optimization, data compression, security, etc. Cross-listed with: CPE 602

NIS 604   Analytical Methods for Networks   (3 - 3 - 0)

This course is an introduction on modern information networks with an emphasis on providing the student with the mathematical background and required analytical skills for performance analysis of information networks protocols. The material concentrates mostly on the bottom three layers of the protocol stack, focusing on delay and throughput analysis. Topics covered include an overview of the OSI layering model, data link layer issues, medium access control, queueing analysis, mathematical models for routing in broadcast and point-to-point networks, and flow and congestion control. Cross-listed with: CPE 604

NIS 605   Probability and Stochastic Processes I   (3 - 3 - 0)

Axioms of probability; discrete and continuous random vectors; functions of random variables; expectations, moments, characteristic functions, and momentgenerating functions; inequalities, convergence concepts, and limit theorems; central limit theorem; and characterization of simple stochastic processes: widesense stationality and ergodicity. Cross-listed with: EE 605

NIS 608   Applied Modeling and Optimization   (3 - 3 - 0)

Engineering, computational science and business students tackle various kinds of real-life optimization problems occurring in areas such as information theory, wireless communications, VLSI design, design and analysis of networks, optimal decision making etc. This course will provide a comprehensive coverage of several aspects of applied modeling and optimization. Complexity issues and numerical techniques (classical and non-classical techniques) to solve optimization problems will be the main thrust. Example problems arising in electrical engineering, computer engineering and business will be extensively used to illustrate the different optimization algorithms. This course will be computer projects based. Software packages such as MAPLE, MATLAB, CPLEX etc. will be used. Cross-listed with: CPE 608, EE 608

NIS 609   Communications Theory   (3 - 3 - 0)

Review of probability theory with applications to digital communications, digital modulation techniques, receiver design, bit error rate calculations, bandwidth efficiency calculations, convolutional encoding, bandwidth efficient coded modulation, wireless fading channel models, and shannon capacity, software simulation of communication systems. Cross-listed with: EE 609

NIS 610   Error Control Coding for Networks   (3 - 3 - 0)

Error-control mechanisms; elements of algebra; linear block codes; linear cyclic codes; fundamentals of convolutional codes; Viterbi decoding codes in mobile communications; Trellis-coded modulation; concatenated coding systems and turbo codes; BCH codes; Reed-Solomon codes; implementation architectures and applications of RS codes; and ARQ and interleaving techniques. Cross-listed with: EE 610

NIS 611   Digital Communications Engineering   (3 - 3 - 0)

Waveform characterization and modeling of speech/image sources; quantization of signals; uniform, nonuniform and adaptive quantizing; pulse code modulation (PCM) systems; differential PCM (DPCM); linear prediction theory, adaptive prediction; delta modulation and sigma-delta modulation systems; subband coding with emphasis on speech coding; data compression methods like Huffman coding, Ziv-Lempel coding and run length coding. Cross-listed with: EE 611

NIS 612   Principles of Multimedia Compression   (3 - 3 - 0)

Brief introduction to nformation theory; entropy and rate; Kraft-McMillan inequality; entropy codes - Huffman and arithmetic codes; scalar quantization- quantizer design issues, the Lloyd quantizer and the Lloyd-Max quantizer; vector quantization - LBG algorithm, other quantizer design algorithms; structured VQs; entropy constrained quantization; bit allocation techniques: generalized BFOS algorithm; brief overview of linear Algebra; transform coding: KLT, DCT, LOT; subband coding; wavelets; wavelet based compression algorithms (third generation image compression schemes)- EZW algorithm, the SPIHT algorithm and the EBCOT algorithm; video compression: motion estimation and compensation; image and video coding standards: JPEG/ JPEG 2000, MPEG, H.263, H.263+; Source coding and error resilience. Cross-listed with: EE 612

NIS 619   E-Commerce Technologies   (3 - 3 - 0)

This course provides an understanding of electronic commerce and related architectures, protocols, and technologies. It describes the e-commerce concept, objectives, and market drivers, as well as its requirements and underpinning techniques and technologies, including the Internet, WWW, multimedia, intelligent agents, client-server relations, and data mining. Security in e-commerce is addressed, including types of security attacks, security mechanisms, Virtual Private Networks (VPNs), firewalls, intranets, and extranets. Implementation issues in e-commerce, including the design and management of its infrastructure and applications (ERP, CRM, and SCM), are discussed. M-commerce is addressed, electronic payment systems with their associated protocols are described, and various B2C and B2B applications are presented. Also, policy and regulatory issues in e-commerce are discussed. Cross-listed with: CPE 619, CS 619, TM 619, CS 619

NIS 626   Optical Communication Systems   (3 - 3 - 0)

Components for and design of optical communication systems; propagation of optical signals in single mode and multimode optical fibers; optical sources and photodetectors; optical modulators and multiplexers; optical communication systems: coherent modulators, optical fiber amplifiers and repeaters, transcontinental and transoceanic optical telecommunication system design; optical fiber LANs. Cross-listed with: EE 626, MT 626, PEP 626

NIS 630 Enterprise Systems Management (3 - 3 - 0)

This course focuses on the role of information technology (IT) in reengineering and enhancing key business processes. The implications for organizational structures and processes, as the result of increased opportunities to deploy information and streamlining business systems are covered. Cross-listed with: MIS 710

NIS 631 Management of Information Technology Organizations (3 - 3 - 0)

The objective of this course is to investigate and understand the organizational infrastructure and governance considerations for information technology. It concentrates on developing students' competency in current/emerging issues in creating and coordinating the key activities necessary to manage the day-to-day IT functions of a company. Topics include: ITs key business processes, IT governance, organizational structure, value of IT, role of the CIO, outsourcing, systems integration, managing emerging technologies and change and human resource considerations.

NIS 632 Strategic Management of Information Technology (3 - 3 - 0)

The objective of this course is to address the important question, "How to improve the alignment of business and information technology strategies?" The course is designed for advanced graduate students. It provides the student with the most current approaches to deriving business and information technology strategies, while ensuring harmony among the organizations. Topics include business strategy, business infrastructure, IT strategy, IT infrastructure, strategic alignment, methods/metrics for building strategies and achieving alignment. Cross-listed with: MIS 760

NIS 633 Integrating IS Technologies (3 - 3 - 0)

This course focuses on the issues surrounding the design of an overall information technology architecture. The traditional approach in organizations is to segment the problem into four areas - network, hardware, data and applications. This course will focus on the interdependencies among these architectures. In addition, this course will utilize management research on organizational integration and coordination science. The student will learn how to design in the large, make appropriate choices about architecture in relationship to overall organization goals, understand the different mechanisms available for coordination and create a process for establishing and maintaining an enterprise architecture. Cross-listed with: MIS 730, MGT 784 Prerequisites: MIS 620, MIS 630 MIS 640

NIS 645 Image Processing and Computer Vision (3 - 3 - 0)

The goal is to acquaint the students with the fundamental techniques of image processing. Specific topics include: Digital imaging fundamentals; neighborhood operators; clustering, region growing; split and merge, segmentation; edge and line linking; degradation model, restoration, inverse filtering; zero-crossing methods, gradient edge detectors; gray level co-occurrence, texture analysis; morphological operations; image registration and enhancement; scale space filtering; motion estimation;3D image recognition and estimation. Cross-listed with: CPE 645

NIS 651 Spread Spectrum and CDMA (3 - 3 - 0)

Basic concepts, models, and techniques; direct sequence frequency hopping, time hopping, chirp and hybrid systems; jamming game, anti-jam systems, and analysis of coherent and non-coherent systems; synchronization and demodulation; multiple access systems; ranging and tracking; and pseudo-noise generators. Cross-listed with: EE 651, EE 631

NIS 653 Cross-Layer Design for Wireless Networks (3 - 3 - 0)

Introduction to wireless networks and layered architecture, principles of cross-layer design, impact of cross-layer interactions for different architectures: cellular and ad hoc networks, model abstractions for layers in cross-layer design for different architectures (cellular and ad hoc networks), quality of service (QoS) provisioning at different layers of the protocol stack with emphasis on physical layer, medium access control (MAC) and network layers, examples of cross-layer design in the literature: joint optimizations involving beamforming, interference cancellation techniques, MAC protocols, admission control, power control, routing and adaptive modulation. Cross-listed with: EE 653

NIS 654 Design and Analysis of Intelligent Network Systems (3 - 3 - 0)

Analysis of current networks, including classic telephone, ISDN, IP, and ATM. Attributes and characteristics of high-speed networks. Principles of network design, including user-network interface, traffic modeling, buffer architectures, buffer management techniques, call processing, routing algorithms, switching fabric, distributed resource management, computational intelligence, distributed network management, measures of network performance, quality of service, self-healing algorithms, and hardware and software issues in future network design. Cross-listed with: CPE 654

NIS 655   Queuing Systems with Communications Applications I   (3 - 3 - 0)

Queuing models will be developed and applied to current problems in telecommunication networks and performance analysis of networked computer systems. Topics include elementary queuing theory, birth-death processes, open and closed networks of queues, priority queues, conservation laws, models for time-shared computer systems and computer communication networks. Cross-listed with: CPE 655, CS 655

NIS 656   Queuing Systems with Computer Applications II   (3 - 3 - 0)

This course is a continuation of NIS 655. Cross-listed with: CPE 656, CS 656 Prerequisite: NIS 655

NIS 672   Applied Game Theory and Evolutionary Algorithms   (3 - 3 - 0)

Part I: Introduction to game theory: games in strategic form and Nash equilibrium, existence and properties of Nash equilibrium, Pareto efficiency, extensive form games, repeated games, Bayesian games and Bayesian equilibrium, types of games and equilibrium properties, learning in games. Part II: Applications for wireless networks: resource allocation, enforcing cooperation in ad hoc networks, cognitive radios. Cross-listed with: EE 672

NIS 674   Satellite Communications   (3 - 3 - 0)

Overview of communication theory, modulation techniques, conventional multiple access schemes and SS/TDMA; satellite and frequency allocation, analysis of satellite link, identification of the parameters necessary for the link calculation; modulation and coding; digital modulation methods and their comparison; error correction coding for the satellite channel including Viterbi decoding and system performance; synchronization methods, carrier recovery; effects of impairment on the channel. Cross-listed with: EE 674

NIS 678   Information Networks I   (3 - 3 - 0)

CpE 678 Information Networks I is the first of two courses on modern computer networks. Its focus is the physical and data link levels of the OSI layers. It traces the evolution of client/server computing to the Internet. Topics covered include OSI layering, TCP/IP overview, the application of Shannon's and Nyquist's bandwidth theorem's, Discrete Wave Division Multiplexing, wireless transmission, local loops, QAM, TDM, SONET/SDH, circuit switching, ATM switching, knockout switch, ISDN, ATM, framing, error detection and correction, CRC, ARQ protocol, sliding window protocols, finite state machines, Universal Modeling Language, PPP, ALOHA, CSMA, LANs, fast and gigabit Ethernet, Bridges and FDDI. A significant amount of time is spent on designing 802.3 LANs. Cross-listed with: CPE 678

NIS 679   Computer and Information Networks   (3 - 3 - 0)

Learn the technologies that make the Internet work. You will understand the IP and TCP protocols and their interaction. You will study TCP slow start in low noise and high noise environments, the use of proxy servers, web caching and gain understanding of the technologies used to make routers perform well under load. These include shortest path routing, new routing algorithms, TCP congestion control, leaky bucket and token bucket admission Control, weighted fair queuing and random early detection of congestion. Networks are described in terms of their architecture, transport, routing, and their management. Quality of Service issues (QoS) are integrated with communication models. The course requires problem solving and extensive reading on network technology. After an introduction to bridges, gigabit Ethernet, routing and the Internet Protocol, a fundamental understanding of shortest path and distance vector routing is taught. A 'problem/solution' approach is used to develop how and why the technology evolved to keep engineering tradeoffs in focus. Continuation of Information Networks I with a focus on the network and transport layers of the OSI layers. Protocol definitions for distributed networks and performance analysis of various routing protocols including Bellman-Ford, BGP, and OSPF. TCP over IP is discussed Other topics include pipelining, broadcast routing, congestion control and reservations, Leaky and Token Bucket algorithms, weighted fair queuing, tunneling, firewalls, Ipv4 and IPv6. Network layers in SAN including the different service categories are discussed. The TCP and UDP transport protocols are discussed in depth along with network security, DNS, SAN, SLIP, firewalls and naming. Cross-listed with: CPE 679

NIS 691   Information Systems Security   (3 - 3 - 0)

History of network security; classical infosec; cryptosecurity; Kerberos for IP networks; private and public keys; nature of network security; fundamental framework for network security; security on demand in ATM networks; analysis and performance impact of ATM network topology; security in IVCC; vulnerabilities and security attack models in ATM, IP and mobile wireless networks; intrusion detection techniques - centralized and distributed; emulation of attack models and performance assessment through behavior modeling and asynchronous distributed simulation; principles of secure network design in the future; projects in network security and invited guest lecturers. Cross-listed with: CPE 691

NIS 700   Seminar in Networked Information Systems   (0 - -)

An ECE seminar on topics of current interest.

NIS 765   Selected Topics in Networked Information Systems   (3 - 3 - 0)

A participating seminar on topics of current interest and importance in Networked Information Systems.

NIS 770   Economics of Networks   (3 - 3 - 0)

This course analyzes the economics of networks and communications services. Theoretical and practical aspects of the subject will be covered based on three pillars: Technologies, Economics/Pricing, and Special Topics (auctions, trading bandwidth, and regulation). Communications technologies are reviewed, e.g., Internet, ATM, Wireless. The course then provides in depth analysis of the economics of monopoly, oligopoly and perfectly competitive markets, as applied to the telecom markets. Pricing alternatives are formalized using simple mathematical models. Students learn how network control and performance of networks relate to the costs of service delivery and the economic analysis of consumer decision making. Special topics related to game theory, risk management of telecom operations, trading of bandwidth as well as auctions of bandwidth and spectrum are covered towards the end of the course. Cross-listed with: TM 770 Prerequisites: TM 605, TM 610

NIS 800   Special Problems in Networked Information Systems   (1 - -)

An investigation of a current research topic at the pre-master's level, under the direction of a faculty member. A written report, which should have the substance of a publishable article, is required. Students with no practical experience who do not write a master's thesis are invited to take advantage of this experience.

NIS 810   Special Topics in Networked Information Systems   (3 - -)

A participating seminar on topics of current interest and importance in Networked Information Systems.

NIS 900   Thesis in Networked Information Systems (M.Eng.)   (1 to 6 - -)

A thesis of significance to be filed in libraries, demonstrating competence in a research area of electrical engineering. Hours and credits to be arranged.

Applied Artificial Intelligence

AAI 800   Special Problems in Applied Artificial Intelligence (M.S.)   (3 - -)

An investigation of current research topic at the pre-master's level, under the direction of a faculty member. A written report is required, which should have the substance of a publishable article. Students with no practical experience who do not write a master's thesis are invited to take advantage of this experience.

AAI 900   Thesis in Applied Artificial Intelligence (M.S.)   (1 to 10 - -)

A thesis of significance to be filed in libraries, demonstrating competence in a research area of Applied Artificial Intelligence. Credits to be arranged.

Department of Mathematical Sciences

FACULTY

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Alexander Taam, Ph.D.
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Alexander Ushakov, Ph.D.
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Associate Professor

EMERITUS FACULTY

Roger Pinkham, Ph.D.
Professor Emeritus

UNDERGRADUATE PROGRAMS

Bachelor of Science in Pure and Applied Mathematics

The Bachelor of Science in Mathematics offers a broad background appropriate for students planning to pursue a job in industry, while also offering students the depth and rigor required for graduate studies in mathematics or related fields.

The curriculum satisfies the core Bachelor of Science curriculum that includes certain breadth requirements in mathematics, physics, chemistry, biology, computer science, the humanities and social sciences. In addition to this science core, the student completes twelve upper-level mathematics courses (called technical electives). Some of these technical courses are prescribed by the program as being foundational to an undergraduate degree in mathematics. The remaining technical electives are chosen by the student in consultation with his/her academic advisor. In some cases courses from other departments can be substituted as technical electives with the approval of the undergraduate advisor. The program also includes two general electives which can be applied toward a minor or a second major in another discipline. Entering freshmen mathematics majors are expected to enroll in the seminar course MA 188 once they have completed the Calculus I requirement. Students interested in taking computer science courses beyond the minimum requirement should plan to take Discrete Mathematics, MA 134, no later than Term 3. Students are required to complete Senior Research Project 1, MA 498. As early as possible, students should discuss with the academic advisor how best to use the electives to focus the program on a particular area of mathematics.

The link to the mathematics curriculum takes you to a recommended study plan. The courses do not need to be taken in exactly the order listed. See the Department of Mathematics Web page for information on when particular courses are offered. There are additional notes at the end of the study plan regarding recommended electives and possible course substitutions. Mathematics majors are required to submit an approved study plan in Term 2.

Mathematics Curriculum

Term I

Course #	Course Name	Lecture	Lab	Study	Credit
PEP 111	Mechanics	3	0	6	3
CH 115	General Chemistry I	3	0	6	3
CH 117	General Chemistry Laboratory I	0	3	1	1
MA 121; MA 122	Differential Calculus; Integral Calculus	4	0	8	4
CS 105	Introduction to Scientific Computing[1]	2	2	6	3
CAL 103	Writing And Communications Colloquium	3	0	6	3
	Total	**15**	**5**	**33**	**17**

Term II

Course #	Course Name	Lecture	Lab	Study	Credit
PEP 112	Electricity and Magnetism	3	0	6	3
CH 116	General Chemistry II	3	0	6	3
CH 118	General Chemistry Laboratory II	0	3	1	1
BIO 281	Biology and Biotechnology	3	0	6	3
MA 123; MA 124	Series, Vectors, Functions, and Surfaces; Calculus of Two Variables	4	0	8	4
CAL 105	CAL Colloquium: Knowledge, Nature, Culture	3	0	6	3
	Total	**16**	**3**	**33**	**17**

Term III

Course #	Course Name	Lecture	Lab	Study	Credit
	Humanities[4]	3	0	6	3
MA 221	Differential Equations	4	0	8	4
PEP 221	Physics Lab I for Scientists	0	3	1	1
BT	Economics[3]	3	0	6	3
G.E.	General Elective[5]	3	0	6	3
PE 200	Physical Education I	0	2	0	0
	Total	**13**	**5**	**27**	**14**

Term IV

Course #	Course Name	Lecture	Lab	Study	Credit
	Humanities[4]	3	0	6	3
MA 222	Probability and Statistics	3	0	6	3
PEP 222	Physics Lab II for Scientists	0	3	1	1
E 234	Thermodynamics (or CH 321)	3	0	6	3
MA 227	Multivariable Calculus	3	0	6	3
MA 240	Proofs and Refutations	3	0	6	3
PE 200	Physical Education II	0	2	0	0
	Total	**15**	**5**	**31**	**16**

Term V

Course #	Course Name	Lecture	Lab	Study	Credit
	Humanities[4]	3	0	6	3
MA 331	Intermediate Statistics	3	0	6	3
MA 232	Linear Algebra	3	0	6	3
T.E.	Technical Elective[2]	3	0	6	3
PE 200	Physical Education III	0	2	0	0
	Total	**12**	**2**	**24**	**12**

Term VI

Course #	Course Name	Lecture	Lab	Study	Credit
	Humanities[4]	3	0	6	3
PEP 242	Modern Physics	3	0	6	3
MA 336	Modern Algebra	3	0	6	3
MA 346	Numerical Methods	3	0	6	3
MA 234	Complex Variables with Applications	3	0	6	3
PE 200	Physical Education IV	0	2	0	0
	Total	**15**	**2**	**30**	**15**

Term VII

Course #	Course Name	Lecture	Lab	Study	Credit
	Humanities[4]	3	0	6	3
MA 441	Introduction to Mathematical Analysis	3	0	6	3
MA 410	Differential Geometry	3	0	6	3
MA 498	Senior Research Project 1	0	8	4	3
T.E.	Technical Elective[2]	3	0	6	3
	Total	**12**	**8**	**28**	**15**

Term VIII

Course #	Course Name	Lecture	Lab	Study	Credit
	Humanities[4]	3	0	6	3
G.E. 2	General Elective[5]	3	0	6	3
T.E.	Technical Elective[2]	3	0	6	3
T.E.	Technical Elective[2]	3	0	6	3
T.E.	Technical Elective[2]	3	0	6	3
	Total	**15**	**0**	**30**	**15**

(1) Students may choose CS 115, Intro. to Computer Science, in place of CS 105.
(2) Technical Elective. Preapproved choices (Fall: MA 360, 450), (Spring: MA 230, 335, 361, 442, 499), MA 134, MA 463, 503.
(3) Economics: Either BT 243 (Macro) or BT 244 (Micro). The second economics course can be used as 200-level Humanities elective.
(4) Humanities electives can be found on pages 568-569.
(5) General elective: Chosen by the student. Any approved 3 credit course. Typical examples: courses used to fulfill minor requirements, language courses, course taken during an international experience.

Minor in Pure and Applied Mathematics

A minor in mathematics can be a valuable qualification for students concentrating in other areas. A student wishing to pursue a minor in mathematics must complete a Minor Program Study Plan signed by the department advisor for mathematics, and meet the School of Engineering and Science requirements for minor programs.

Required courses for a Minor in Mathematics:

Six courses are required with a minimum two-course overload.

Take two (2) of the following three (3) courses*.

▸ MA 221 Differential Equations

▸ MA 227 Multivariable Calculus

▸ MA 222 Probability and Statistics

Plus

▸ MA 232 Linear Algebra

Plus three (3) electives; at least two must be at 300-level or above.

▸ 200 level: MA 230, 234, 236, 240

▸ 300 level: MA 331, 335, 336, 346, 360, 361

▸ 400 level: MA 410, 441, 450/575, 463, 464

▸ 500 level: MA 503, 525, 560

Course substitutions are possible with the approval of the department advisor. Typical substitutions are Multivariable Calculus & Optimization, MA 230, in place of MA 227 and the Probability & Statistics course used in the engineering curriculum, E-243, in place of MA 222.

Completion of Calculus II (MA-124 or MA-116) is a prerequisite for undertaking the minor program.

For more information regarding the School of Engineering and Science requirements for minor programs, please see the Guidelines for Science Minor Programs.

Courses outside these MA offerings may be used with approval of the minor advisor.

* All three courses (221, 227, 222) can appear on the minor study plan only in cases where the major program does not include all three as required courses. Some of the exceptions are: Computer Science, Cybersecurity, Chemical Biology, Biology, Computer Engineering, Electrical Engineering, Quantitative Finance and the Business programs.

Graduation Requirements

Physical Education Requirements

‣ All undergraduate students must complete a minimum of four semesters of Physical Education (P.E.). A large number of activities are offered in lifetime, team and wellness areas.

‣ All P.E. courses must be completed by the end of the sixth semester. Students can enroll in more than the minimum required P.E. for graduation and are encouraged to do so.

‣ Participation in varsity sports can be used to satisfy up to three semesters of the P.E. requirement.

‣ Participating in club sports can be used to satisfy up to two of the P.E. requirements.

Note: Student may repeat Physical Education class but the repeated course (excluding varsity and club sports) will not count toward the graduation requirement.

Humanities Requirements

All undergraduate students are required to fulfill certain Humanities requirements in order to graduate. Please see pages 599-600 for a breakdown of specific requirements by program.

GRADUATE PROGRAMS

Admission Criteria and Application Requirements

Applications to all graduate programs, degree and certificate, must be prepared and submitted according to the Stevens Office of Graduate Admissions regulations. Instructions and forms may be found on the Graduate Admissions web site. Notice that the procedure is different for domestic and international applicants. The following sections describe requirements specific to graduate programs in the Department of Mathematical Sciences.

Master Degree and Certificate Programs

Adequate undergraduate preparation for admission to any master degree or certificate program includes analytic geometry and calculus, elementary differential equations, one semester of linear algebra, and one semester of probability or probability and statistics. It is possible to be admitted with the requirement that you make up a deficiency in preparation. Applications to any master degree or certificate program should include

‣ Two letters of recommendation

‣ Official transcripts and diplomas. For non-English speaking institutions, these documents must be accompanied by a certified English translation

‣ GRE General Test scores

‣ TOEFL score for international students

Master of Science - Applied Mathematics

The program prepares students for careers in science, engineering, and business, where advanced methods in differential equations, nonlinear optimization, statistics, and computational mathematics play a significant role in technology development and innovation. It accommodates individuals with varying academic backgrounds and career objectives, including students interested in pursuing a Ph.D. in the mathematical sciences.

The program offers three concentrations: Differential Equations, Optimization of Stochastic Systems and Data Science. Upon completion of the program, the students are expected to have broad knowledge and fundamental understanding of real analysis, differential equations, probability, nonlinear optimization, statistics, and numerical methods, gain expertise in at least one of subfields of applied mathematics and develop awareness of the interplay between mathematical disciplines and their relevance to science, engineering, and business.

Common Core Courses

‣ MA 635 Functional Analysis I

‣ MA 540 Introduction or Probability Theory or MA 611 Probability

‣ MA 615 Numerical Analysis

Core Courses for Concentration in Differential Equations

‣ MA 649 Intermediate Differential Equations

‣ MA 650 Partial Differential Equations

‣ MA 653 Numerical Solutions of Partial Differential Equations

‣ MA 681 Complex Analysis

Core Courses for Concentration in Optimization of Stochastic Systems

‣ MA 541 Statistical Methods or MA 612 Mathematical Statistics

‣ MA 623 Stochastic Processes

‣ MA 629 Nonlinear Optimization

‣ MA 662 Stochastic Optimization

Core Courses for Concentration in Data Science

‣ MA 644 Numerical Linear Algebra for Big Data

‣ MA 541 Statistical Methods or MA 612 Mathematical Statistics

‣ MA 641 Time Series Analysis I

‣ MA 661 Dynamic Programming and Reinforcement Learning

Electives

‣ MA 544 Numerical Linear Algebra for Big Data

‣ MA 541 Statistical Methods

▶ MA 612 Mathematical Statistics

▶ MA 613 Spatial and Spatio-Temporal Statistical Modeling

▶ MA 617 Tensor Methods in Data Science

▶ MA 620 Introduction to Network and Graph Theory

▶ MA 623 Stochastic Processes

▶ MA 627 Combinatorial Analysis

▶ MA 629 Nonlinear Optimization

▶ MA 630 Advanced Optimization Methods

▶ MA 631 Calculus of Variations

▶ MA 632 Game Theory

▶ MA 641 Time Series Analysis I

▶ MA 649 Intermediate Differential Equations

▶ MA 650 Partial Differential Equations

▶ MA 651 Topology I

▶ MA 653 Numerical Solutions of Partial Differential Equations

▶ MA 655 Optimal Control

▶ MA 661 Dynamic Programming and Reinforcement Learning

▶ MA 662 Stochastic Optimization

▶ MA 681 Complex Analysis

▶ MA 711 Inverse Problems in Science & Engineering

▶ MA 712 Mathematical Models of Risk

▶ MA 720 Multivariate Statistics

▶ MA 800 Special Problems in Mathematics (MS)

▶ MA 810 Special Topics in Mathematics

Master of Science - Data Science

Data Science is a coherent framework of principles for processing and analyzing data towards decision-making. The Master of Science in Data Science (MSDS) provides the theoretical knowledge and practical skills required for dealing with the contemporary collection, exploration, analysis, and modeling of data along with the related challenges pertaining to inference and prediction. Emphasis is put on the mathematical foundations underpinning state-of-the-art methodologies: probability theory, statistical modeling, numerical methods, optimization, and Markov decision processes for statistical learning.

The core courses cover generally applicable theory and methods in a self-sufficient framework, while elective courses can tailor particular paths towards industry and business applications, or towards an academic career. The choice of electives can lead to a concentration, which is optional. Four concentrations are offered: Fundamentals of Data Science, Data Acquisition and Management, Data Security, and Business Applications.

Core Courses

15 credits totaled over the following 5 core courses.

- MA 541 Statistical Methods
- CS 583 Deep Learning
- MA 630 Advanced Optimization Methods
- MA 661 Dynamic Programming and Reinforcement Learning
- CPE 695 Applied Machine Learning

  MA 612 Mathematical Statistics or MA 701 Statistical Inference can be taken instead of MA 541 given sufficient preparation.

Electives

15 credits to be chosen among the elective classes listed below.

Students may choose MA 900 Master of Science Thesis for 6 credits as one of their electives to work on a specific project with an advisor. The approval of the program coordinator is required for enrollment in MA 900.

Also, students may choose one (and only one) of the following as one of their electives:

- CS 570 Introduction to Programming, Data Structures and Algorithms
- EE 551 Engineering Programming: Python

The elective courses listed below are grouped in 4 concentrations. Choosing a concentration is not a requirement. Students that do choose a concentration must then select at least 9 credits out of the 15 electives from the corresponding list.

Elective Courses for Concentration in Fundamentals of Data Science

At least 9 credits out of the 15 credits in elective classes must be chosen among the following courses.

- MA 544 Numerical Linear Algebra for Big Data
- MA 641 Time Series Analysis I
- MA 613 Spatial and Spatio-Temporal Statistical Modeling
- MA 617 Tensor Methods in Data Science
- MA 620 Introduction to Networks and Graph theory
- MA 623 Stochastic Processes
- MA 662 Stochastic Optimization
- MA 720 Multivariate Statistics
- CPE 646 Pattern Recognition and Classification
- CS 584 Natural Language Processing
- CS 601 Algorithmic Complexity

Elective Courses for Concentration in Data Acquisition and Management

At least 9 credits out of the 15 credits in elective classes must be chosen among the following courses.

▶ CS 526 Enterprise and Cloud Computing

▶ CS 549 Distributed Systems and Cloud Computing

▶ CS 561 Database Management Systems I

▶ CS 562 Database Management Systems II

▶ CS 609 Data Management and Exploration on the Web

▶ EE 627 Data Acquisition and Processing I

▶ EE 628 Data Acquisition and Processing II

Elective Courses for Concentration in Data Security

At least 9 credits out of the 15 credits in elective classes must be chosen among the following courses.

▶ CS 573 Fundamentals of Cyber Security

▶ CS 503/MA 503* Discrete Mathematics for Cryptography

▶ CS 579/CPE 579* Foundations of Cryptography

▶ CS 578* Privacy in a Networked World

▶ CS 594 Enterprise Security and Information Assurance

▶ CS 696 Database Security

▶ CS 595 Information Security and the Law

▶ CPE 691 Information Systems Security

* These three courses must be taken in the sequence CS 503 - CS 579 - CS 578.

Elective Courses for Concentration in Business Applications

At least 9 credits out of the 15 credits in elective classes must be chosen among the following courses.

▶ CS 526 Enterprise and Cloud Computing

▶ BIA 660 Web Analytics

▶ BIA 662 Cognitive Computing

▶ BIA 672 Marketing Analytics

▶ BIA 674 Supply Chain Analytics

▶ BIA 676 Data Streams Analytics: Internet of Things

▶ BIA 678 Big Data Technologies Seminar

▶ FE 555 2D Data Visualization Programming for Financial Applications

▶ MIS 636 Data Warehousing and Business Intelligence

Master of Science - Actuarial Mathematics and Quantitative Risk

This program is designed to provide fundamental concepts of actuarial science with an emphasis on mathematical methods and ensuing models to evaluate, manage and control actuarial risk. The program will introduce insurance strategies and their financial instruments through six core courses and four elective courses.

Core Courses

- ▸ MA 540 Introduction to Probability
- ▸ MA 541 Statistical Methods
- ▸ MA 542 Actuarial Finance I
- ▸ MA 543 Actuarial Finance II
- ▸ MA 545 Short Term Actuarial Mathematics
- ▸ MA 546 Long Term Actuarial Mathematics

Electives

- ▸ MA 548 Advanced Calculus II
- ▸ MA 552 Axiomatic Linear Algebra
- ▸ MA 615 Numerical Analysis
- ▸ MA 611 Probability
- ▸ MA 612 Mathematical Statistics
- ▸ MA 623 Stochastic Processes
- ▸ MA 629 Nonlinear Optimization
- ▸ MA 641 Time Series Analysis I
- ▸ MA 661 Dynamical Programing and Reinforcement Learning
- ▸ MA 662 Stochastic Optimization
- ▸ MA 701 Statistical Inference
- ▸ MA 712 Mathematical Models of Risk
- ▸ BIA 670 Risk Management Methods and Applications
- ▸ EMT 606 Economics
- ▸ BIA 650 Optimization and Process Analytics
- ▸ CS 506 Introduction to IT Security

In addition, students enrolled in this program should consider taking the following courses listed among the electives:

- ▸ For mathematical sciences requirement: MA 641 Time Series Analysis I
- ▸ For financial and accounting requirements: EMT 606 Economics, BIA 650 Optimization and Process Analytics

Master of Science - Mathematics

A master's degree in mathematics requires 30 credits of coursework, including the six core courses. Taking a course not listed under Electives requires approval from the academic advisor prior to enrolling in the course. Credit for courses taken without approval might not be counted towards the degree.

Core Courses

- MA 552 Linear Algebra
- MA 605 Foundations of Algebra I
- MA 611 Probability
- MA 635 Real Variables I
- MA 651 Topology I
- MA 681 Functions of a Complex Variable I

Electives

- MA 606 Foundations of Algebra II
- MA 620 Intro to Networks & Graph Theory
- MA 623 Stochastic Processes
- MA 627 Combinatorial Analysis
- MA 629 Nonlinear Optimization
- MA 631 Calculus of Variations
- MA 636 Real Variables II
- MA 649 Intermediate Differential Equations
- MA 650 Partial Differential Equations
- MA 717 Algebraic Topology
- MA 800 Special Problems in Mathematics (MS)
- MA 810 Special Topics in Mathematics

Doctoral Program - Pure and Applied Mathematics

Admission Requirements

Admission to the doctoral program requires the preparation specified above. If your goal is a Ph.D., you should apply directly to the doctoral program and not to a master's program. In order to receive full consideration, applications to the doctoral program should be received by February 15 for admission in the Fall Semester, and October 15 for admission in the spring semester. Because of constraints due to course scheduling, admission for the spring semester is not always feasible and may depend on the student's preparation. In addition, financial aid is usually not available for students admitted in the spring semester. Applicants requesting financial aid should apply by February 15 and clearly state that such aid is being requested.

Applications to the doctoral program should include the following items, all of which enter into the Graduate Program Committee's evaluation of applicants:

- A personal statement that, in a succinct manner, describes the student's reasons for pursuing a Ph.D., prior classroom and research experience in mathematics, and current mathematical interests. This should not exceed two pages.

- Official transcripts and diplomas. For non-English-speaking institutions, these documents must be accompanied by a certified English translation.

- Letters of recommendation: at least two; at most, four.

- GRE General Test scores (Math Subject Test recommended).

Financial Aid

The department supports a limited number of Ph.D. students through teaching assistantships which entitle the recipients to a salary and a waiver of their tuition costs. Teaching assistants are considered for renewal each year, depending on the student's progress towards graduation and performance evaluations as a teaching assistant. Save for exceptional cases, financial support from Stevens is limited to four years beyond the Master's degree. Assistantships are usually available only for students entering in the fall.

Students who wish to be considered for a teaching assistantship beginning their first year should mention this in their Personal Statement. Students with prior teaching experience are encouraged to submit additional documentation that addresses their teaching skills, such as letters of recommendation, evaluation forms, teaching awards, etc. However, no teaching experience is required for an incoming student to be considered for a teaching assistantship.

Degree Requirements

The primary requirement for a doctoral degree in mathematics is that you produce a dissertation containing an original and significant result in mathematics. You will work under the guidance of a faculty advisor who is an expert in your area of research.

Preparation for dissertation work includes both courses in mathematical fundamentals and practice in communicating mathematics orally and in writing. The courses you take will not necessarily include everything you will need to know. As a doctoral student you will be expected to learn some mathematics on your own outside of class. Seminars afford a means to that end. They can be organized informally among students or more formally with a faculty advisor. Seminars of the latter type may be taken for academic credit. Students are encouraged to identify subjects they would like to study and to seek out faculty advisors.

Coursework and Credits

The doctoral program requires 84 credits beyond the bachelor's degree (54 credits beyond the master's) of which at least 30 credits must be doctoral research credits (MA 960). This credit total includes the three-credit "Signature" course, PRV961. Some of the 30 research credits can be substituted by course credits with approval from the thesis advisor. A prior master's degree may be transferred for up to 30 credits without specific course descriptions and with approval of the department and the Graduate Academics & Student Success. Up to one-third of additional course credits may be transferred with the approval of the thesis committee and the Graduate Academics & Student Success. The grade of "B" (3.0 GPA) or better is required for such courses and such courses may not have been already used to obtain an academic degree.

General Exam

The general (qualifying) exam tests the knowledge of three subjects: real analysis and two subjects chosen in consultation with the student's academic advisor. The real analysis subject is based on two courses: Functional Analysis I and II (MA 635,

MA 636), and each chosen subject is based on two closely related courses. Subjects and corresponding courses include but are not limited to:

- ‣ Algebra: Foundations of Algebra I and II (MA 605, MA 606)

- ‣ Discrete Mathematics: Combinatorial Analysis (MA 627) and Introduction to Network & Graph Theory (MA 620)

- ‣ ODEs and Numerical Analysis: Numerical Analysis (MA 615) and Intermediate Differential Equations (MA 649)

- ‣ Optimization: Nonlinear Optimization (MA 629) and either Advanced Optimization Methods (MA 630) or Dynamic Programming and Reinforcement Learning (MA 661) or Stochastic Optimization (MA 662) or Optimal Control (MA 655)

- ‣ PDEs & Complex Analysis: Partial Differential Equations (MA 650) and either Functions of a Complex Variable I (MA 681) or Numerical Solutions of PDEs (MA 653) or Inverse Problems in Science and Engineering (MA 711)

- ‣ Probability & Statistics: Probability (MA 611) and either Mathematical Statistics (MA 612) or Stochastic Processes (MA 623) or Time Series Analysis I (MA 641) or Multivariate Statistics (MA 720)

A student and his/her academic advisor can propose different course combinations for the above subjects or propose other subjects along with corresponding courses. Such proposals must be submitted to the graduate committee for approval three months prior to taking the qualifying exam. Students admitted to the Ph.D. program with BS/MS degrees should attempt the qualifying exam no later than the end of their fourth/second semester.

Students pass the qualifying exam and are admitted to Ph.D. candidacy if they score at least 70 out of 100 on each subject. Students failing all three subjects will not be admitted to Ph.D. candidacy. Students failing at most two subjects are allowed a second attempt to pass exams on the failed subjects. This second attempt is to take place in the following semester. Students are admitted to Ph.D. candidacy only if they pass all remaining subjects on the second attempt.

Dissertation Advisory Committee

Upon entering the Ph.D. program, a doctoral student is assigned an adviser who helps devise the study plan for the first academic year and consults the student on academic matters. The PhD students are urged to determine their research interests and choose a thesis adviser before taking the qualifying exam. Within six months of becoming a doctoral candidate, the student and the Research Advisor should have agreed on a research topic. Refer to the Graduate Student Handbook for further details on the requirements and process for approving the Advisory Committee.

Within one year from the date of successfully passing the qualifying exam, the Ph.D. candidate will prepare and defend a research proposal. The research proposal should address (i) problem motivation and literature review, (ii) problem formulation, (iii) approaches and methods to be used and (iv) expected results and potential impact. A few days prior to the defense, the candidate will deliver to the advisory committee a brief (two-page) summary of the proposal.

Dissertation

The final and most important step of the Ph.D. program is writing a dissertation of publishable quality. This will embody the results of the student's original research in mathematics, and the dissertation will be presented by the student at a public defense. If the suitably appointed Dissertation Committee approves the defense, the student will be recommended to the Office of Graduate Academics for the Ph.D. degree.

Graduate Certificates

The Mathematical Science department offers graduate certificates in Applied Statistics and Stochastic Systems. Each program consists of four courses, including one elective chosen with the consent of the departmental advisor. Most courses may be used toward a master's degree, as well as for the certificate.

The admissions requirements for certificate programs are the same as for the master degree as described above. The course requirements are listed below.

Applied Statistics

▶ MA 552 Linear Algebra

▶ MA 611 Probability

▶ MA 612 Mathematical Statistics

Electives

▶ MA 623 Stochastic Process

▶ MA 641 Time Series Analysis I

▶ MA 712 Mathematical Models of Risk

Stochastic Systems

▶ MA 611 Probability

▶ MA 612 Mathematical Statistics

▶ MA 629 Nonlinear Optimization

Electives

▶ MA 623 Stochastic Process

▶ MA 630 Advanced Optimization Methods

▶ MA 632 Game Theory

▶ MA 661 Dynamic Programming and Reinforcement Learning

▶ MA 662 Stochastic Optimization

▶ MA 712 Mathematical Models of Risk

COURSE OFFERINGS

Mathematics

MA 090   Pre-Calculus   (3 - 3 - 0)
Partial fractions, polynomials, Remainder Theorem, Fundamental Theorem of Algebra, Descartes' Rule, exponential and log functions, trigonometric functions, trigonometry of triangles, right triangles, laws of sines and cosines, and conic sections.

MA 115   Calculus I   (4 - 4 - 0)
An introduction to differential and integral calculus for functions of one variable. Begins with limits and continuity, and ends with integration techniques and applications of the definite integral. As of Fall 2012, MA 115 is replaced by the sequence MA 121 and MA 122.

MA 116   Calculus II   (4 - 4 - 0)
Improper integrals, infinite series. Taylor series, vector operations in 3D, calculus for functions of two and three variables including graphical representations, partial derivatives, the gradient, optimization, iterated integrals in rectangular and polar coordinates and applications of double integrals. As of Spring 2013 MA116 is replaced by the sequence MA123 and MA124.

MA 117   Calculus for Business and Liberal Arts   (4 - 4 - 0)

Limits, the derivatives of functions of one variable, differentiation rules, and applications of the derivative. Definite integrals for functions of one variable, antiderivatives, the Fundamental Theorem, integration techniques, and applications of the integral.

MA 119   Multivariable Calculus & Finite Mathematics   (3 - 3 - 0)

The first third of this course introduces students to calculus for functions of several variables and requires that students are familiar with the main results and techniques from one-variable calculus. The applied problems emphasize optimization problems for functions of two and three variables. The second part of the course reviews the use of matrices in representing systems of linear equations and then returns to the theme of optimization with an introduction to Linear Programming. The final third of the course teaches set notation and theory, basic counting principles, and an introduction to discrete probability. Throughout the course, motivating examples are drawn from applications in business, engineering, and the social sciences. Prerequisite: MA 117 or MA 122 or MA 115

MA 120   Introduction to Calculus   (2 - 4 - 0)

The first part of the course reviews algebra and precalculus skills. The second part of the course introduces students to topics from differential calculus, including limits, rates of change and differentiation rules. This is a seven week course.

MA 121   Differential Calculus   (2 - 4 - 0)

Limits and derivatives of functions of one variable including the trigonometric, inverse trigonometric, logarithmic and exponential functions; differentiation rules, implicit differentiation, geometric and physical interpretations of the derivative, applications of the derivative including optimization and sketching graphs of one variable functions. This is a seven week course.

MA 122   Integral Calculus   (2 - 4 - 0)

Definite integrals of functions of one variable, antiderivatives, the two versions of the Fundamental Theorem of Calculus, integration techniques including substitution, integration by parts, inverse trigonometric substitutions, and partial fraction decompositions; improper integrals, L'Hospital's Rule, applications to geometry and physics including calculation of areas, volumes, and work done by a variable force. This is a seven week course. Prerequisite: MA 121

MA 123   Series, Vectors, Functions, and Surfaces   (2 - 4 - 0)

Taylor polynomials and series, functions of two and three variables, linear functions, implicit functions, vectors in two and three dimensions. This is a seven week course. Prerequisite: MA 122 or MA 115

MA 124   Calculus of Two Variables   (2 - 4 - 0)

Partial derivatives, the tangent plane and linear approximation, the gradient and directional derivatives, the chain rule, implicit differentiation, extreme values, application to optimization, double integrals in rectangular coordinates. This is a seven week course. Prerequisite: MA 123

MA 134   Discrete Mathematics   (3 - 3 - 0)

This course provides the background necessary for advanced study of mathematics or computer science. Topics include propositional calculus, predicates and quantifiers, elementary set theory, countability, functions, relations, proof by induction, elementary combinatorics, elements of graph theory, mends, and elements of complexity theory.

MA 188   Seminar in Mathematical Sciences   (1 - 1 - 0)

Selected topics in the Mathematical Sciences and applications of mathematics. Topics typically reflect the research interests of the department faculty. The course may be repeated for credit. Pass/Fail.

MA 221   Differential Equations   (4 - 4 - 0)

Ordinary differential equations of first and second order, homogeneous and non-homogeneous equations; improper integrals, Laplace transforms; review of infinite series, series solutions of ordinary differential equations near an ordinary point; boundary-value problems; orthogonal functions; Fourier series; separation of variables for partial differential equations. Prerequisite: MA 124 or MA 116

MA 222   Probability and Statistics   (3 - 3 - 0)

Introduces the essentials of probability theory and elementary statistics. Lectures and assignments greatly stress the manifold applications of probability and statistics to computer science, production management, quality control, and reliability. Contents include: descriptive statistics, pictorial and tabular methods, and measures of location and of variability; sample space and events, probability axioms, and counting techniques; conditional probability and independence, and Bayes' formula; discrete random variables, distribution functions and moments, and binomial and Poisson distributions; continuous random variables, densities and moments, normal, gamma, and exponential and Weibull distributions unions; distribution of the sum and average of random samples; the Central Limit Theorem; confidence intervals for the mean and the variance; hypothesis testing and p-values, and applications for the mean; simple linear regression, and estimation of and inference about the parameters; and correlation and prediction in a regression model. Prerequisite: MA 124 or MA 116

MA 227   Multivariable Calculus   (3 - 3 - 0)

Review of matrix operations, Cramer's rule, row reduction of matrices; inverse of a matrix, eigenvalues and eigenvectors; systems of linear algebraic equations; matrix methods for linear systems of differential equations, normal form, homogeneous constant coefficient systems, complex eigenvalues, nonhomogeneous systems, the matrix exponential; double and triple integrals; polar, cylindrical and spherical coordinates; surface and line integrals; integral theorems of Green, Gauss and Stokes. Prerequisite: MA 124 or MA 116 Corequisite: MA 221

MA 230   Multivariable Calculus and Optimization   (3 - 3 - 0)

This course starts with some fundamental notions in multivariate analysis and geometry as well as basic notions and results of convex analysis: (gradient, Jacobian and Hessian, closed and open sets, convex sets, convex hulls, convex cones, polyhedral sets, convex functions, and convexity criteria). These notions are used to present the theory and methods of nonlinear optimization: necessary and sufficient conditions of optimality for nonlinear optimization problems with and without constraints, and duality theory. Numerical methods for unconstrained and constrained problems with differentiable functions include, gradient methods, Newton method, conjugate gradients, gradient projection, reduced gradient, simplex method, penalty methods, dual methods. Optimization problems from statistics, engineering, and business will serve as examples. Prerequisite: MA 124 or MA 116

MA 232   Linear Algebra   (3 - 3 - 0)

This course introduces basic concepts of linear algebra from a geometric point of view. Topics include the method of Gaussian elimination to solve systems of linear equations; linear spaces and dimension; independent and dependent vectors; norms, inner product, and bases in vector spaces; determinants, eigenvalues and eigenvectors of matrices; symmetric, unitary, and normal matrices; matrix representations of linear transformations and orthogonal projections; the fundamental theorems of linear algebra; and the least-squares method and LU-decomposition. Prerequisite: Sophomore or higher class standing.

MA 234   Complex Variables with Applications   (3 - 3 - 0)

An introduction to functions of a complex variable. The topics covered include complex numbers, analytic and harmonic functions, complex integration, Taylor and Laurent series, residue theory, and improper and trigonometric integrals. Corequisite: MA 227

MA 236   Introduction to Mathematical Reasoning   (3 - 3 - 0)

This course introduces students to first order logic and to fundamental discoveries about the nature and limits of mathematics which have emerged in the last hundred years. The course begins with a concrete treatment of first order logic and culminates with the unsolvability of the halting problem and the Church-Turing Theorem on the undecidability of first order logic.

MA 240   Proofs and Refutations   (3 - 3 - 0)

This course is concerned with the art of constructing rigorous mathematical arguments, i.e. proofs. Famous and elegant proofs in various branches of mathematics are studied in detail. Different methods of proof, including direct proof, reductio ad absurdum, proof by induction, and others are practiced and assessed. Prerequisite: MA122. Open only to students majoring in Pure and Applied Mathematics or Computational Science. Other students require the signature of the instructor to register.

MA 281   Honors Mathematical Analysis III   (4 - 4 - 0)

Covers the same material as that dealt with in MA 221, but with more breadth and depth. By invitation only.

MA 282   Honors Mathematical Analysis IV   (4 - 4 - 0)

Covers the same material as that dealt with in MA 227, but with more breadth and depth. By invitation only.

MA 293   Supplementary Topics of Differential Equations   (1 - 1 - 0)

This course is designed for the completion of transferring credits for MA 221 Differential Equations. The transfer students, who need to learn some topics of MA 221 not included in the courses taken elsewhere, may enroll in this course only once with permission of an undergraduate adviser in the Math Department, and are required to complete this course under the guidance of the MA 221 course coordinator. The students who pass this course will receive the full transfer credits for MA 221. The students who fail will then be required to enroll in the full course of MA 221 at Stevens. Pass/Fail.

MA 294   Supplementary Topics of Calculus IV   (1 - 1 - 0)

This course is designed for the completion of transferring credits for MA 227 Multivariable Calculus. The transfer students, who need to learn some topics of MA 227 not included in the courses taken elsewhere, may enroll in this course only once with permission of an undergraduate adviser in the Math Department. The students are required to complete this course under the guidance of the MA 227 course coordinator. The students who pass this course will receive the full transfer credits for MA 227. The students who fail will then be required to enroll in the full course of MA 227 at Stevens. Pass/Fail.

MA 331   Intermediate Statistics   (3 - 3 - 0)

An introduction to statistical inference and to the use of basic statistical tools. Topics include descriptive and inferential statistics; review of point estimation, method of moments, and maximum likelihood; interval estimation and hypothesis testing; simple and multiple linear regression; analysis of variance and design of experiments; and nonparametric methods. Selected topics, such as quality control and time series analysis, may also be included. Statistical software is used throughout the course for exploratory data analysis and statistical inference based in examples and in real data relevant for applications. Prerequisite: MA 222 or E 243

MA 335   Introduction to Number Theory   (3 - 3 - 0)

This is an introductory course to number theory. Topics include divisibility, prime numbers and modular arithmetic, arithmetic functions, the sum of divisors and the number of divisors, rational approximation, linear Diophantine equations, congruences, the Chinese Remainder Theorem, quadratic residues, and continued fractions.

MA 336   Modern Algebra   (3 - 3 - 0)

A rigorous introduction to group theory and related areas with applications as time permits. Topics include proof by induction, greatest common divisor, and prime factorization; sets, functions, and relations; definition of groups and examples of other algebraic structures; and permutation groups, Lagrange's Theorem, and Sylow's Theorems. Typical application: error correcting group codes.

MA 346   Numerical Methods   (3 - 3 - 0)

This course begins with a brief introduction to writing programs in a higher level language, such as Matlab. Students are taught fundamental principles regarding machine representation of numbers, types of computational errors, and propagation of errors. The numerical methods include finding zeros of functions, solving systems of linear equations, interpolation and approximation of functions, numerical integration and differentiation, and solving initial value problems of ordinary differential equations. Prerequisite: MA 124 or MA 116

MA 360   Intermediate Differential Equations   (3 - 3 - 0)

This course offers more in-depth coverage of differential equations. Topics include ordinary differential equations as finite-dimensional dynamical systems; vector fields and flows in phase space; existence/uniqueness theorems; invariant manifolds; stability of equilibrium points; bifurcation theory; Poincaré-Bendixson Theorem and chaos in both continuous and discrete dynamical systems; and applications to physics, biology, economics, and engineering. Prerequisite: MA 221

MA 361   Intermediate Partial Differential Equations   (3 - 3 - 0)

This course offers a rigorous approach to classical partial differential equations. It begins with definitions, properties, and derivations of some basic equations of mathematical physics followed by the topics: solving of first order equations with the method of characteristics; classification of second order equations; the heat equation and wave equation; Fourier series and separation of variables; Green's functions and elliptic theory; examples of the first and second order nonlinear partial differential equations. Prerequisite: MA 221

MA 410   Differential Geometry   (3 - 3 - 0)

This course is an introduction to the geometry of curves and surfaces. Topics include tangent vectors, tangent bundles, directional derivatives, differential forms, Euclidean geometry and calculus on surfaces, Gaussian curvatures, Riemannian geometry, and geodesics. Prerequisite: MA 227

MA 441   Introduction to Mathematical Analysis   (3 - 3 - 0)

This course introduces students to the fundamentals of mathematical analysis at an adequate level of rigor. Topics include fundamental mathematical logic and set theory, the real number systems, sequences, limits and completeness, elements of topology, continuity, derivatives and related theorems, Taylor expansions, the Riemann integral, and the Fundamental Theorem of Calculus. Prerequisite: MA 227

MA 442   Real Variables   (3 - 3 - 0)

This course introduces principles of real analysis and the modern treatment of functions of one and several variables. Topics include metric spaces, the Heine-Borel theorem in R-n, Lebesgue measure, measurable functions, Lebesgue and Stieltjes integrals, Fubini's theorem, abstract integration, L-p classes, metric and Banach space properties, and Hilbert space. Prerequisites: MA 232, MA 441

MA 450   Optimization models in finance   (3 - 3 - 0)

This course introduces the students to mathematical models and computational methods for static and dynamic optimization problems occurring in finance. The models involve knowledge of probability, optimality conditions, duality, and basic numerical methods. Special attention will be paid to portfolio optimization and to risk management problems. Prerequisites: MA 222, MA 230

MA 460   Chaotic Dynamics, with Computations and Applications   (3 - 3 - 0)

This course introduces students to the concepts behind the modern theory of dynamical systems, particularly chaotic systems. Although the course is mathematical in nature, the emphasis is on the underpinning ideas and applications, rather than a systematic exposition of results. Topics include: standard examples and definitions, solutions of ODEs as dynamical systems, flows, and maps; fixed points of linear maps, periodic orbits, limit cycles, and asymptotic stability; rudiments of hyperbolicity; and symbolic dynamics and the Horse Shoe. Further topics may include: fundamentals of topological dynamics, fundamentals of ergodic theory, attractors, and fractals. A good part of the assigned work involves computer experimentation and computations. Prerequisites: MA 221, MA 232

MA 461   Special Problems I   (2 - -)
Individual projects in pure and applied mathematics.

MA 462   Special Problems II   (2 - -)
Individual projects in pure and applied mathematics.

MA 463   Seminar in Mathematics I   (3 - 3 - 0)
Seminar in selected topics, such as: combinatorial topology, differential geometry, finite groups, number theory, or statistical techniques.

MA 464   Seminar in Mathematics II   (3 - 3 - 0)
Seminar in selected topics such as: combinatorial topology, differential geometry, finite groups, number theory, or statistical techniques.

MA 498   Senior Research Project I   (3 - 0 - 8)
Students will do a research project under the guidance of a faculty advisor. Senior standing and prior approval are required. Topics may be selected from any area of mathematics with the instructor's approval. Each student will be required to present results in both a written and oral report. The written report must be read and approved by a faculty reader in addition to the faculty advisor. Upon approval the student can proceed to the oral report, which will be open to all faculty members.

MA 499   Senior Research Project II   (3 - 0 - 8)

Students will do a research project under the guidance of a faculty advisor. Senior standing and prior approval are required. Topics may be selected from any area of mathematics with the instructor's approval. Each student will be required to present results in both a written and oral report. The written report must be read and approved by a faculty reader in addition to the faculty advisor. Upon approval the student can proceed to the oral report, which will be open to all faculty members.

MA 501   Introduction to Mathematical Analysis   (3 - 3 - 0)

This course is an introduction to the basic ideas of pre-calculus and calculus for the people who need preparation or review before taking more advanced courses. The exact content depends upon the particular needs of those enrolled and the requirements of degree programs they are pursuing. Topics covered will be selected from the following: algebra, functions, and graphs; slopes and secant lines; derivatives; chain rule; optimization; curve sketching; integration; the exponential and natural logarithm; and probability density functions and integration by parts.

MA 502   Mathematical Foundations of Computer Science   (3 - 3 - 0)

This course provides the necessary mathematical prerequisites for the computer science master's program and also serves as a foundation for further study in mathematics. The topics covered include prepositional calculus: predicates and quantifiers; elementary number theory and methods of proof; mathematical induction; elementary set theory; combinatorics; functions and relations; countability; recursion and O-notation. Applications to computer science are stressed.

MA 503   Discrete Mathematics for Cryptography   (3 - 3 - 0)

Topics include basic discrete probability, including urn models and random mappings; a brief introduction to information theory; elements of number theory, including the prime number theorem, the Euler phi function, the Euclidean algorithm, and the Chinese remainder theorem; and elements of abstract algebra and finite fields including basic fundamentals of groups, rings, polynomial rings, vector spaces, and finite fields. Carries credit toward the Applied Mathematics degree only when followed by CS 668. Recommended for high-level undergraduate students. Cross-listed with: CS 503 Prerequisite: MA 502

MA 505   Introduction to Mathematical Methods   (3 - 3 - 0)

Elementary mathematical techniques important to applied mathematics. Topics covered include review of functions and continuity; ordinary and partial derivatives; integration; ordinary and partial differential equations; infinite series and numerical techniques for solving differential equations; and multiple integration and surface integrals. Applications to problems of applied mathematics are given where feasible.

MA 525   Introduction to Computational Science   (3 - 3 - 0)

This course is primarily for students interested in using numerical methods to solve problems in mathematics, science, engineering, and management. Computational projects will be a significant part of this course and it is expected that students already have experience programming in at least one high level language. Standard topics include numerical solutions of ordinary and partial differential equations, techniques in numerical linear algebra, the Fast Fourier Transform, optimization methods, and an introduction to parallel programming. Additional topics will depend on the interests of the instructor and students. Prerequisites: MA 232, MA 346

MA 529   Applied Mathematics for Engineers and Scientists I   (3 - 3 - 0)

Review of limits, continuity, partial differentiation, Leibnitz's rule; implicit functions and Jacobians; gradients, divergence, curl, line and surface integrals; theorems of Stokes, Gauss and Green; complex numbers, elementary functions, analytic functions, complex integration, power series, residue theorem, evaluation of real definite integrals; systems of linear equations, rank, eigenvalues and eigenvectors. Prerequisite: MA 227

MA 530   Applied Mathematics for Engineers and Scientists II   (3 - 3 - 0)

Review of first order and second order constant coefficient differential equations, nonhomogeneous equations; series solutions, Bessel and Legendre functions; boundary value problems, Fourier-Bessel series and separation of variables for partial differential equations; classification of partial differential equations; Laplace transform methods; calculus of variations; introduction to finite-difference methods. Prerequisite: MA 227

MA 534   Methods of Applied Mathematics   (3 - 3 - 0)

Difference equations; calculus of variations; integral equations; and applications to engineering and science. Prerequisite: MA 227

MA 540   Introduction to Probability Theory   (3 - 3 - 0)

Sample space, events, and probability; basic counting techniques and combinatorial probability; random variables, discrete and continuous; probability mass, probability density, and cumulative distribution functions; expectation and moments; some common distributions; jointly distributed random variables, conditional distributions and independence, bivariate normal, and transformations of variables; and Central Limit Theorem. Some additional topics may include an introduction to confidence intervals and hypothesis testing.

MA 541   Statistical Methods   (3 - 3 - 0)

This course offers an introduction to exploratory data analysis and the use of basic statistical tools. Topics will include: data collection; descriptive statistics, and graphical and tabular treatment of quantitative, qualitative, and count data; detecting relations between variables; confidence intervals and hypothesis testing for one and two samples; simple and multiple linear regression; analysis of variance; design of experiments; and nonparametric methods. Selected topics, such as quality control and time series analysis, may also be included. Statistical software will be used throughout the course and statistical inference will be based on examples using real data. Students will participate in group projects of data analysis. They will be trained in the different phases of the professional statistician's work, namely: data collection, description, analysis, testing, and presentation of the conclusions. Prerequisite: MA 540

MA 542   Actuarial Finance I   (3 - 3 - 0)

This course introduces the fundamental concepts of financial mathematics with mathematical and statistical methods applied to calculating various streams of values, including interest, pricing, assets, liability management, capital budgeting, contingent cash flows and insurance. Prerequisite: Basic knowledge or undergraduate class in linear algebra

MA 543   Actuarial Finance II   (3 - 3 - 0)

This course is an introduction to investment and financial market with applications of mathematics to pricing and hedging options, efficient market hypothesis, evaluation of investment risk and stock analysis, capital structures, and derivative instruments in risk management. Prerequisite: MA 542

MA 544   Numerical Linear Algebra for Big Data   (3 - 3 - 0)

This course will introduce foundational ideas as well as advanced techniques in linear algebra that are employed in computational science of Big Data. Students will work with vector-matrix representation of various types of structured and unstructured data and how different models and processes could be understood in terms of linear algebra operations and algorithms. Efficient implementation of algorithm for high dimensional data by using *Randomized Numerical Linear Algebra* will be one of the focal points. Students will develop and improve their coding skills in Python and MATLAB for implementation of several algorithms. In addition, students will read past and current literature in machine learning and data science to familiarize themselves of the current trends and challenges in linear algebra for solving real life problems. Prerequisites: MA 123, MA 124 or equivalent, MA 232 or equivalent, MA 222 or equivalent, and have basic knowledge of MATLAB (FE 516) or Python (FE 520).

MA 545   Short-Term Actuarial Mathematics   (3 - 3 - 0)

This course is tailored for the validation of Short Term Actuarial Mathematics (STAM) exam by Society of Actuaries (SOA). The main materials include (i) probability models commonly used for severity, frequency, risk aggregations, coverage modifications, and (ii) risk indications commonly used in credibility theory and reinsurance. The aim is to build up probability and statistical foundation for graduate students with concentration in actuarial science, and the focus is put on calculations concerned with coverage modifications and risk measures, construction and estimation of parametric models. Also, the attention is paid to the basics of insurance and reinsurance, the calculation of premiums and reserve for the short-term insurance as well. Prerequisites: MA 540 and MA 541

MA 546   Long-Term Actuarial Mathematics   (3 - 3 - 0)

This course is designed to satisfy the Validation by ASA requirement for Long-Term Actuarial Mathematics (LTAM) Exam. The course contents comprise various aspects of long- term actuarial mathematics, including, long-term insurance coverages, survival models and their estimation, present value random variables, premium calculation, reserves calculation, pension plans and retirement benefits. Discussions are also made on applying advanced probability and statistic to evaluate various long-term insurances. Prerequisites: MA 540 and MA 541

MA 547   Advanced Calculus I   (3 - 3 - 0)

Elementary topology of Euclidean spaces; differential calculus of functions of several variables; inverse and implicit function theorems; integration; differential forms; and theorems of Gauss, Green, and Stokes. Prerequisite: MA 227

MA 548   Advanced Calculus II   (3 - 3 - 0)

A continuation of MA 547, but with greater emphasis on mathematical rigor. Topics covered may include convergence of series, Riemann-Stieltjes integration, functions of bounded variation, metric spaces, introduction to measure theory, and functional analysis. Prerequisite: MA 547

MA 550   Introduction to Lie Theory   (3 - 3 - 0)

This course introduces students to fundamentals of Lie theory by focusing on matrix groups. Topics include, but are not limited to, the orthogonal and unitary groups, tangent spaces for matrix groups, Lie algebras, matrix exponentiation, matrix logarithms, the Campbell-Baker-Hausdorff formula, Lie correspondence, basic theory of differentiable manifolds and Lie groups, roots and structure of compact classical Lie groups. Time permitting some applications to differential equations, physics or quantum computation will be considered based on students' interests. Prerequisites: MA227, MA232 and MA336, or bachelor degree in mathematics.

MA 552   Axiomatic Linear Algebra   (3 - 3 - 0)

Fields and vector spaces; subspaces and quotient spaces; basis and dimension; linear transformations and matrices; determinants; and the theory of a single linear transformation.

MA 560   Special Topics in Mathematics   (3 - -)

Special topics in mathematics not covered in regularly scheduled courses and suitable for both graduates and advanced undergraduates. May be taken more than once.

MA 565   Quantum Algorithms   (3 - 3 - 0)

The course provides an introduction to the theory and practice of quantum computation. It starts with a brief and abstract introduction to quantum mechanics, introduces quantum gates and quantum circuits. Then it concentrates on different quantum algorithms (Deutsch-Jozsa algorithm, Simon's algorithm, quantum Fourier transforms, Shor's integer factorization and discrete logarithm algorithms, Grover's search algorithm) and demonstrates their advantage over classic counterparts. Finally, it gives a short introduction to quantum information theory, quantum communication complexity, and quantum cryptography. Prerequisites: Familiarity with Basic linear algebra, complexity theory and basic probability.

MA 567   Computational Algebraic Geometry   (3 - 3 - 0)

The course is devoted to systems of polynomial equations (ideals), their solution sets (varieties), and how these objects can be effectively manipulated (algorithms). It introduces main computational techniques used to solve systems of polynomial equations. These techniques are very important in a wide range of problems including applications to robotics, motion planning, and computer proofs/ automatic theorem proving. Special attention is given to multivariate cryptography, the branch of post quantum cryptography that uses hardness of solving systems of polynomial equations over finite fields.

MA 570   Calculus Review   (1 - 1 - 0)

A review of calculus for students who have successfully completed two or more semesters of calculus but feel a bit rusty. Emphasis is placed on problem solving and on an intuitive understanding of basic concepts. This module is offered in various formats, all of which include substantial online content.

MA 571   Differential Equations Review   (1 - 1 - 0)

A review of differential equations for students who have completed an undergraduate course in differential equations. The course reviews the general theory of linear ODEs and analytical methods for deriving explicit solutions; use of numerical ODE solvers; two-point boundary value problems; separation of variables for linear partial differential equations (PDEs); eigenvalues, eigenfuctions and Fourier Series expansions.

MA 572   Probability and Statistics Review   (1 - 1 - 0)

This module serves as a review of fundamental knowledge in probability and statistics for those students who have already successfully completed an undergraduate course in probability and statistics. Also it covers several concepts and theories useful in engineering and management as supplement.

MA 573   Linear Algebra Review   (1 - 1 - 0)

A review of linear algebra concepts and results for students who have successfully completed an undergraduate course in linear algebra or have been introduce to linear algebra concepts as a part of another undergraduate class.

MA 575   Optimization Models in Quantitative Finance   (3 - 3 - 0)

This course introduces the students to mathematical models and computational methods for static (one-step) and dynamic optimization problems occurring in finance. The models involve knowledge of probability, optimality conditions, duality, and basic numerical methods. We shall discuss approaches to portfolio optimization with fixed income securities, immunization, risky assets portfolios, asset-liability management in dynamic models, dynamic optimization techniques for pricing, re-balancing, and others. Special attention will be paid to mathematical models of risk and risk management for static and dynamic systems. Most assignments will require use of software. Prerequisite: Undergraduate knowledge of probability and optimization

MA 603   Methods of Mathematical Physics I   (3 - 3 - 0)

A unified development of mathematical tools for treating a variety of problems in physics and engineering. Linear algebra, normed and inner product spaces, and spectral theory of operators; integral equations; boundary value problems for ordinary and partial differential equations; Green's functions; calculus of variations; and other related topics as time permits. Problem solving is stressed.

MA 604   Methods of Mathematical Physics II   (3 - 3 - 0)

A unified development of mathematical tools for treating a variety of problems in physics and engineering; linear algebra, normed and inner product spaces, spectral theory of operators; integral equations; boundary value problems for ordinary and partial differential equations; Green's functions; calculus of variations; other related topics as time permits; problem solving is stressed.

MA 605   Foundations of Algebra I   (3 - 3 - 0)

Topics covered in the sequence MA 605-606 include: elementary number theory, basic group theory, Lagrange's theorem, isomorphism theorems, solvability, direct products, Jordan-Holder theorem, Sylow theorems, basic properties of rings, quotient rings, field of quotients of an integral domain, polynomial rings, factorization, elementary properties of fields, field extensions, and Galois theory.

MA 606   Foundations of Algebra II   (3 - 3 - 0)

Topics covered in the sequence MA 605-606 include: elementary number theory, basic group theory, Lagrange's theorem, isomorphism theorems, solvability, direct products, Jordan-Holder theorem, Sylow theorems, basic properties of rings, quotient rings, field of quotients of an integral domain, polynomial rings, factorization, elementary properties of fields, field extensions, and Galois theory. Prerequisite: MA 605

MA 611   Probability   (3 - 3 - 0)

Foundations of probability, random variables and their distributions, discrete and continuous random variables, independence, expectation and conditioning, generating functions, multivariate distributions, convergence of random variables, and classical limit theorems.

MA 612   Mathematical Statistics   (3 - 3 - 0)

Point estimation, method of moments, maximum likelihood, and properties of point estimators; confidence intervals and hypothesis testing; sufficiency; Neyman-Pearson theorem, uniformly most powerful tests, and likelihood ratio tests; and Fisher information and the Cramer-Rao inequality. Additional topics may include nonparametric statistics, decision theory, and linear models. Prerequisite: MA 611

MA 613   Spatial and Spatio-Temporal Statistical Modeling   (3 - 3 - 0)

This course introduces the students to data exploration tools, algorithms and statistical models designed for spatial and spatio-temporal data. The course is a natural follow-up to time series modeling or introductory stochastic processes courses in that it expands on the notions of stationarity and ergodicity, auto-correlation, and the Markov property. The first part of the course focuses on spatial data, highlighting the generalization to the Euclidean plane from a one-dimensional indexing typical of time series. The second part of the course deals with spatio-temporal data, emphasizing how concepts can then be extended further to indexing of higher dimensions. The course balances the mathematical study of the properties of models with the computational aspects involved in their implementation and the interpretation of real-life data examples, the latter relying on the statistical software and environment R. Prerequisites: Linear algebra, real analysis, elementary probability and statistics, basic programming skills in R, having taken MA 641 Time Series Analysis I recommended

MA 615   Numerical Analysis   (3 - 3 - 0)

The course provides a rigorous mathematical foundation for numerical methods and algorithms to be used in scientific computing. It covers the following topics: floating-point format, roundoff errors, absolute and relative errors, loss of significance in computations, condition number of computational procedures, nonlinear equations and systems of linear equations, polynomial approximation and interpolation, numerical differentiation and integration, and ordinary and partial differential equations. Discussion of each method includes analysis of convergence and accuracy as well as efficient implementation. Course assignments focus not only on theoretical analysis of the developed numerical methods but also on implementation of those methods by coding and by using computational packages/software. Prerequisites: MA 551 or equivalent, MA 448, MA 449

MA 616   Numerical Analysis II   (3 - 3 - 0)

The MA 615-616 sequence covers topics in numerical analysis and numerical methods including: errors and accuracy; polynomial approximation; interpolation; numerical differentiation and integration; numerical solution of differential equations; least square and minimum-maximum error approximations; nonlinear equations; simultaneous linear equations; summing series, Fourier series, filter design, the frequency approach, design of numerical tools, and statistics of error analysis; eigenvalues and eigenvectors of matrices; and the orientation throughout is toward computers. Prerequisite: MA 615

MA 617   Tensor Methods for Data Analysis   (3 - 3 - 0)

The goal of course is to introduce tensor numerical methods designed for the solution of the multidimensional problems in scientific computing and data analysis. These methods are based on the rank-structured approximation of multivariate functions and operators by using appropriate tensor decompositions (formats). The old and new rank-structured tensor formats are presented, as: canonical, Tucker, hierarchical, tensor train, quantized tensor train formats and their generalizations, which leads to tensor networks, i.e. representation of high dimensional tensors as interconnected low dimensional tensors in variety of ways. Under suitable conditions these formats allow a stable representation and a reduction of the data size from exponential complexity (with respect to the dimension of the space) to a linear complexity, which kills the curse of dimensionality. Another goal of the course is to present variety of relatively novel unsupervised machine learning methods using matrix and tensor decompositions, as latent variable analysis based on (1) statistical independence and (2) sparsity assumptions, kernel and generalized principal component analysis, and non-negative tensor decomposition, all of which reveal hidden patterns in the data. Prerequisites: MA 124, MA 232, MA 346, MA 222

MA 619   Introductory Sampling   (3 - 3 - 0)

This course covers basic ideas in sampling theory and uses only elementary mathematics. Topics include multistage sampling, stratified sampling, systematic sampling, self-weighting samples, and optimum allocation.

MA 620   Introduction to Network and Graph Theory   (3 - 3 - 0)

Introduction to the theory and applications of networks and graphs. Topics include paths, connectivity, trees, cycles, planarity, network flows, matchings, colorings, and some extremal problems. Prerequisite: MA 502 or equivalent.

MA 623   Stochastic Processes   (3 - 3 - 0)

Random walks and Markov chains; Brownian motions and Markov processes; and applications, stationary (wide sense) processes, infinite divisibility, and spectral decomposition. Prerequisite: MA 611

MA 625   Fundamentals of Geometry   (3 - 3 - 0)

Absolute geometry as founded on axioms of incidence, order, congruence, and continuity; models of absolute geometry and problems of consistency; independence and categoricity of an axiom system; Euclidean and non-Euclidean geometry; brief description of the Erlangen program; and classical differential geometry of surfaces.

MA 627   Combinatorial Analysis   (3 - 3 - 0)

Fundamental laws of counting, permutations, combinations, recurrence relations, Mšbius inversion, probleme des menages, probleme des recontres, partitions, trees, generating functions, Ramsey theory, transversal theory, and matroid theory.

MA 629   Nonlinear Optimization   (3 - 3 - 0)

This course introduces the students to the foundation of optimization. The first part of the class focuses on basic results of convex analysis and their application to the development of necessary and sufficient conditions of optimality and Lagrangian duality theory. The main numerical methods of optimization and their convergence constitute the second portion of the class. Along with the theoretical results and methods, examples of optimization models in probability, statistics, and approximation theory will be discussed as well as some basic models from management, finance, and other practical situations will be introduced in order to illustrate the discussed notions and phenomena, and to demonstrate the scope of applications. Linear optimization techniques will be treated as a special case. Some attention will be paid to using optimization software in the numerical assignments. Prerequisite: undergraduate knowledge about optimization at the level of MA 230 Multivariate Analysis and Optimization.

MA 630   Advanced Optimization Methods   (3 - 3 - 0)

This course introduces the students to the several advanced topics in the theory and methods of optimization. The first portion of the class focuses on subgradient calculus for non-smooth convex functions, optimality conditions for non-smooth optimization problems, conjugate and Lagrangian convex duality. The second part of the class discusses numerical methods for non-smooth optimization as well as approaches to large-scale optimization problems. The latter include decomposition methods, design of distributed and parallel methods of optimization, as well as stochastic approximation methods. Along with the theoretical results and methods, examples of optimization models in statistical learning and data mining, compressed sensing and image reconstruction will be discussed in order to illustrate the challenges and the phenomena, and to demonstrate the scope of applications. Some attention will be paid to using optimization software in the numerical assignments. Prerequisite: MA 629

MA 631   Calculus of Variations   (3 - 3 - 0)

The course aims to introduce the students to the theory and methods of calculus of variations with application to mechanics, physics, and chemistry. Calculus of variations deals with minimizing or maximizing functionals that may depend on several functions and their derivatives subject to various constraints on those functions. Functionals frequently arise from physical principles; examples include the least action principle, maximal entropy principle, Fermat's principle in optics. The calculus of variations has applications in many areas: differential geometry (minimal surfaces, geodesic problem), geometric optics, elastic media (string, beam and membrane), dynamics of particles, entropy maximization, optimal path planning with various objectives and constraints, shape optimization in linear continuum mechanics, to name just a few. Prerequisite: MA 547 and/ or instructor's approval

MA 632   Theory of Games   (3 - 3 - 0)

Strategic games and Nash equilibrium, strictly competitive (zero-sum) games and max-minimization, sStrategic games with imperfect information (Bayesian games), extensive games with perfect information (bargaining and repeated games), extensive games with imperfect information and signaling games, coalitional games (the core, stable sets, and bargaining sets), and auctions.

MA 633   Generalized Functions and Other Operational Methods   (3 - 3 - 0)

Modern theory of the delta function and other generalized functions: Fourier and Laplace transforms and applications to ordinary and partial differential equations. Prerequisite: MA 547

MA 634   Methods of Operations Research   (3 - 3 - 0)

Queuing theory, transportation problem, traffic theory, inventory control, search theory, and methods of optimization. Prerequisite: MA 540

MA 635   Functional Analysis I   (3 - 3 - 0)

In this course the students learn the foundations of measure theory and integration, the main principles of analysis in metric, normed, Banach and Hilbert spaces. Open, closed, compact sets, continuity, convergence, completeness, contraction mapping principle, linear operators and functionals are included. Prerequisite: MA 547

MA 636   Functional Analysis II   (3 - 3 - 0)

In this course the students continue to study the principles of analysis in functional spaces on a deeper level. They will consider Hahn-Banach theorem and separability, separability, linear topological spaces; weak topologies; spectral analysis; introduction in C*-algebras; applications to integral and differential equations; spectral theorems for self-adjoint operators; Stone-Weierstrass approximation theorem; Lebesgue measures and integral; Fredholm alternative; theory of nonlinear operators; Schauder fixed-point theorem; unbounded operators. Prerequisite: MA 635

MA 637   Mathematical Logic I   (3 - 3 - 0)

Prepositional calculus; syntax and semantics of first order theories; completeness theorem; elementary model theory: axiomatic development of Zermelo-Fraenkel or Bernays-Gödel set theory; and ordinals, cardinals, the axiom of choice, and several equivalent axioms.

MA 638   Mathematical Logic II   (3 - 3 - 0)

First order number theory; primitive and general recursive functions; arithmetization; Gödel's incompleteness theorems; Tarski's theorems; and syntax and semantics of second order theories. Prerequisite: MA 637

MA 641   Time Series Analysis I   (3 - 3 - 0)

Scope and applications of time series analysis: process control, financial data analysis and forecasting, and signal processing. Exploratory data analysis: graphical analysis, trend and seasonality detection and removal, and moving-average filtering. Review of basic statistical concepts related to the characterization of stationary processes. ARMA models and prediction of stationary processes. Estimation of ARMA models and model building and forecasting with ARMA models. Spectral analysis: periodogram testing for seasonality and periodicities and the maximum entropy and maximum-likelihood estimators. Asymptotic convergence. Selected topics, such as multivariate time series, nonlinear models, Kalman filtering, econometric forecasting, and long-memory processes. Selected applications, such as the unit-root problem in economics, forecasting and testing for market efficiency in financial time series, process control, and quality control.

MA 642   Time Series Analysis II   (3 - 3 - 0)

Scope and applications of time series analysis: process control, financial data analysis and forecasting, signal processing. Exploratory data analysis: graphical analysis, trend and seasonality detection and removal, moving-average filtering. Review of basic statistical concepts related to the characterization of stationary processes. ARMA models, prediction of stationary processes. Estimation of ARMA models, model building and forecasting with ARMA models. Spectral analysis: periodogram testing for seasonality and periodicities, the maximum entropy and maximum-likelihood estimators. A symptotic convergence. Selected topics such as multivariate time series, nonlinear models, Kalman filtering, econometric forecasting, and long-memory processes. Selected applications such as the unit-root problem in economics, forecasting and testing for market efficiency in financial time series, process control and quality control. Prerequisite: MA 641

MA 649   Intermediate Differential Equations   (3 - 3 - 0)

Theory and application of ordinary differential equations (ODEs) with an emphasis on ODEs as continuous dynamical systems on a finite-dimensional phase space. Standard topics include existence and uniqueness theorems, general theory for linear equations, the exponential of linear map, stability of equilibrium points, hyperbolicity and structural stability, Lyapunov's method, invariant manifolds, Floquet theory for periodic orbits, and Poincare-Bendixon theorem. Corequisite: MA 547

MA 650   Partial Differential Equations   (3 - 3 - 0)

This course discusses the classical theory and applications of partial differential equations and introduces the student to the modern theory. Classification of second order equations; well-posedness; existence and uniqueness for the Cauchy problem; Riemann function; Dirichlet and Neumann problems; Green's functions; perturbation theory; elliptic operators; variational formulation for the Laplace equation; weak solutions; and Sobolev spaces. Corequisite: MA 547

MA 651   Topology I   (3 - 3 - 0)

Metric spaces and topological spaces, bases and sub-bases, connectivity, local (path) connectivity, separation axioms, compactness and local compactness, concepts of convergence, Tychonoff's theorem, Urysohn's lemma, Tietze extension theorem, and selected topics as time permits.

MA 652   Topology II   (3 - 3 - 0)

Metric spaces and topological spaces, bases and sub-bases, connectivity, local (path) connectivity, separation axioms, compactness and local compactness, concepts of convergence, Tychonoff's theorem, Ury-sohn's lemma, Tietze extension theorem; homotopy type, fundamental group, covering spaces; topology of Euclidean space and manifold; selected topics as time permits.

MA 653   Numerical Solutions of Partial Differential Equations   (3 - 3 - 0)

This course is an introduction to methods and theory in numerical solutions of partial differential equations. The finite difference and pseudo-spectral methods will be used as examples to solve partial differential equations, including parabolic, hyperbolic, and elliptic equations in one or higher dimensional space. The theory on consistency, convergence, and Von Neumann stability analysis of numerical schemes will be emphasized for a basic understanding about how to control numerical errors and to achieve higher order accuracy for numerical solutions. Students will also be assigned projects to obtain the first-hand experience in numerical computations. Prerequisite: MA 650

MA 655   Optimal Control   (3 - 3 - 0)

The main purpose of this course is to present the foundations of the optimal control theory, some applications, and their solutions. The students will be introduced to the core concepts and results of control and system theory. The foundational and basic results will be derived for discrete and continuous time scales, and state variables. Topics to be covered: proportional-derivative control; state-space and spectrum assignment; outputs and dynamic feedback; reachability; controllability; feedback and stability; Lyapunov theory; linearization principle of observability; dynamic programming algorithm; multipliers for unconstrained and constrained controls; and Pontryagin maximum principle. Prerequisites: MA 547, MA 649

MA 661   Dynamic Programming & Reinforcement Learning   (3 - 3 - 0)

The main purpose of this course is to present an introduction to dynamic programming as the most popular methodology for learning and control of dynamic stochastic systems. We discuss basic models, some theoretical results and numerical methods for these problems. They will be developed starting from basic models of dynamical systems, through finite-horizon stochastic problems, to infinite-horizon stochastic models of fully or partially observable systems. Throughout the class special attention will be paid on the application of dynamic programming to statistical learning. The class will include introduction to approximate dynamic programming techniques, which are used in statistical learning, such as tree-based methods for classification, Bayesian learning, etc. The concepts and methods will be illustrated by various applications including learning in stochastic networks, engineering, business, and finance. Prerequisites: MA 547, MA 623

MA 662   Stochastic Optimization   (3 - 3 - 0)

This course introduces students to modeling and numerical techniques for optimization under uncertainty and risk. Topics include: generalized concavity of measures, optimization problems with probabilistic constraints (convexity, differentiability, optimality, and duality), numerical methods for solving problems with probabilistic constraints, two-stage and multi-stage models (structure, optimality, duality), decomposition methods for two-stage and multi-stage models, risk averse optimization models, Prerequisites: MA 547, MA 629

MA 681   Functions of a Complex Variable I   (3 - 3 - 0)

Complex numbers; elementary functions; Möbius transformations; analytic functions; power series; integration; Cauchy-Goursat theorems; Cauchy integral formula; Taylor and Laurent series; singularities; residue theory; and meromorphic and entire functions. Prerequisite: MA 548

MA 682   Functions of a Complex Variable II   (3 - 3 - 0)

Analytic continuation; Riemann surfaces; elliptic functions; gamma function; conformal mapping. Prerequisite: MA 681

MA 691   Dynamical Systems   (3 - 3 - 0)

Theory and methods in continuous and discrete dynamical systems. Topics may vary, but will typically include local bifurcation theory for vector fields and maps, center manifold reductions, normal forms, periodic orbits and Poincaré maps, averaging methods, Melnikov methods, chaotic dynamics, the Smale horseshoe map, and symbolic dynamics. Prerequisite: MA 649

MA 701   Statistical Inference   (3 - 3 - 0)

This course aims to systematically introduce all important aspects of statistical theory, including statistical models, sampling distributions, point estimations, confidential intervals, hypothesis testing, analysis of variance, and linear regression etc. This course is designed to prepare the theoretical support for various statistical applications in practice. Also it enables graduate students to handle statistical methods and related computations in the area of management and business. Students should have taken courses in Calculus, Elementary probability and statistics.

MA 707   Integral Transforms   (3 - 3 - 0)

Study of the classical transforms, the Laplace, Fourier, Hilbert, and other transforms; inversion and application to solution of differential, difference, and integral equations; and Abelian and Tauberian theorems, including Wiener's theory. Prerequisites: MA 635, MA 681

MA 708   Hilbert Space Theory   (3 - 3 - 0)

Geometry of Hilbert space; spectral theory of self-adjoint and normal operators; applications to differential operators; multiplicity theory; and families of operators, Stone's theorem, and introduction to rings of operators. Prerequisites: MA 635, MA 681

MA 711   Inverse Problems in Science and Engineering   (3 - 3 - 0)

This course introduces basic concepts and techniques to solve inverse problems for both integral and differential equations. Topics include: Ill-posed problems, Tikhonov regularization, collocation methods, Galerkin methods, inverse eigenvalue problems, inverse boundary value problems, conditions on dense solvability. Computational projects may be assigned. Prerequisite: MA 547

MA 712   Mathematical Models of Risk   (3 - 3 - 0)

The course will introduce the students to the fundamental mathematical models of risk and approaches to decision-making under uncertainty and risk-aversion. The mathematical models will range from classical models as Expected Utility Theory, Prospect Theory, Dual Utility Theory, to state-of-the-art work on stochastic dominance, the theory of coherent risk measures, and general deviation measures. The course also surveys recent developments in particular applied areas as portfolio optimization, asset pricing, nuclear safety, reliability, etc.

MA 715   Functional Analysis   (3 - 3 - 0)

Linear topological spaces, local convexity, and spaces of distribution; Banach spaces; three fundamental theorems and applications to classical analysis; operators, operational calculus, compact operators, and applications to integral equations; Klein-Milman theorems; and fixed point theorems with applications to nonlinear problems. Prerequisite: MA 635

MA 717   Algebraic Topology   (3 - 3 - 0)

Notion of simplicial complex, absolute, and relative homology groups of a space; exact sequences; cohomology; axioms for homology theory; introduction to homological algebra; and homotopy and the fundamental group. Prerequisites: MA 651, MA 605

MA 719   Advanced Probability   (3 - 3 - 0)

Martingales; generalized weak and strong laws; infinitely divisible distribution; stable distributions, limiting distributions for triangular arrays; semigroup theory applications; bilateral Laplace transforms; renewal equation; random walks;. Markov processes. Prerequisite: MA 611

MA 720   Advanced Statistics   (3 - 3 - 0)

Selected topics may include: distribution theory; theory of inference; foundations of probability; spectral analysis; multivariant analysis.

MA 721   Advanced Ordinary Differential Equations   (3 - 3 - 0)

Existence and uniqueness of solutions; dependence on parameters; periodic solutions; nonlinear autonomous systems; Poincare-Bendixon theory; continuous transformation groups; linear systems; Floquet theory; linear systems in complex domain; regular and irregular singularities; asymptotic expansions; Stokes' phenomenon; boundary value problems. Prerequisite: MA 649

MA 723   Advanced Partial Differential Equations   (3 - 3 - 0)

Characteristics and classification of equations; Cauchy-Kowalewski theorem; linear and quasilinear systems; elliptic equations and potential theory; Green's function; mean value theorems; a priori estimates; functions space methods; hyperbolic equations; Riemann's solution of the Cauchy problem; discontinuities and shocks; Huyghen's principle; method of spherical means; parabolic equations. Prerequisite: MA 650

MA 725   Advanced Numerical Analysis   (3 - 3 - 0)

Selected topics in numerical analysis not treated in MA615-616; topics may include: numerical solution of partial differential equations, boundary value problems, approximation theory; Monte Carlo methods, power spectral methods as they apply to numerical analysis, optimal search problems.

MA 727   Theory of Algebraic Numbers   (3 - 3 - 0)

Algebraic number fields; rings of algebraic integers and integral basis of field discriminant; unique factorication for ideals; splitting and ramifications of primes; Kummer's theorem with applications to quadratic and roots of unity fields; padic numbers; Hensel's lemMA ; geometry of numbers; units in an algebraic extension; finiteness of class numbers of a field; and computation of class numbers in special cases. Prerequisites: MA 605, MA 606

MA 751   Advanced Topics in Analysis   (3 - 3 - 0)

Selected topics in advanced analysis not treated in other courses; topics may include: integral transforms, general convolution transform, approximation theory, theorems of Jackson and Bernstein, functions of exponential type, Nevalinna's theory of meromoporhic functions, asymptotic development, perturbation theory.

MA 752   Advanced Topics in Algebra   (3 - 3 - 0)

Selected topics in algebra not treated in other courses; topics may include: group representations, Lie algebra, structure of rings, valuation theory, algebraic curves, Galois theory of non-commutative fields, polynomial ideals, elimination theory.

MA 753   Advanced Topics in Mathematical Logic   (3 - 3 - 0)

Selected topics in mathematical logic; topics may include: a study of the connection between the semantical and syntactical treatments of propositional calculus and quantification theory, including references to the works of Harbrand, Dreben and Hintikka, Gödel's completeness for theorem for the first order and predicate calculus, recursive function theory, decidable theories, and Gödel's incompleteness theorem for arithmetic, axiomatic set theory, model theory. Prerequisites: MA 637, MA 638

MA 754   Advanced Topics in Topology   (3 - 3 - 0)

Selected topics in topology; topics may include: K theory, infinite dimensional analysis, knot theory, applications of algebraic topology to algebraic geometry.

MA 758   Special Topics in Graph Theory   (3 - -)

This course will focus on one or more topics of current interest in graph

MA 775   Nonlinear Analysis   (3 - 3 - 0)

Existence and uniqueness of solutions to nonlinear partial differential equations with applications to equations from physics and engineering. Topics covered will include Degree Theory, The Mountain Pass Lemma, Variational Methods, Index Theory, Nash-Moser Iteration Schemes. The course will also include a review of Hilbert space methods.

MA 800   Special Problems in Mathematics (MS)   (1 to 6 - -)

One to six credits. Limit of six credits for the degree of Master of Science.

MA 801   Special Problems in Mathematics   (1 to 6 - -)

One to six credits. Limit of six credits for the degree of Doctor of Philosophy.

MA 810   Special Topics in Mathematics   (3 - -)

Special topics in mathematics not covered in regularly scheduled courses and suitable for both graduates and advanced undergraduates. May be taken more than once.

MA 900   Thesis in Mathematics   (1 to 10 - -)

For the degree of Master of Science. Hours and credits to be arranged.

MA 960   Research in Mathematics   (- -)

Original research carried out under the guidance of a member of the faculty which may serve as the basis for the dissertation required for the degree of Doctor of Philosophy. Hours and credits to be arranged.

Department of Mechanical Engineering

FACULTY

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DEPARTMENT CHAIR

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Associate Professor

Constantin Chassapis, Ph.D.
Professor & Vice Provost for Graduate Education

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Damiano Zanotto, Ph.D.
Assistant Professor

Xian (Annie) Zhang, Ph.D.
Assistant Professor

Jean Zu, Ph.D.
Professor & Dean of Schaefer School of Engineering
and Science

EMERITUS FACULTY

Marehalli Prasad, Ph.D.
Professor Emeritus

Fernando Sisto, Ph.D.
Professor Emeritus

UNDERGRADUATE PROGRAMS

Founded in 1870, Stevens Institute of Technology featured a single, rigorous engineering curriculum leading to a baccalaureate degree designated as "Mechanical Engineer." A broad-based interdisciplinary philosophy was put into practice by the founders of the institute from the first graduating class. While the original area of concentration was mechanical engineering, and despite the title of the degree, the curriculum included courses in all of the then-current engineering disciplines; mechanical, civil, chemical, and electrical engineering. Over time the program has grown to include other engineering disciplines.

Members of the Stevens family were pioneer engineers, inventors and entrepreneurs whose achievements molded the American Society of Mechanical Engineering (ASME). Stevens' first president, Henry Morton, was the founding president of the ASME as he presided over the society's first meeting on the Stevens campus in 1880.

Of all the engineering professions, mechanical engineering is the broadest and most diversified. From gadgets to medical devices, from air, ground, sea and space vehicles to power plants and industrial machines, from engines to robots, mechanical engineers design systems or parts for nearly every product manufactured throughout the world. The range and scope of mechanical engineering has undergone major changes over the past decade, while retaining and expanding traditional areas of endeavor. Some of the changes have been due to the improvements in auxiliary fields, such as new materials, or the introduction of new fields, such as bioengineering, additive manufacturing, sustainable energy, micronano technology, artificial intelligence and machine learning.

At Stevens we offer our ME students a solid, broad-based foundation in fundamental engineering principles and liberal arts, along with in-depth disciplinary knowledge, preparing them for a successful career in engineering. Classroom instruction and hands-on laboratory work combine to give students a thorough understanding. In training students for work in business, industry, or academia, we emphasize teamwork by encouraging students to collaborate with their peers and faculty on a wide range of experiments and design projects.

The ME program at Stevens strives to educate "the complete engineer." In addition to our emphasis on scientific and engineering proficiency, we instill in our students the values of professionalism, leadership, entrepreneurship, and ethics. Our students also receive extensive training in communication, learning how to effectively present technical information orally, visually and in written form.

Reflecting the wide diversity of subject matter to be found in the present-day practice in the field, our mechanical engineering program offers a multitude of opportunities for study and research. Major areas of interest include: biomedical devices and bio-mechanical systems, design and manufacturing, solid mechanics, dynamics, machine design, fluid mechanics, heat transfer, turbomachinery, energy conversion, combustion, HVAC, robotics and autonomous systems, automatic controls, and vibrations. If you have particular interests or highly-specific objectives, we can generally satisfy your individual goals through elective courses and appropriate project work. Furthermore, the available pool of electives allows the student to specialize in one of the following concentration areas:

- ‣ Aerospace Engineering
- ‣ Automotive Engineering
- ‣ Biomedical Engineering
- ‣ Pharmaceutical Manufacturing
- ‣ Power Generation
- ‣ Product Design and Manufacturing
- ‣ Robotics and Autonomous Systems
- ‣ Sustainable Energy

Program Mission, Program Educational Objectives, and Student Outcomes

The mission of the mechanical engineering program is to produce graduates with a broad-based foundation in fundamental engineering principles and liberal arts, together with the depth of disciplinary knowledge needed to succeed in a career in mechanical engineering or a related field, including a wide variety of advanced technological and management careers.

To achieve its mission, the Department of Mechanical Engineering, with input from its constituents, has established the following Program Educational Objectives:

1. Graduates identify and solve problems in mechanical engineering and related fields using their broad-based knowledge of fundamental engineering concepts and state-of-the-art tools and techniques.

2. Graduates develop mechanical and thermal devices and systems to meet the needs of society.

3. Graduates excel in working within and leading multi-disciplinary teams.

4. Graduates conduct themselves in a socially responsible manner and adapt to technological change.

Student Outcomes - By the time of graduation, mechanical engineering students will have:

1. *(Scientific Foundations)* the ability to use applied scientific knowledge to solve problems in mechanical engineering and related fields *(ABET Criterion 3a)*.

2. *(Engineering Foundations)* the ability to use fundamental engineering knowledge to solve problems in mechanical engineering and related fields *(ABET Criterion 3a)*.

3. *(Experimentation)* the ability to design and conduct experiments, as well as to analyze and interpret experimental data for mechanical engineering and related applications *(ABET Criterion 3b)*.

4. *(Technical Design)* the technical ability to design mechanical and thermal engineering devices or systems to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability *(ABET Criterion 3c)*.

5. *(Design Assessment)* the ability to develop and assess alternative designs of both mechanical and thermal engineering systems based on technical and non-technical criteria including their impact in a global, economic, environmental, and societal context *(ABET Criterion 3h)*.

6. *(Tools)* the ability to use the relevant tools necessary for practice in mechanical engineering and related fields *(ABET Criterion 3k)*.

7. *(Professionalism)* the ability to recognize and achieve high levels of professionalism in their work *(ABET Criterion 3f)*.

8. *(Leadership)* the ability to assume leadership roles *(ABET Criterion 3d)*.

9. *(Teamwork)* the ability to function on multidisciplinary teams *(ABET Criterion 3d)*.

10. (*Communication*) the ability to communicate effectively and persuasively *(ABET Criterion 3g)*.

11. *(Ethics)* a critical understanding of ethical responsibility *(ABET Criterion 3f)*.

12. *(Contemporary Issues)* a knowledge of contemporary issues *(ABET Criterion 3j)*

13. (*Lifelong Learning*) a recognition of the need for an ability to engage in lifelong learning and development *(ABET Criterion 3i)*.

14. *(Entrepreneurship)* fundamental knowledge and an appreciation of the technology and business processes necessary to nurture new technologies from concept to commercialization.

Areas of Concentration

Mechanical engineering students can select their elective courses among two ME technical electives and three general electives in various ways. Some of them may wish to cluster those electives in ways that would help them gain expertise in an area of specialization within mechanical engineering. The following groupings are possible specialty (concentration) areas that students can select from within the mechanical engineering program (In addition to the courses needed for each specialty area, students are encouraged to select their senior design project within their area of concentration.):

Aerospace Engineering

▸ ME 545 Introduction to Aerospace Engineering

and two courses from the following:

▸ ME 512 Intermediate Fluid Mechanics

▸ ME 520 Analysis & Design of Composites

▸ ME 546 Introduction to Turbomachinery

▸ ME 595 Heat Exchanger Design

Automotive Engineering

▸ ME 515 Automotive Engineering

and two courses from the following:

▸ ME 512 Intermediate Fluid Mechanics

▸ ME 520 Analysis & Design of Composites

▸ ME 529 Modern & Advanced Combustion Engines

▸ ME 595 Heat Exchanger Design

Biomedical Engineering

Choose any three courses from the following:

▸ ME 525 Biomechanics

and two courses from the following:

▸ ME 526 Biofluid Mechanics

▸ ME 527 Mechanics of Human Movement

▸ ME 580 Medical Device Design and Technology

▸ ME 587 Human Factors Engineering

Product Design and Manufacturing

Take any three courses from the following:

▸ ME 554 Introduction to CAD

▸ ME 564 Principles of Optimum Design and Manufacturing

▸ ME 565 Intro. to Additive Manufacturing

▸ ME 566 Design for Manufacturability

Power Generation

▸ ME 510 Power Plant Engineering

and two courses from the following:

▸ ME 512 Intermediate Fluid Dynamics

▸ ME 513 Intro to Nuclear Engineering

▸ ME 529 Modern & Advanced Combustion Engines

▸ ME 546 Intro. to Turbomachinery

▸ ME 595 Heat Exchanger Design

Sustainable Energy

▸ ME514 Sustainable Energy

and two courses from the following:

▸ ME 511 Wind Energy -Theory & Application

▸ ME 513 Introduction to Nuclear Engineering

▸ ME 518 Solar Energy - Theory & Application

▸ ME 519 Solar Energy - System Designs

Robotics and Autonomous Systems

▸ ME 598 Introduction to Robotics

and two courses from the following:

▸ ME 522 Mechatronics I

▸ ME 551 Microprocessor Applications in ME

▸ ME 523 Mechatronics II

▸ ME 594 Numerical Methods in ME

Pharmaceutical Manufacturing

▸ ME 530 Introduction to Pharmaceutical Manufacturing

▸ ME 535 Good Manufacturing Practice in Pharmaceutical Facilities Design

▸ ME 540 Validation in Life Sciences Manufacturing

Mechanical Engineering Curriculum

Term I

Course #	Course Name	Lecture	Lab	Study	Credit
CH 115	General Chemistry I	3	0	6	3
CH 117	General Chemistry Laboratory I	0	3	1	1
E 101	Engineering Experiences I	1	0	0	1
E 121	Engineering Design I: Introduction to Systems Thinking	0	3	2	2
E 120	Engineering Graphics	0	2	1	1
E 115	Introduction to Programming	1	2	3	2
MA 121; MA 122	Differential Calculus; Integral Calculus	4	0	8	4
CAL 103	Writing And Communications Colloquium	3	0	6	3
	Total	**12**	**10**	**27**	**17**

Term II

Course #	Course Name	Lecture	Lab	Study	Credit
	Science Elective[1]	3	0	6	3
E 122	Engineering Design II: Field Sustainable Systems with Sensors	0	3	3	2
MA 123; MA 124	Series, Vectors, Functions, and Surfaces; Calculus of Two Variables	4	0	8	4
PEP 111	Mechanics	3	0	6	3
CAL 105	CAL Colloquium: Knowledge, Nature, Culture	3	0	6	3
MGT 103	Introduction to Entrepreneurial Thinking	1	2	0	2
	Total	**14**	**5**	**29**	**17**

Term III

Course #	Course Name	Lecture	Lab	Study	Credit
MA 221	Differential Equations	4	0	8	4
PEP 112	Electricity and Magnetism	3	0	6	3
E 126	Mechanics of Solids	4	0	8	4
E 245	Circuits and Systems	2	3	7	3
E 231	Engineering Design III: Structural Performance and Failure	0	3	2	2
Hum	Humanities[3]	3	0	6	3
PE 200	Physical Education I	0	2	0	0
	Total	**16**	**8**	**37**	**19**

Term IV

Course #	Course Name	Lecture	Lab	Study	Credit
MA 227	Multivariable Calculus	3	0	6	3
E 232	Engineering Design IV: Systems with Analog Circuits	2	3	7	3
ME 234	Mechanical Engineering Thermodynamics	3	0	6	3
	Science Elective[1]	3	0	6	3
ME 225	Dynamics	3	0	6	3
Hum	Humanities[3]	3	0	6	3
PE 200	Physical Education II	0	2	0	0
	Total	**17**	**5**	**37**	**18**

Term V

Course #	Course Name	Lecture	Lab	Study	Credit
ME 342	Fluid Mechanics	3	0	6	3
E 344	Materials Processing	3	0	6	3
E 321	Engineering Design V: Materials Selection and Process Optimization	0	3	2	2
E 243	Probability and Statistics for Engineers	3	0	6	3
ME 361	Design of Machine Components	3	0	6	3
Hum	Humanities[3]	3	0	6	3
PE 200	Physical Education III	0	2	0	0
	Total	**15**	**5**	**32**	**17**

Term VI

Course #	Course Name	Lecture	Lab	Study	Credit
ME 345	Modeling and Simulation	2	2	4	3
E 355	Engineering Economics	3	3	6	4
ME 322	Engineering Design VI	2	2	4	2
ME 335	Thermal Engineering	3	0	6	3
ME 358	Machine Dynamics and Mechanisms	3	1	6	3
G.E.	General Elective[2]	3	0	6	3
PE 200	Physical Education IV	0	2	0	0
IDE 400	Senior Innovation I[5]	1	0	2	1
	Total	**17**	**10**	**34**	**19**

Term VII

Course #	Course Name	Lecture	Lab	Study	Credit
ME 354	Heat Transfer	3	0	6	3
ME 483	Control Systems	3	0	6	3
G.E.	General Elective[2]	3	0	6	3
ME 423	Engineering Design VII	1	6	4	3
IDE 401	Senior Innovation II	1	0	2	1
T.E.	Technical Elective[4]	3	0	6	3
	Total	**14**	**6**	**30**	**16**

Term VIII

Course #	Course Name	Lecture	Lab	Study	Credit
ME 491	Manufacturing Processes and Systems	3	0	6	3
T.E.	Technical Elective[4]	3	0	6	3
G.E.	General Elective[2]	3	0	6	3
ME 424	Engineering Design VIII	1	6	4	3
ME 470	Mechanical Engineering Systems Laboratory	0	3	2	2
Hum	Humanities[3]	3	0	6	3
IDE 402	Senior Innovation III	1	0	2	1
	Total	**14**	**9**	**32**	**18**

(1) Science Electives Engineering programs have specific requirements. See pages 79-80 for details.

(2) General Elective can be: a) a Mech Eng 400 or 500 course; b) an upper level SES, SSE, or SOB 3 credit course c) any other course with Advisor approval.

(3) Humanities electives can be found on pages 568-569.

(4) Mechanical Engineering Technical Elective (to be selected from available ME 400 and ME 500 course offerings, can be used towards ME concentration area.

(5) IDE 400 can be taken concurrently with IDE 401 in Term VII as determined by the engineering program

Graduation Requirements

Physical Education Requirements

‣ All undergraduate students must complete a minimum of four semesters of Physical Education (P.E.). A large number of activities are offered in lifetime, team and wellness areas.

‣ Varsity and club sports can be used to satisfy up to four semesters of PE.

‣ All P.E. courses must be completed by the end of the sixth semester. Students can enroll in more than the minimum required P.E. for graduation and are encouraged to do so.

‣ Participation in varsity sports can be used to satisfy up to three semesters of the P.E. requirement.

‣ Participating in club sports can be used to satisfy up to two of the PE requirements.

Note: Student may repeat Physical Education class but the repeated course (excluding varisty and club sports) will not count toward the graduation requirement.

Humanities Requirement

All undergraduate students are required to fulfill certain Humanities requirements in order to graduate. Please see pages 599-600 for a breakdown of specific requirements by program.

Minors

Students from other engineering programs may pursue a minor in mechatronics by taking the required courses indicated below. Enrollment in a minor program means that you must also meet Stevens School of Engineering and Science requirements for minor programs. Only courses completed with a grade of "C" or better are accepted towards the minor.

Requirements for a Minor in Mechatronics

‣ ME 225 Dynamics

‣ ME 358 Machine Dynamics and Mechanics

‣ ME 483 Control Systems

▸ ME 522 Mechatronics

▸ ME 551 Microprocessor Applications in ME **or** ME 523 Mechatronics II **or** ME 573 Introduction to Micro-Electromechanical Systems (MEMS)

GRADUATE PROGRAMS

The Department of Mechanical Engineering provides three graduate programs in mechanical engineering leading to the following degrees: (i) the "Master of Engineering - Mechanical" degree, (ii) the professional "Mechanical Engineer" degree, and (iii) the "Doctor of Philosophy" degree with a concentration in mechanical engineering. A major objective of the graduate program is to encourage research work at all levels so that individuals can progressively solve more challenging problems with a wider research scope as they gain confidence and competence.

In addition to the above-mentioned three graduate degree programs, the Department of Mechanical Engineering also offers the following graduate programs: (i) "Master of Engineering in Integrated Product Development" degree program, (ii) Master of Science in Pharmaceutical Manufacturing" degree program, and (iii) various graduate certificate programs.

The Department of Mechanical Engineering has active research interests in the following areas: biomedical devices, biosensors and cell/tissue-based physiological platforms, composites and structured materials, computational and experimental fluid dynamics and heat transfer, computer-aided design and manufacturing, integrated product and process design, control theory, design of thermal systems, knowledge-based engineering systems, noise control and vibration, robotics and automation, nano/micro system modeling, design and fabrication, sustainable energy and pharmaceutical manufacturing.

Master's Program in Mechanical Engineering

The Master of Engineering - Mechanical degree program is intended to extend and broaden the undergraduate preparation. It can be considered as a terminal degree or as preparation for the Ph.D. program. A bachelor's degree in mechanical engineering is needed for acceptance to the master's program. Applicants with undergraduate degrees in other engineering disciplines may be required to take appropriate undergraduate courses before being formally admitted into the program.

The Master of Engineering - Mechanical degree requires 30 credits, approved by the student's academic advisor. The program structure is as follows:

▸ Two required core courses

▸ At least four courses from any one of the seven concentrations below

▸ Four elective courses must be chosen as described below

Core Courses

▸ ME 635 Modeling and Simulation

▸ ME 641 Engineering Analysis I

Concentration Courses

At least four courses from any one of the seven concentrations:

Product Design

▸ ME 520 Analysis and Design of Composites

▸ ME 615 Thermal Systems Design

▸ ME 658 Advanced Mechanics of Solids

▶ ME 659 Advanced Structural Design

▶ ME 663 Finite Element Methods

▶ ME 665 Advanced Product Development

Manufacturing

▶ ME 565 Introduction to Additive Manufacturing

▶ ME 566 Design for Manufacturability

▶ ME 644 Computer Integrated Design and Manufacturing

▶ ME 645 Design of Production Systems

▶ ME 652 Advanced Additive Manufacturing

▶ ME 653 Design for Additive Manufacturing

Thermal, Fluids, Energy

▶ ME 510 Power Plant Engineering

▶ ME 601 Engineering Thermodynamics

▶ ME 604 Advanced Heat Transfer

▶ ME 615 Thermal Systems Design

▶ ME 674 Fluid Dynamics

▶ ME 675 Computational Fluid Dynamics and Heat Transfer

Pharmaceutical Manufacturing

▶ ME 530 Introduction to Pharmaceutical Manufacturing

▶ ME 535 Good Manufacturing Practice in Pharmaceutical Facilities Design

▶ ME 540 Validation in Life Sciences Manufacturing

▶ ME 628 Manufacturing and Packaging of Pharmaceutical Oral Solid Dosage Products

▶ ME 629 Manufacturing of Sterile Pharmaceuticals

▶ ME 647 Environmental Systems (HVAC) in Healthcare Manufacturing

Medical Devices

▶ ME 525 Biomechanics

▶ ME 526 Biofluid Mechanics

▶ ME 580 Medical Device Design and Technology

▶ ME 658 Advanced Mechanics of Solids

▶ ME 660 Medical Devices Manufacturing

▶ ME 674 Fluid Dynamics

Robotics & Control

- ME 598 Introduction to Robotics
- ME 621 Introduction to Modern Control Engineering
- ME 622 Optimal Control and Estimation of Dynamical Systems
- ME 631 Mechanical Vibrations I
- ME 651 Analytic Dynamics
- ME 654 Advanced Robotics

Micro/Nano Systems

- ME 573 Introduction to MEMS
- ME 581 Introduction to BioMEMS
- ME 680 Fundamentals of Micro/Nano Fluidics
- ME 681 Applications of Advanced Micro/Nano Materials, Structures, and Devices
- NANO 525 Techniques of Surface and Nanostructure Characterization
- NANO 600 Nanoscale Science and Technology

Elective Courses

Four elective courses must be chosen. Of these four courses, a maximum of two courses may be non-ME courses, and of the non-ME courses, a maximum of one may be a non-SES course (i.e. any Stevens graduate course). A student may substitute a Project (ME 800 Special Problems in Mechanical Engineering, 3 credits) or a Master's Thesis (ME 900 Thesis in Mechanical Engineering, 6 credits) for the appropriate number of courses.

In order to graduate with a Master of Engineering - Mechanical degree, a student must obtain a minimum of "B" average in the major field, as well as an overall average of "B" in all the courses needed to meet the 30-credit requirement for the degree. In addition, no more than four 500 level graduate courses can be taken to satisfy the credit requirement for the degree. Please see the Office of Graduate Admissions section on Student Status.

Master's Program in Integrated Product Development

The Integrated Product Development program is an integrated Master of Engineering degree program. The core courses emphasize the design, manufacture, implementation, and life-cycle issues of engineering systems. The remaining courses provide a disciplinary focus. The program embraces and balances qualitative, as well as quantitative, aspects and utilizes state-of-the-art tools and methodologies. It aims to educate students in problem-solving methodologies, modeling, analysis, simulation, and technical management. The program trains engineers in relevant software applications and in productive deployment and integration in the workplace.

All students in this program must complete ten courses (30 credits), comprised of four core courses and up to six elective courses selected from one of the four engineering tracks listed below. The student, with the approval of the graduate program director, may design customized tracks. Up to six elective credits may be taken in lieu of the course credits toward a project relevant to the selected track.

Core Courses

- IPD 601 Integrated Product Development I
- IPD 602 Integrated Product Development II
- IPD 611 Modeling and Simulation
- IPD 612 Project Management and Organizational Design

Tracks

Students then choose from one of the following four engineering tracks:

- Armament Engineering
- Electrical and Computer Engineering
- Manufacturing Technologies
- Systems Reliability and Design

Armament Engineering Track

This technology track provides an interdisciplinary graduate education in Armament Engineering. The program emphasizes systems engineering of military weapons from concept through development and field use. Technical disciplines in the design and manufacture of explosives, modeling and simulation of the interior and exterior ballistics, rocket and missile design, guidance and control, modern research instrumentation, and testing procedures are emphasized.

- ME 504 Interior Ballistics and Design for Projection
- ME 505 Theory and Performance of Propellants and Explosives I
- ME 506 Theory and Performance of Propellants and Explosives II
- ME 507 Exterior Ballistics
- ME 508 Terminal Ballistics
- plus one free elective.

Manufacturing Technologies Track

This track integrates product design, materials processing, and manufacturing expertise with modern computer software technology. The program is specifically concerned with product design for manufacturing, manufacturing systems analysis and development, robotics and control, and the integration of the various phases and activities associated with turning a concept into a deliverable product. Different manufacturing processes are introduced, and the design and control of these processes are discussed. Of particular interest are the development and implementation of models to predict the effects of design and manufacturing choices on system performance, producibility, and economics.

- ME 560 Quality in Pharmaceutical Manufacturing
- ME 564 Principles of Optimal Design and Manufacture
- ME 598 Introduction to Robotics
- ME 621 Introduction to Modern Control Engineering
- ME 644 Computer-Integrated Design and Manufacturing or ME 520 Analysis and Design of Composites
- ME 645 Design of Production Systems

The complete description of the IPD program can be found in the Interdisciplinary Programs section of the catalog.

Master's Program in Pharmaceutical Manufacturing

The Pharmaceutical Manufacturing (PME) master's degree program is intended to integrate the study of pharmaceutical manufacturing concepts with more advanced engineering design and scientific methodologies to satisfy specialty needs within the industry. The Master of Science (M.S.) in Pharmaceutical Manufacturing is a 30-credit degree program that concentrates primarily on industry areas related to commercial manufacturing, such as GMP, manufacturing technologies, facilities design, validation, compliance, and quality. All students are required to take the five required core courses below:

Required Core Courses

- PME 530 – Introduction to Pharmaceutical Manufacturing
- PME 535 – Good Manufacturing Practices in Pharmaceutical Facilities Design
- PME 540 – Validation in Life Sciences Manufacturing
- PME 560 – Quality in Life Sciences Manufacturing
- PME 602 – Statistical Methods in Life Science Industries

Many electives are available to students for the remaining five courses. At least two electives must be 600-level PME technology courses (e.g. PME 626, 628, 629).

Primary Elective Courses (recommended)

- PME 541 – Validation of Computerized Systems
- PME 542 – Global Regulation and Compliance in Life Science Industries
- PME 626 – Manufacturing of Biopharmaceutical Products
- PME 628 – Manufacturing and Packaging of Pharmaceutical Oral Solid Dosage Products
- PME 629 – Manufacturing of Sterile Pharmaceuticals

Additional Elective Courses

- PME 531 – Process Safety Management in Pharmaceutical Manufacturing
- PME 555 – Lean Six Sigma
- PME 580 – Medical Device Design and Technology
- PME 600 – Engineering Economics and Cost Analysis
- PME 609 – Project Management Fundamentals
- PME 639 – Modeling and Simulation of Pharmaceutical Manufacturing Systems
- PME 647 – Environmental Systems (HVAC) in Healthcare Manufacturing
- PME 660 – Medical Devices Manufacturing
- PME 800 – Special Problems in Pharmaceutical Manufacturing and Engineering
- PME 900 – Thesis in Pharmaceutical Manufacturing and Engineering

In addition to the master's degree-level offerings, the program currently offers two Graduate Certificates (GCs), each of which requires four courses and is described below.

Pharmaceutical Manufacturing (PM) provides an introductory overview of pharmaceutical manufacturing, touching on all basic manufacturing processes, facility design issues, validation, compliance, and quality assurance concepts, and pharmaceutical technologies

Courses: PME 530, 535, 540 and 1 of the following – PME 626, 628 or 629.

Validation, Compliance & Quality (VCQ) is designed for individuals who work or aspire to work in validation, compliance, or quality functions in industries driven by Good Manufacturing Practices (GMP). Students learn approaches to process validation, qualification of equipment, utilities, facilities, analytical methods, cleaning validation, etc., as well as quality-related concepts and methods, and regulatory compliance issues in the global environment.

Courses: PME 540, 560, 602 and one of the following – PME 541 or 542

Doctoral Program in Mechanical Engineering

Admission to the doctoral program is made through the Department Director in conjunction with the Graduate Committee, and it is based on an assessment of the applicant's academic background, competence and aptitude for advanced study and research. Applicants with a GPA of 3.5 or better in a master's program in mechanical engineering or a related field as well as with excellent TOEFL and GRE scores are encouraged to apply for the Ph.D. program in mechanical engineering. Exceptionally well qualified applicants who obtained only a bachelor's degree in mechanical engineering or a related field will also be considered for direct admission into the Ph.D. program in mechanical engineering. If deemed acceptable, the student will be assigned an Advisor. Then, the student, in conjunction with the Advisor, will select a thesis topic and complete a study plan within three months in the program.

Courses are selected to develop knowledge and skills in a particular area of interest. While this coursework is necessary to develop the knowledge and skills of the student's profession, the most important aspect of the doctoral program is the student's original research in a selected topic of interest.

The subject of the doctoral dissertation (ME 960) is open to a wide range of particular choices. The selection of a topic by the doctoral aspirant provides for a sub-specialization within the broad range of mechanical engineering disciplines. The courses selected for the study plan should complement the student's dissertation subject.

Upon submission of an approved study plan by the student and no later than after one year of enrollment in the program, a Doctoral Committee is appointed for each student by the Department Director in conjunction with the Graduate Committee, with the Advisor as the chairperson. All doctoral students are required to take a qualifying examination (consisting of a Core Competency Test (CCT) and a Research Competency Test (RCT)) at the first offering after one year in the program. Upon failing the qualifying examination, the student may take the examination for a second time at the next offering. Upon failing the examination for the second time, the student will be asked to leave the program. In addition to the qualifying examination, all doctoral students are required to present a research proposal (including a written report and an oral presentation) to the Doctoral Committee for its approval. The candidate must present the proposal within 24 months of enrollment into the program. The Doctoral Committee, at its discretion, may decide on additional oral/written examinations before accepting the proposed dissertation plan. In the case where the committee rejects the research proposal, the candidate may submit a request for a second and final chance for presenting a revised research proposal during the following academic semester.

Upon satisfactory completion of the research proposal and all coursework, the student will be considered a doctoral candidate and continue the research which will form the basis of the student's dissertation. The dissertation must be based upon original investigation in the field of mechanical engineering, approved by the Department Director and Graduate Committee, and must be a contribution worthy of publication in the current professional literature. Before receiving the doctoral degree, the student must also satisfy the requirements for residence and publication of the dissertation.

Nanotechnology Concentration

The mechanical engineering doctoral program is an integral part of the institute-wide nanotechnology graduate program. A Ph.D. degree option in mechanical engineering with concentration in nanotechnology is available to students who satisfy the conditions and requirements of the nanotechnology area which are outlined in a separate section of the catalog.

PhD Credit and Defense Requirements

The Ph.D. program in mechanical engineering requires a total of 84 credits beyond the bachelor's degree in an approved program of study. Up to 30 credits previously obtained in a master's degree program in mechanical engineering or a related field may be applied towards this requirement. (A minimum of 24 course credits and 24 research credits beyond Master Degree are required. The remaining 6 credits can be either course or research credits approved by the research advisor and thesis committee. PRV 961 and English language requirements should be also satisfied according to the Institute requirement).

In addition, the Ph.D. program in mechanical engineering culminates in a Ph.D. dissertation based on the results of original research carried out under the guidance of a faculty member and defended in a public examination.

Graduate Certificate Programs

The Mechanical Engineering Department offers several graduate certificate programs to students meeting the regular admission requirements for the master's program. Each graduate certificate program is self-contained and highly focused, carrying 12 graduate credits. All of the courses may be used toward a master's or doctoral degree, as well as for the graduate certificate. Current graduate programs include:

Additive Manufacturing

▸ ME 565 Introduction to Additive Manufacturing

▸ ME 652 Advanced Additive Manufacturing

▸ ME 653 Design for Additive Manufacturing

▸ ME 691 Additive Manufacturing for Biological Systems

Advanced Manufacturing

▸ ME 566 Design for Manufacturability

▸ ME 621 Introduction to Modern Control Engineering

▸ ME 652 Advanced Additive Manufacturing

▸ ME 564 Principles of Optimum Design and Manufacture

Computational Fluid Mechanics and Heat Transfer

▸ ME 594 Numerical Methods in Mechanical Engineering

▸ ME 604 Advanced Heat Transfer or ME 609 Convective Heat Transfer

▸ ME 674 Fluid Dynamics

▸ ME 675 Computational Fluid Dynamics and Heat Transfer

Design and Production Management

▸ ME 566 Design for Manufacturability

▸ ME 636 Project Management and Organizational Design

▸ ME 644 Computer-Integrated Design and Manufacturing

▸ ME 645 Design of Production Systems

Medical Devices

▸ ME 525 Biomechanics

▸ ME 580 Medical Device Design and Technology

▸ ME 660 Medical Devices Manufacturing

and one of the following courses:

▸ ME 581 Introduction to BioMEMS

▸ ME 691 Additive Manufacturing for Biological Systems

Ordnance Engineering

▸ ME 505 Theory and Performance of Propellants and Explosives I

▸ ME 507 Exterior Ballistics

and any two of the following courses:

▸ ME 504 Interior Ballistics and Design for Projection

▸ ME 506 Theory of Performance of Propellants and Explosives II

▸ ME 508 Terminal Ballistics

Power Generation

▸ ME 510 Power Plant Engineering

▸ ME 595 Heat Exchanger Design

and two of the following:

▸ ME 529 Modern and Advanced Combustion Engines

▸ ME 546 Introduction to Turbomachinery

▸ ME 625 Gas Turbines

Robotics and Control

▸ ME 598 Introduction to Robotics

▸ ME 621 Introduction to Modern Control Engineering

▸ ME 654 Advanced Robotics

and one of the following:

▸ ME 622 Optimal Control and Estimation of Dynamical Systems

▸ ME 623 Design of Control Systems

Structural Analysis and Design

▶ ME 658 Advanced Mechanics of Solids

▶ ME 659 Advanced Structural Design

▶ ME 661 Advanced Stress Analysis

▶ ME 663 Finite-Element Methods

Sustainable Energy Systems

▶ ME 514 Sustainable Energy

▶ ME 615 Thermal Systems Design

and two of the following five courses

▶ ME 510 Power Plant Engineering

▶ ME 511 Wind Energy - Theory and Application

▶ ME 513 Introduction to Nuclear Engineering

▶ ME 518 Solar Energy - Theory and Application

▶ ME 519 Solar Energy - System Designs

Vibration and Noise Control

▶ ME 584 Vibration and Acoustics in Product Design

▶ ME 611 Engineering Acoustics

▶ ME 631 Mechanical Vibrations I

▶ ME 651 Analytic Dynamics

COURSE OFFERINGS

Mechanical Engineering

ME 181   Seminar in Mechanical Engineering   (1 - 1 - 0)

Introduction to current research topics in Mechanical Engineering and the academic research enterprise. The applications chosen demonstrate the breadth, impact, and future of Mechanical Engineering. Typical topics include additive manufacturing, biomechanics and biomedical applications of Mechanical Engineering, energy, advanced materials, robotics, and nanotechnology.

ME 225   Dynamics   (3 - 3 - 0)

Particle kinematics and kinetics, systems of particles, work-energy, impulse and momentum, rigid-body kinematics, relative motion, Coriolis acceleration, rigid-body kinetics, direct and oblique impact, eccentric impact. Prerequisites: MA 116 or MA 124, PEP 112, and E 126

ME 234   Mechanical Engineering Thermodynamics   (3 - 3 - 0)

Concepts of energy, heat and work; thermodynamic properties of substances and property relationships, phase change; First and Second Laws for closed and open systems including steady and transient processes and cycles; using entropy; representative applications including vapor and gas power and refrigeration cycles. Prerequisites: MA 116 or MA 124, CH 115, PEP 111

ME 322   Engineering Design VI   (2 - 2 - 2)

This course is intended to teach modern systematic design techniques used in the practice of mechanical engineering. Methodology for the development of design objective(s), literature surveys, base case designs, and design alternatives are given. Economic analyses with an emphasis on capital investment and operating costs are introduced. Integrated product and process design concepts are emphasized with case studies. Students are encouraged to select their senior capstone design project near the end of the course, form teams, and commence preliminary work. A number of design projects are required of all students. Prerequisite: E 321 Corequisite: ME 345

ME 335   Thermal Engineering   (3 - 3 - 0)

Applications of First and Second Laws to thermal systems including gas turbine, and internal and external combustion engines. Vapor cycles, including supercritical binary and combined cycles, regeneration and recuperation, gas compression, refrigeration and gas liquefaction. Analysis of thermal processes, including available energy and availability, irreversibility, effectiveness. Laboratory work in air compressors, internal combustion engines, furnaces, heat pumps, and gas turbines. Prerequisites: MA 221 and ME 234

ME 342   Fluid Mechanics   (3 - 3 - 0)

Properties of a fluid, basic flow analysis techniques, fluid kinematics, hydrostatics, manometry, pressure distribution in rigid body motion of a fluid, control volume analysis, conservation of mass, linear and angular momentum, Bernoulli and energy equations, dimensional analysis, viscous flow in pipes, flow metering devices, external flows, estimation of lift and drag, turbo-machinery, open channel flow. Prerequisites: E 126, MA 221, ME 225

ME 345   Modeling and Simulation   (3 - 2 - 2)

Modeling and simulation methodologies including model-block building, logical and data modeling, validation, simulation and trade-off analysis, decision-making, and optimization. Product and assembly modeling; visual simulation; process modeling; production modeling; process plans and resource modeling, entity flow modeling including conveyors, transporters, and guided vehicles; Input and output statistical analysis. Several CAD/CAE simulation software are used. Prerequisites: MA 221, ME 225, and ME 234

ME 354   Heat Transfer   (3 - 3 - 0)

Basic modes of heat transfer, steady heat conduction, extended surface heat transfer, transient heat conduction, computational methods, forced and free convection, boiling and condensation, thermal radiation, heat exchangers. Design projects. Prerequisites: MA 227, ME 234, and ME 342

ME 358   Machine Dynamics and Mechanisms   (3 - 3 - 1)

The principles of dynamics as applied to the analysis of the accelerations and dynamic forces in machines such as linkages, cam systems, gears trains, belts, chains and couplings. The effect these dynamic forces have on the dynamic balance and operation of the machines and the attending stresses in the individual components of the machines. Some synthesis techniques. Students also work in teams on a semester long project associated with the design of a mechanical system from recognizing the need through a detailed conceptual design. Prerequisites: E 126, E 232, MA 227, and ME 225

ME 361   Design of Machine Components   (3 - 3 - 0)

Application of the principles of strength of materials to the analysis and design of machine parts. Stress and deflection analysis. Curved bars, multi-support shafts, torsion, cylinders under pressure, thermal stresses, creep, and relaxation, rotating disks, fasteners, springs, bearings, gears, brakes and other machine elements are considered. Failure of structural materials under cyclic stress. Prerequisites: MA 221, E 126

ME 401   Special Problem in ME   (3 - 3 - 0)

Individual investigation in a subject area of current interest in Mechanical Engineering undertaken at an undergraduate level under the guidance of a faculty advisor. The type of project undertaken must be consistent with the student's academic level. To register for this course, the student and faculty advisor jointly submit a detailed proposal.

ME 421   Energy Conversion Systems   (3 - 3 - 0)

Technology and economics of energy sources, storage and utilization, overview of fundamental concepts of mechanical, thermal, chemical, nuclear, electrical energy conversion (practical and visionary), thermo chemical conversion, including combustion in power plants, propulsion systems, thermo mechanical conversion in nozzles and turbomachinery, "direct" energy conversion in fuel cells, etc., nuclear energy conversion. Prerequisites: ME 335, ME 342 Corequisite: ME 354

ME 423   Engineering Design VII   (3 - 1 - 6)

Senior design courses. Complete design sequence with a required capstone project spanning two semesters. Prerequisite: ME 322

ME 424   Engineering Design VIII   (3 - 1 - 6)

Senior design courses. Complete design sequence with a required capstone project spanning two semesters. Prerequisite: ME 423

ME 463   Research in Mechanical Engineering I   (3 - 0 - 8)

Individual investigation of a substantive character undertaken at an undergraduate level under the guidance of a faculty advisor leading to a thesis with a public defense. Thesis committee will consist of the faculty advisor and one or more reader.

ME 464   Research in Mechanical Engineering II   (3 - 0 - 8)

Individual investigation of a substantive character undertaken at an undergraduate level under the guidance of a faculty advisor leading to a thesis with a public defense. Thesis committee will consist of the faculty advisor and one or more reader.

ME 470   Mechanical Engineering Systems Laboratory   (2 - 0 - 3)

Experiments in selected mechanical engineering systems areas, including principles and applications of experimentation, data-acquisition, design of experiments, and written and oral reporting on experimental hardware and results. Prerequisites: ME 335, ME 342, and ME 361

ME 471   Mechanics of Materials   (3 - 3 - 0)

Multidimensional stress, strain and transformation equations, yield conditions and theories of failure, constitutive laws including linear elasticity, viscoelasticity and temperature influences, equations of elasticity, simple applications to uniaxial stress and symmetric bending, unsymmetrical bending and shear center of beams, torsions, combined stresses with applications to beams, thin-walled cylinders and pressure tanks, shrink fits, bending beyond the elastic limit, instability and energy methods. Prerequisite: ME 361

ME 473   Design of Mechanical Systems   (3 - 3 - 0)

Static and dynamic force analysis of mechanisms, dynamics of reciprocating and rotating machinery, balancing of machinery, friction and wear, vibration and noise control in machines, manipulators and robots, computer-aided design. Prerequisites: MA 227, ME 358

ME 483   Control Systems   (3 - 3 - 0)

Analysis and synthesis of single-input, single-output (SISO) linear time-invariant (LTI) feedback control systems. Laplace transforms, transfer functions, poles and zeros, block diagrams, time response, and frequency response. Performance criteria, multi-domain systems modeling, Routh-Hurwitz stability, root-locus, Bode plots, stability margins, compensator design, applications relevant to mechanical engineering. Prerequisites: MA 227, ME 225

ME 491   Manufacturing Processes and Systems   (3 - 3 - 0)

Analysis of both bulk-forming (forging, extrusion, rolling, etc.) and sheet-forming processes, metal cutting, and other related manufacturing processes; physics and stochastic nature of manufacturing processes and their effects on quality, rate, cost and flexibility; role of computer-aided manufacturing in manufacturing system automation; methodologies used to plan and control a manufacturing system, forecasting, production scheduling, facility layout, inventory control, and project planning. Prerequisites: ME 345, ME 361

ME 501   Basic Engineering Mechanics   (3 - 3 - 0)

This course is intended to provide an introduction to engineering mechanics. Topics include Static and Dynamics, Strength of Materials, and Systems Modeling. The course will emphasize basic relationships in those areas necessary for the understanding of design and manufacturing principles as covered in ME 503.

ME 502   Introduction to Engineering Analysis   (3 - 3 - 0)

Basic concepts and introduction to engineering analysis techniques in mechanical and manufacturing engineering. Topics include: applications of ordinary and partial differential equations, linear algebra and numerical analysis to mechanical and manufacturing engineering system. Prerequisite: ME 501

ME 503   Principles of Mechanical Engineering   (3 - 3 - 0)

This course is intended to provide non-mechanical engineering students with an understanding of the principles of mechanical design. It is given from the viewpoint that design is the central activity of the engineering profession, and it is more concerned with the introduction of mechanical engineering principles pertinent to design of products. This course presents design as an interdisciplinary activity that draws on such diverse subjects as materials selection, modeling and analysis, and manufacturing processes.

ME 504   Interior Ballistics and Design for Projection   (3 - 3 - 0)

The ballistic regimes, simple piezo ballistics, Corner's analysis, Frankle-Baer simulation, interior ballistics interactive simulation, comparison of models, projectile design practice, cannon design practice, exterior intermediate ballistic regimes, flight trajectories, terminal ballistics, numerical simulation of impact and fragmentation. (At Dover, NJ)

ME 505   Theory and Performance of Propellants and Explosives I   (3 - 3 - 0)

A treatment of the physical and chemical theoretical principles which govern the characteristics and performance of propellants and explosives; theories to explain stability, sensitivity, combustion, detonation, initiation, power, shaped charge effect, and flash and smoke formations; thermochemical and thermodynamic calculations to enable performance to be predicted; kinetics of reaction of important systems; modern research instrumentation; test procedures; methods of evaluating propellants and explosives.

ME 506   Theory of Performance of Propellants and Explosives II   (3 - 3 - 0)

A treatment of the physical and chemical theoretical principles which govern the characteristics and performance of propellants and explosives; theories to explain stability, sensitivity, combustion, detonation, initiation, power, shaped charge effect, and flash and smoke formations; thermochemical and thermodynamic calculations to enable performance to be predicted; kinetics of reaction of important systems; modern research instrumentation; test procedures; methods of evaluating propellants and explosives.

ME 507   Exterior Ballistics   (3 - 3 - 0)

Basic principles of exterior ballistics are introduced. Flight terminology, vacuum trajectories and flat fire point mass trajectories are discussed. Siacci Method, Coriolis Effect, yaw or repose, wind effects, 6-DOF trajectories and modified point mass trajectories are covered.

ME 508   Terminal Ballistics   (3 - 3 - 0)

Simplified equations for determination of flight stability and roll resonance are developed. Terminal ballistics are described and nomenclature introduced. Shock and stress wave effects in material are discussed. Penetration and perforation of solids and the governing equations are described. Penetration of armor by shaped charged jets are discussed. Term project focuses on investigation of terminal ballistic effects tailored to a specific job application.

ME 509   Special Topics in Mechanical Engineering   (3 - 3 - 0)

Courses on special topics of current interest in Mechanical Engineering.

ME 510   Power Plant Engineering   (3 - 3 - 0)

Analysis of thermodynamics, hydraulic, environmental, and economic considerations that affect the design and performance of modern power plants; overview of power generation system and its components, including boilers, turbines, circulating water systems, and condensate-feedwater systems; fuels and combustion; auxiliary pumping and cleanup systems; gas turbine and combined cycles; and introduction to nuclear power plants and alternate energy systems based on geothermal, solar, wind, and ocean energy.

ME 511   Wind Energy-Theory & Application   (3 - 3 - 0)

This course provides the fundamentals of the conversion of wind energy to electricity and describes the effective use of wind energy for a variety of applications. It spans a wide range of fields, from meteorology through mechanical, electrical, structural engineering and aerodynamics, to economics and environmental concerns. Topics include wind energy principles, wind site assessment, wind turbine components, wind power generation machinery, economics of wind energy, environmental concerns and the future of wind power.These topics are covered in sufficient detail for everyones understanding without requiring prior background in all these disciplines. Using the knowledge gained from the course, the students are expected to complete a class project designing a small scale wind energy.

ME 512   Intermediate Fluid Mechanics   (3 - 3 - 0)

Differential equations of fluid flow, Navier-Stokes equations, introduction to fluid turbulence, inviscid incompressible flow, introduction to airfoil theory, compressible fluid flow and applications nozzles, ducts and airfoils. Cross-listed with: NE 453 Prerequisites: MA 227, ME 342

ME 513   Introduction to Nuclear Engineering   (3 - 3 - 0)

A development of the background necessary for nuclear engineering, beginning with a review of atomic physics and including radioactivity, nuclear reactions, neutron physics and elementary reactor theory, reactor dynamics and control, reactor types.

ME 514   Sustainable Energy   (3 - 3 - 0)

This course assesses the current and potential future energy systems, covers resources, extraction, conversion, and end-use, and emphasizes meeting regional and global energy needs in the 21st century in a sustainable manner. Topics relevant to renewable and conventional energy technologies will be presented including fossil fuels, combustion, environmental effects, carbon sequestration, nuclear power, wind power, solar energy, hydrogen and fuel cells. Key attributes will be described within a framework that aids in evaluation and analysis of energy technology systems in the context of political, social, economic, and environmental goals. Cross-listed with: E 580 Prerequisite: ME 234

ME 515   Automotive Engineering   (3 - 3 - 0)

Analysis of the automotive vehicle as an entire integrated system under highway and off-road conditions. Significant subject areas include power-train design, control and stability; suspension design, tire-road interface, soil-vehicle interface, four-wheeled, tracked and unconventional vehicles; emphasis is on design theory.

ME 516   Nuclear Reactor Safety and Waste Disposal   (3 - 3 - 0)

This course covers fundamental principles related to nuclear power reactor reliability, safety and waste disposal. Topics include radiation and radiological concepts and measurement, the fuel cycle and waste classification, State and Federal regulations and regulatory agencies, radiochemistry and the environmental fate of radionuclides, uranium-related wastes, low-level waste characteristics and management, high-level wastes characteristics and management, private fuel storage, waste package stability, risk assessment, geologic repositories, theory of retrievability in waste management, deep-well injection, transporting radioactive wastes, decontamination and decommission, transmutation, an international perspective on radioactive waste management, the Global Nuclear Energy Partnership, and the latest from the Blue Ribbon Commission.

ME 517   Nuclear Power Plant Design & Operation   (3 - 3 - 0)

This course covers design methodologies for major systems and components in a nuclear power plant and discusses how the integrated nuclear plant works and the challenges an operator faces. The course provides a study of the interrelationship and propagation of effects that systems and design changes have on one another, especially in relation to nuclear power plant operations and safety. Emphasis is placed on how operations of and faults in systems and components can influence reactivity and core behavior. The students will examine a typical nuclear power plant and those components and systems of the nuclear plant system that have the potential for affecting core power and whose failure could be an initiating event for a plant transient. One main outcome is the ability to predict behavior under complex interactions among systems and to predict transient behavior of the integrated nuclear plant considering factors that are important for safe and efficient operation of the plant including reactivity management and control, coolant inventory control and core heat removal. A replica simulator (PCTRAN) is used as an effective way for students to understand accident control, emergency operating procedures and plant control. The course includes case studies and design projects.

ME 518   Solar Energy: Theory & Application   (3 - 3 - 0)

This course is an in depth treatment of the principles and practice associated with using solar radiation as an alternate energy source. It examines the science of solar radiation, technologies for its capture and the design principles that are used to apply solar energy in building design. Cross-listed with: MT 518

ME 519   Solar Energy: System Designs   (3 - 3 - 0)

This course provides an in-depth treatment of how to transfer the latest solar thermal technology available to real world applications. It takes the student through the various phases of development of a solar space heating and photovoltaic integrated building; review occupant's requirements, site analysis, design concept, solar system design, cost estimates, building design, performance predictions and construction. The emphasis of the class is on solar system design methods, economic optimization of solar systems and installation. Cross-listed with: MT 528

ME 520   Analysis and Design of Composites   (3 - 3 - 0)

Composite material characterization; composite mechanics of plates, panels, beams, columns, and rods integrated with design procedures; analysis and design of composite structures, joining methods and procedures, introduction to manufacturing processes of filament winding, braiding, injection, compression and resin transfer molding, machining and drilling, and industrial applications. Cross-listed with: MT 520

ME 521   Nondestructive Evaluation   (3 - 3 - 0)

This course will introduce principles and applications of Nondestructive Evaluation (NDE) techniques which are important in design, manufacturing, and maintenance. Most commonly used methods such as ultrasonics, magnetics, radiography, penetrants, and eddy currents will be discussed. Physical concepts behind each of these methods as well as practical examples of their applications will be emphasized. Cross-listed with: CE 530

ME 522   Mechatronics   (3 - 3 - 0)

This course introduces principles of mechatronics to integrate mechanical, electronic/electrical, and control/computer/software components for motion control systems. Electromechanical components and integration concepts include: machine construction and control concepts, control modes (open/closed loop, servo, and process control) and motion profiles, motion drivers and actuators (AC drives, motors, gearing, servo and stepper motors), PLC control and programming (ladder and Boolean and combinatorial logic interfaces), microprocessor/computer based (logic, operating systems, SCADA, and HMI), field devices, signal conditioning, and communication (I/O hardware and management, vision systems, protocols, and programming languages), and introduction to system integration. Course includes hands-on lab work, small design projects, case studies, and industry guest lectures.

ME 523   Mechatronics II   (3 - 3 - 0)

This course builds upon the foundation formed in ME522 Mechatronics I. It emphasizes the fundamentals of machine design, thus advancing the student's knowledge of the principles of motion control, mechanical power transmission, safety as well as aspects of industrial standards as they affect equipment design and component selection, programmable logic controller (PLC) programming, and industrial component sizing. Industrial modeling tools are provided and used during the semester as are discussions on backlash, mechanical resonance, and PID loops. This course fosters a systematic understanding of today's industrial products selection and applications of components for machine design.

ME 525   Biomechanics   (3 - 3 - 0)

This course introduces the fundamental principles of mechanics applied to the study of biological systems and relates the design of implants and prosthetics to the biomechanics of the musculoskeletal system. Specific types of tissue covered include bone, ligament, skeletal and cardiac muscle, and articular cartilage. An introduction to the basic concepts of continuum mechanics is provided, including finite-deformation kinematics, stress, constitutive equations, and the governing conservation laws of mass, momentum, and energy applied to deformable continua. Rigid-body kinematics is introduced in the context of applications in biomechanics.

ME 526   Biofluid Mechanics   (3 - 3 - 0)

This entry-level graduate course provides an introduction to biofluid mechanics with an emphasis on macrocirculation, microcirculation, and other flows in the human body. The fundamental principles of fluid mechanics are reviewed and related to various human biological systems, including the cardiovascular, pulmonary, lymphatic, ocular, synovial and renal systems. Prerequisites: Undergraduate level fluid mechanics, heat transfer, thermodynamics and solid mechanics; Introductory level physical course recommended.

ME 527   Mechanics of Human Movement   (3 - 3 - 0)

This course introduces the basic anatomy of skeletal muscles, tendons, ligaments and joints (including shoulder, hip, knee, foot and ankle). Mechanical principles are applied to the analysis of human movement in daily living, work settings, sports and exercise. Quantitative video analysis techniques are introduced and applied to selected movement analysis projects. Prerequisites: ME 225, ME 361

ME 528   Physiological Systems (for Engineers)   (3 - 3 - 0)

A study of the physiological functions of major organ systems (Neural, Blood, Muscle, Heart, Vascular System Renal, Respiratory and Lymphatics) and how they interact to maintain homeostasis from a systems engineering point of view. Functional anatomy and physiology will be covered as well as quantitative methods for the analysis of organ function and their interactions. An analysis of changes in the major physiological variables with exercise will be used as an example of the integration of the major organs to compensate for stress. Cross-listed with: BME 503 Prerequisites: CH 381 or BIO 381

ME 529   Modern and Advanced Combustion Engines   (3 - 3 - 0)

The internal combustion engine examined in terms of the four fundamental disciplines that determine its characteristics: 1) fluid mechanics; 2) chemistry of combustion and of exhaust emission; 3) first and second laws of thermodynamics, and 4) mechanics of reciprocating and rotary motion; high output Otto and Diesel engines for terrestrial, maritime and aerospace environments; normal and abnormal combustion; stratified charge and advanced low emission engines; hybrid and multifuel engines; Sterling and other space engines; free-piston and rotary-piston concepts and configurations.

ME 530   Introduction to Pharmaceutical Manufacturing   (3 - 3 - 0)

Pharmaceutical manufacturing is vital to the success of the technical operations of a pharmaceutical company. This course is approached from the need to balance company economic considerations with the regulatory compliance requirements of safety, effectiveness, identity, strength, quality, and purity of the products manufactured for distribution and sale by the company. Overview of chemical and biotech process technology and equipment, dosage forms and finishing systems, facility engineering, health, safety and environment concepts, and regulatory issues. Cross-listed with: PME 530 and CHE 530

ME 531   Process Safety Management   (3 - 3 - 0)

This course reviews the 12 elements of the Process Safety Management (PSM) model created by the Center for Chemical Process Safety of the American Institute of Chemical Engineers. PSM systems were developed as an expectation/demand of the public, customers, in-plant personnel, stockholders and regulatory agencies because reliance on chemical process technologies were not enough to control, reduce and prevent hazardous materials incidents. PSM systems are comprehensive sets of policies, procedures and practices designed to ensure that barriers to major incidents are in place, in use and effective. The objectives of this course are to: define PSM and why it is important, describe each of the 12 elements and their applicability, identify process safety responsibilities, give real examples and practical applications to help better understand each element, share experiences and lessons learned of all participants, and assess the quality and identify enhancements to student's site PSM program. Cross-listed with: PME 531 and CHE 531

ME 532   Air Pollution Principles and Control   (3 - 3 - 0)

An introduction to the principles and control of air pollution, including: types and measurement of air pollution; air pollution chemistry; atmospheric dispersion modeling; compressible fluid flow; particle dynamics; ventilation systems; inertial devices; electrostatic precipitators; scrubbers; filters; absorption and adsorption; combustion; condensation. Cross-listed with: EN 506

ME 535   Good Manufacturing Practice in Pharmaceutical Facilities Design   (3 - 3 - 0)

Current Good Manufacturing Practice compliance issues in design of pharmaceutical and biopharmaceutical facilities. Issues related to process flow, material flow, and people flow, and A&E mechanical, industrial, HVAC, automation, electrical, and computer. Bio-safety levels. Developing effective written procedures, so that proper documentation can be provided, and then documenting through validation that processes with a high degree of assurance do what they are intended to do. Levels I, II, and III policies. Clinical phases I, II, III and their effect on plant design. Defending products against contamination. Building quality into products. Cross-listed with: PME 535 and CHE 535

ME 540   Validation in Life Sciences Manufacturing   (3 - 3 - 0)

Validation of a pharmaceutical manufacturing process is an essential requirement with respect to compliance with Good Manufacturing Practices (GMP). Course covers: validation concepts for process, equipment, facility, cleaning, sterilization, filtration, analytical methods and computer systems; validation Master Plans, IQ, OQ, and PPQ protocols; and validation for medical devices. Cross-listed with: PME 540, CHE 540

ME 541   Validation of Computerized Systems   (3 - 3 - 0)

Computers and computerized systems are ubiquitous in pharmaceutical manufacturing. Validation of these systems is essential to assure public safety and compliance with appropriate regulatory issues regarding validation: GMP, GCP, 21CFR Part 11, etc. This course covers validation concepts for various classes of computerized systems and applications used in the pharmaceutical industry; importance of requirements engineering in validation; test protocols and design; organizational maturity considerations. Cross-listed with: PME 541 Prerequisite: ME 540

ME 543   Air-Conditioning   (3 - 3 - 0)

Analysis of refrigeration cycles, properties of refrigerants and coolants; psychrometry; factors affecting human comfort; environmental control requirements in industrial processes; estimation of infiltration and ventilation, heat transmission coefficients, insulation; heating and cooling load on buildings; numerical methods for building energy analysis; selection of air distribution systems, ducting and fans; selection of water and steam distribution systems, piping and pumps.

ME 545   Introduction to Aerospace Engineering   (3 - 3 - 0)

This course lays the foundations in aerospace engineering. Topics include the history of aviation, basic aerodynamics, airfoils, wings and other aerodynamic shapes, aircraft performance, stability and control, aircraft structures (structural analysis and materials), propulsion, flight test, rockets, space flight, and orbits. Prerequisite: ME 342

ME 546   Introduction to Turbomachinery   (3 - 0 - 0)

Aerodynamic and thermodynamic fundamentals applicable to turbomachinery; design configurations and types of turbomachinery; turbine, compressor and ancillary equipment kinematics, thermodynamics and performance; selection and operational problems of turbomachinery.

ME 551   Microprocessor Applications in Mechanical Engineering   (3 - 3 - 0)

Introduction to basic concepts and current state-of-the-art hardware; architecture and elementary programming; instruction sets; fundamental software concepts; interfacing microprocessors to external devices; microprocessors in control systems; hands-on laboratory applications of microprocessors in mechanical engineering systems.

ME 554   Introduction to Computer-Aided Design   (3 - 3 - 0)

An introduction to using a computer system to aid in engineering design, fundamental components of hardware and software; databases and database management, numerical control and computer-aided manufacturing. Integration of manufacturing system from conceptual design through quality control to final shipping is discussed. Applications include solids modeling, CAD drawing and solution using finite element method.

ME 555   Lean Six Sigma   (3 - 3 - 0)

Course explores the current application of Lean Six Sigma in Manufacturing. Topics covered include: Lean Six Sigma Concepts and Techniques, Project and Team Dynamics, Tools of Lean Six Sigma and their Application, and Designing Manufacturing Processes for Lean Six Sigma. Emphasis is on DMAIC, including Define, Measure, Analyze, Improve, and Control methodology, with the students' skill set developed through case studies and project work on actual manufacturing processes using statistical software (Minitab). At the conclusion of this course, students will understand the concepts and principles of Lean Six Sigma, be competent with Minitab software and be able to apply these techniques to manufacturing processes. Cross-listed with: PME 555

ME 560   Quality in Life Sciences Manufacturing   (3 - 3 - 0)

This course provides a detailed exploration of quality programs with specific application to the particular requirements of the pharmaceutical industry. Students will develop an understanding of the quality philosophy which drives the industry from discovery through manufacturing, and of the systems and tools that are employed to implement and maintain a sustainable and successful quality system. Application of quality strategies in research and development, commercial production, computer systems, post-marketing, and other areas will be included. Where appropriate, case studies will be used to illustrate the challenges and issues associated with quality system deployment.

ME 564 Optimization Principles in Mechanical Engineering (3 - 3 - 0)

Application of mathematical optimization techniques, including linear and nonlinear methods, to design and manufacture of devices and systems of interest to mechanical engineers; optimization techniques include: constrained and unconstrained optimization in several variables, problems for structured multi-stage decision, and linear programming; formulation of design and manufacturing problems using computer- based methods; optimum design of parts and assemblies to minimize the cost of manufacture. Cross-listed with: SYS 564

ME 565 Introduction to Additive Manufacturing (3 - 3 - 0)

This course introduces the students to the rapidly growing field of additive manufacturing (more commonly known as 3D printing). The course takes the students through the entire additive manufacturing process, including CAD modeling and tolerancing for additive manufacturing, 3D scanning and file processing, part orientation and layout, model slicing, support and tool path generation, machine and material selection, print optimization as well as an overview of the basic economics of additive manufacturing. The students will get hands-on exposure to many of the technical aspects and applications of additive manufacturing through several projects. The course will also allow students to gain practical experience in machine operation and maintenance tasks such as machine setup and post-processing operations. Prerequisites: E 120 and ME 322

ME 566 Design for Manufacturability (3 - 3 - 0)

This course is involved in the design and development of parts and assemblies for manufacturability and functionality; characteristics and capabilities of significant manufacturing processes; principles of design for manufacturability; product planning; conceptual design; embodiment design; dimensional tolerances; optimum design of products to minimize cost of manufacture; materials specifications for ease of manufacturability and good functional results; design for ease of assembly; integrated product development; concurrent engineering practice.

ME 573 Introduction to Micro-Electromechanical Systems (3 - 3 - 0)

Introduction to microsystem design, modeling and fabrication. Course topics include material properties of Microelectromechanical systems (MEMS), microfabrication technologies, structural behavior, sensing and actuation principles and methods. Emphasis on microsystems design, modeling and simulation including lumped element modeling and finite element analysis. The emerging nano-materials, processes and devices will also be discussed. Student teams design microsystems (sensors, actuators and sensing/control systems) of a variety of types, (optical MEMS, bioMEMS, inertial sensors, etc.) to meet a set of performance specifications using a realistic microfabrication process.

ME 580 Medical Device Design and Technology (3 - 3 - 0)

Early history of medical devices and procedures. Minimally invasive and open procedures, techniques and devices, including mechanical and electrosurgical devices. Manufacturing methods for catheters, balloons, plastic and metal components. Design of metal device components including material selection and strength and deformation adequacy using material properties and classical mechanics. Selection of insulation materials for and testing of electrosurgical devices. Selection of medical plastics and design elements. Balloon and catheter burst strength. The Poiseuille flow equation and its use for fluid flow through catheters and vessels. Rapid prototyping techniques, advantages and limitations. Understanding of biocompatibility testing and accelerated age testing using the Arrhenius equation. Device sterilization methods and testing. Developing a project plan from brainstorming to product release for a new device. Cross-listed with: PME 580

ME 581 Introduction to Bio Micro Electro Mechanical Systems (BioMEMS) (3 - 3 - 0)

Bringing together the creative talents of electrical, mechanical, optical and chemical engineers, materials specialists, clinical-laboratory scientists, and physicians, the science of biomedical microelectromechanical systems (Bio MEMS) promises to deliver sensitive, selective, fast, low cost, less invasive, and more robust methods for diagnostics, individualized treatment, and novel drug delivery. The goals of this course are to introduce microfabrication, microfluidics, sensors, actuators, drug delivery systems, micro total analysis systems and lab-on-a-chip devices, detection and measurement systems. The main focus is on the fundamental challenges and limitations involved in designing and demonstrating BioMEMS devices.

ME 584 Vibration and Acoustics in Product Design (3 - 3 - 0)

This course offers concurrent design as they apply to quiet product design; vibration and acoustic characteristics in design or products and systems; source-path-receiver model for vibration and acoustics; vibration of single and two degrees of freedom models; features of continuous systems, design for low vibration and vibration control; acoustic plane and spherical waves; acoustical source models; acoustic performance descriptions; design of quiet products and systems; application of computational methods; case studies.

ME 587   Human Factors Engineering   (3 - 3 - 0)

This course is a graduate-level introduction to Human Factors Engineering, the discipline that examines the interactions between humans and other elements of a system. The course will present theory, principles, data and methods to design for humans ranging from infants to the aged with special attention to their biological and physical needs. Achieving optimal person- environment interaction requires knowledge about the broad range of human functional capacity, including – but not limited to – anthropometry, biomechanics, sensory processes and others. The course involves a project that applies the obtained knowledge to real world problems with innovative product designs.

ME 594   Numerical Methods in Mechanical Engineering   (3 - 3 - 0)

Problems in mechanical engineering illustrating the application of computer methods to solve roots of algebraic and transcendental equations, system of algebraic equations, curve fitting, numerical integration and differentiation, ordinary and partial differential equations.

ME 595   Heat Exchanger Design   (3 - 3 - 0)

Basic principles of heat exchanger design; types of heat exchangers, heat exchanger effectiveness; uncertainty analysis of design and operating parameters; fouling factors; heat transfer augmentation in heat exchangers, two-phase flow, boiling and condensation in heat exchangers, second law of thermodynamics for optimization of heat exchanger design; tube vibrations; codes and standards; individually supervised heat exchanger design project.

ME 598   Introduction to Robotics   (3 - 3 - 0)

Elements of a robotic/flexible automation system; overview of applications; manipulator anatomy; drive systems; end effectors; sensors; computer control: functions, levels of intelligence, motion control, programming and interfacing to sensors and actuators; applications: identification, hardware selection, work cell design, economics, case studies; design of parts and assemblies; advanced topics.

ME 601   Engineering Thermodynamics   (3 - 3 - 0)

Fundamental laws of the thermodynamics of mechanical, thermal and chemical equilibrium systems; thermodynamic properties of materials including multiphase, multicomponent systems with gaseous chemical reactions; analysis of thermodynamic systems (open and closed) based primarily on the first and second laws.

ME 602   Statistical Methods in Life Science Industries   (3 - 3 - 0)

This course is focused on the application of statistics and statistical reasoning in pharmaceutical manufacturing, particularly in production, quality assurance, quality control, validation and analytical laboratories. Basic statistical definitions and concepts are described. Students will learn various measures of central tendency and spread of data, how to present data graphically and be introduced to the probability distributions most commonly encountered in pharmaceutical manufacturing. Approaches to choosing samples for analysis, statistical inference, sample size and power will be discussed. The course also covers regression and correlation, analysis of variance, gage repeatability and reproducibility, statistical process control, process capability analysis and design of experiments as applied to pharmaceutical manufacturing. Students will learn to apply statistical software to analyze common problems that arise in pharmaceutical manufacturing operations, including evaluation of dosage form weight and content uniformity, potency, dissolution, bio-equivalency and other product quality attributes.

ME 604   Advanced Heat Transfer   (3 - 3 - 0)

Fundamental modes of heat transfer; conduction, thermal resistance, extended surface with variable cross-section area, application of analytical, numerical and analog methods to the steady and unsteady state; convection, fluid flow and elementary boundary layer theory, dimensional analysis, forced convection for internal and external flows, natural convection, laminar and turbulent flow correlation formulas, condensation and boiling; radiation, physical foundations, radiative properties of surfaces, enclosure radiation, view factors, electrical analogy, gas radiation.

ME 605   Conduction Heat Transfer   (3 - 3 - 0)

Lumped, integral and differential formulation of general laws, statement of particular laws, initial and boundary conditions; steady one-dimensional conduction, principles of superposition; extended surfaces, power series solutions and Bessel functions, approximate solutions; steady two- and three-dimensional conduction, unsteady problems, separation of variables and orthogonal functions; steady periodic problems and complex temperature; finite difference formulation and numerical solutions; introduction to finite element formulation of conduction problems.

ME 607   Radiation Heat Transfer   (3 - 3 - 0)

An introduction to the theoretical and empirical foundation of thermoradiation; Plank's Law and Wien's Law; Stefan-Boltzmann law; radiative properties of surfaces; conductors and dielectrics; energy balances on radiating surfaces; radiative properties of gases; energy transitions of molecules; interactions between molecules and radiation; band absorption; equation of radiative transfer in an absorbing, emitting and scattering medium; radiation in a gas filled enclosure; radiation combined with conduction and convection.

ME 609   Convective Heat Transfer   (3 - 3 - 0)

Place of convective heat transfer among engineering sciences, concepts related to thermodynamics, mechanics and deformable moving media. General principles: conservation of mass, balance of linear momentum, conservation of total energy, increase of entropy; formulation of parallel flows, buoyancy driven flows, thermal boundary layers, fully developed heat transfer in pipes and channels, heat transfer correlations for turbulent flows.

ME 610   Advanced Topics in Mechanical Engineering   (3 - 3 - 0)

Courses on advanced topics of current interest in Mechanical Engineering, including but not limited to any of the following: steam turbines, random vibrations, stability of nonlinear mechanical systems, stress waves in solids, lubrication theory, radiative heat transfer, mechanism design, buckling of metal structures.

ME 611   Engineering Acoustics   (3 - 3 - 0)

Fundamentals of wave motion, acoustical plane waves, spherical waves, transmission of sound through media, radiation of sound, acoustical source mechanisms, absorption of sound, principles of underwater acoustics, ultrasonics.

ME 614   Nuclear Reactor Theory & Design   (3 - 3 - 0)

This course covers the basic elements of nuclear reactor theory for reactor core design and operation. Emphasis is placed on thermal and hydraulic analyses of power reactors, neutronics, fuel cycles, economics, nuclear analysis, control and safety. Complete reactor systems are analyzed. Standard reactor design codes are utilized.

ME 615   Thermal Systems Design   (3 - 3 - 0)

Introduction to fluid mechanics and heat transfer; design of piping systems; selection of pumps; analysis and design of heat exchangers; modeling and simulation of thermal systems; system optimization and design; case studies.

ME 616   Thermal-Hydraulics Design of Nuclear Power Reactors   (3 - 3 - 0)

This course covers the application of fundamental thermal and hydraulic principles and their application to nuclear power reactor design and analysis. It assumes that the student has a basic knowledge of fundamental principles in fluid mechanics, thermodynamics and heat transfer. Topics include: principal characteristics of nuclear power reactors; thermal design principles and application; transport equations for single-phase and two-phase flow; thermodynamics of nuclear power plant systems (steady and unsteady flow); thermal analysis of fuel elements; single-phase and two-phase flow and heat transfer; pool and flow boiling; single heated channel steady-state analysis. Major industry software including PCTRAN and TRNSYS are utilized in case studies and design projects.

ME 621   Introduction to Modern Control Engineering   (3 - 3 - 0)

Introduction to state space concepts; state space description of physical systems such as electrical, mechanical, electromechanical, thermal, hydraulic, pneumatic, aerospace, etc. systems. Eigenvalues, eigenvectors and other topics in linear algebra, modal decomposition and other coordination transformations. Relationship between classical transfer function methods and modern state methods. Analysis of linear continuous and discrete time linear systems, solution by state transition matrix, control ability, observability and stability properties; synthesis of linear feedback control systems via pole assignment and stabilizability and performance index minimization. Brief introduction to optimal control, estimation and identification.

ME 622   Optimal Control and Estimation of Dynamical Systems   (3 - 3 - 0)

Introduction to vector stochastic processes; response of linear differential systems to white noise, state estimation of linear stochastic systems by Kalman Filtering, combined optimal control and estimation of continuous time Linear Quadratic Gaussian (LQG) regulators; optimization techniques for dynamic systems using nonlinear programming methods and variational calculus; optimal control of linear and nonlinear systems by Pontryagin's maximum principle and Hamilton-Jacobi-Bellman theory of dynamic programming; computational methods in optimal control and estimation; applications to aerospace, mechanical electrical and other physical systems. Prerequisite: ME 621

ME 623   Design of Control Systems   (3 - 3 - 0)

This course focuses on the application of advanced process control techniques in pharmaceutical and petrochemical industries. Among the topics considered are bioreactor and polymerization reactor modeling, biosensors, state and parameter estimation techniques, optimization of reactor productivity for batch, fed-batch and continuous operations, and expert systems approaches to monitoring and control. An overview of a complete automation project of a pharmaceutical plant, from design to start-up, will be discussed, including process control issues and coordination of interdisciplinary requirements and regulations. Guest speakers from local industry will present current technological trends. A background in differential equations, biochemical engineering and basic process control is required. Cross-listed with: CHE 661

ME 624   Intelligent Mechatronic Systems   (3 - 3 - 0)

This course spans the background, fundamental principles and elements of hardware/software required for design and prototyping intelligent mechatronic systems and fundamentals for developing knowledge-bases, tools and methods that contribute to the intelligent response of system to expected and unexpected stimuli. The course introduces hardware and software development system architectures, interfacing to the analog world with sensors, response synthesis and actuation. Model-based, learning-based and knowledge-based algorithms that enable intelligent response synthesis by the system will be studied. Prerequisite: ME522 Mechatronics I

ME 626   Manufacturing of Biopharmaceutical Products   (3 - 3 - 0)

This course is focused on topics related to the technology, design and operations of modern biopharmaceutical facilities. It covers process, utilities and facility design issues and encompasses all major manufacturing areas, such as fermentation, harvest, primary and final purification, media and buffer preparation, equipment cleaning and sterilization, critical process utilities, unit operations including cell culture, centrifugation, conventional and tangential flow filtration, chromatography, solution preparation, and bulk filling. The application of current Good Manufacturing Practices and Bioprocessing Equipment Standards will be discussed. Prerequisite: PME 530 or ME 530 or CHE 530

ME 628   Manufacturing and Packaging of Pharmaceutical Oral Solid Dosage Products   (3 - 3 - 0)

The course covers oral solid dosage (OSD) manufacturing and packaging in the pharmaceutical industry. Production unit operations include blending, granulation, size reduction, drying, compressing, and coating for tablets, as well as capsule filling. Packaging aspects reviewed include requirements for primary and secondary containers and labeling, package testing. The course emphasizes design, scale-up, trouble-shooting, validation, and operation of typical OSD manufacturing and packaging facilities, including equipment, material flow, utilities, and quality assurance. Topics related to cGMP, process validation, manufacturing and packaging documentation, QA and QC in OSD manufacturing will be presented. The term project required for this course involves conceptual design of a contract manufacturing and packaging facility for OSD products, including equipment selection, development of the process flow diagrams, room layouts and other design elements, as well as preparation of Standard Operating Procedures for various unit operations. Cross-listed with: PME 628 Prerequisite: PME 530 or ME 530 or CHE 530

ME 629   Manufacturing of Sterile Pharmaceuticals   (3 - 3 - 0)

This course is focused on the special characteristics and types of sterile dosage forms and the technologies for their manufacturing. Topics such as environmental and contamination controls, facility design, water and air quality, personnel and other requirements for sterile manufacturing are covered. Sterilization methods for the equipment, components, intermediate and finished products are reviewed. Terminal sterilization and aseptic processing technologies including blow-fill-seal and barrier isolation systems are discussed. The course also includes topics such as Good Manufacturing Practices (GMP) regulations and guidance on aseptic manufacturing, quality assurance and control, stability, storage and distribution applicable to sterile dosage forms manufacturing. Prerequisite: CHE 530 or ME 530 or PME 530

ME 631   Mechanical Vibrations I   (3 - 3 - 0)

Vibration of linear system with one degree of freedom; multidegree of freedom systems; vibration control; Lagrange's equation; theory of small vibrations; matrix methods; normal coordinates; approximate methods of Holzer and Rayleigh-Stodola.

ME 632   Mechanical Vibrations II   (3 - 3 - 0)

Vibration of continuous systems; theory and application using finite element method; nonlinear systems; transient response, shock and impact phenomena; random vibrations.

ME 635   Modeling and Simulation   (3 - 3 - 0)

This course emphasizes the development of modeling and simulation concepts and analysis skills necessary to design, program, implement and use computers to solve complex systems/products analysis problems. The key emphasis is on problem formulation, model building, data analysis, solution techniques and evaluation of alternative designs/processes in complex systems/products. Overview of modeling techniques and methods used in decision analysis, including multi-attribute utility models, decision trees and optimization methods are discussed. Cross-listed with: IPD 611

ME 636   Project Management of Complex Systems   (3 - 3 - 0)

This project-based course exposes students to tools and methodologies useful for forming and managing an effective engineering design team in a business environment. Topis covered will include: personality profiles for creating teams with balanced diversity; computational tools for project coordination and management; real-time electronic documentation as a critical design process variable; and methods for refining project requirements to ensure that the team addresses the right problem with the right solution. Cross-listed with: IPD 612

ME 639   Modeling and Simulation of Pharmaceutical Manufacturing Systems   (3 - 3 - 0)

This course will introduce students to the modeling and simulation applications in the pharmaceutical manufacturing. Learn the basics of discreet event simulation and use commercially available software to develop models of various manufacturing and service systems. Approaches to the development of conceptual and computer models, data collection and analysis, model verification and validation, simulation output analysis are discussed. Learn how to model chemical, biochemical and separation processes in pharmaceutical manufacturing using process simulation software. Develop material balances, stream reports, operations and equipment Gantt charts, conduct process debottlenecking and cost analysis. Cross-listed with: PME 639, CHE 639

ME 641   Engineering Analysis I   (3 - 3 - 0)

Introduction to the application of engineering analysis techniques and mathematical principles of mechanical engineering. In addition to analytical and computational techniques, case studies and project-based examples will be given.

ME 642   Engineering Analysis II   (3 - 3 - 0)

Topics included are applications of complex variables, linear algebra, ordinary and partial differential equations, numerical analysis and other mathematical methods applied to mechanical engineering.

ME 644   Computer-Integrated Design and Manufacturing   (3 - 3 - 0)

Fundamentals of Computer-Integrated Design and Manufacturing addresses design and manufacturing as a global closed-loop system comprising four major functions: marketing, part design, process specifications and production. The emphasis of this course is on the computer integration of the islands of automation created by isolated computerized systems within these major functions in an enterprise.

ME 645   Design of Production Systems   (3 - 3 - 0)

Introduction to the design and control of production systems using mathematical, computational and other modern techniques. Topics that will be investigated include forecasting, inventory systems, aggregate production planning, material requirements planning, project planning, job sequencing, operations scheduling and reliability, in addition to capacity, flexibility and economic analysis of flexible manufacturing systems.

ME 647   Environmental Systems (HVAC) in Healthcare Manufacturing

Proven techniques and creative tools presented for design, development, and delivery of Environmental Systems necessary for the control and monitoring of classified spaces to manufacture drugs, medical devices, and research labs with potent or biologic compounds. Obtain knowledge of pharmaceutical environmental requirements, understanding of theories and principles of operation for Heating, Ventilating, and Air Conditioning (HVAC) equipment and system configurations to satisfy regulatory acceptance criteria, gaining practical knowledge of environmental system design and implementation including validation that suppots drug production. Course also incudes Building Automation Systems conceptual design and application for controlling and monitoring a regulated production environment. Exploring new trends and tehnologies of HVAC systems and design for sterile and aseptic manufacturing, barrier and isolation technologies, containment of potent compounds, specific extraction, flammable solvent handling, and using HVAC system as secondary protection of products and operators. Cross-listed with: PME 647, CHE 647

ME 648   Mechanics of Continuous Media   (3 - 3 - 0)

A basically physical approach to the study of continuum Prerequisite: ME 658

ME 651   Analytic Dynamics   (3 - 3 - 0)

Fundamentals of Newtonian mechanics; principle of virtual work; d'Alembert's Principle; Hamilton's Principle; Lagrange's equations; Hamilton's equations; motion relative to moving reference frames; rigid-body dynamics; Hamilton-Jacobi equation; applications.

ME 652   Advanced Additive Manufacturing   (3 - 3 - 0)

This advanced graduate-level course introduces the students to the latest developments in and novel applications of additive manufacturing (AM), a new manufacturing method that adds material layer-by-layer to produce objects. In addition to various advanced AM techniques, the course also discusses the implications of AM on current design practice, products and users. Through several projects, the students gain a deep understanding of advanced AM technologies and related applications.

ME 653   Design for Additive Manufactoring   (3 - 3 - 0)

In this graduate course, the students will develop a rich knowledge and deep understanding of design for additive manufacturing concepts and techniques, along with methods for analyzing and optimizing product designs according to additive manufacturing guidelines. This course is structured around the study of the pertinent technical literature, carrying out design assignments, utilizing software tools and completing a comprehensive term project.

ME 654   Advanced Robotics   (3 - 3 - 0)

Robot path control, dynamics of robot systems, mechanical drive systems; microcomputers, computational architectures, digital control of manipulators; sensors, force and compliance control, vision systems, tactile sensing, range finding and navigation; intelligence and task planning. Prerequisite: ME 598

ME 655   Wearable Robotics and Sensors   (3 - 3 - 0)

Review of introductory robotics and modern control topics. Biomechanics of human locomotion: kinematics and kinetics. Design, analysis, sensing, actuation, and low-level control of robotic exoskeletons and powered orthoses. Finite state machines for powered orthoses. Principles of human cooperative control for rehabilitation and assistance. Model-based and model-free assistive controllers. Machine learning control in wearable robotics. Overview of wearable inertial sensors and applications to motion analysis and wearable robotics. Supervised learning methods for motor task classification and motion analysis. Prerequisite: ME 598

ME 656   Autonomous Navigation for Mobile Robots   (3 - 3 - 0)

Mobile robot geometry, kinematics, and dynamics. Control and estimation for autonomous vehicles. Motion planning, including discrete and continuous methods, and sampling-based planning. Simultaneous localization and mapping, including active SLAM and autonomous exploration with occupancy grids. Markov decision processes and partially observable Markov decision processes with application to mobile robots; planning under uncertainty. Introduction to supervised learning and reinforcement learning, including deep learning. Applications of machine learning to autonomous navigation. Prerequisite: ME 598

ME 657   Advanced Mechanics of Materials   (3 - 3 - 0)

This course introduces mechanical behaviors, properties and modeling approaches for engineering materials including metals, ceramics, polymers, active materials and micro-/nano-scale materials such as thin films, nanowires and nanotubes. It emphasizes the fundamentals of mechanical behaviors including elasticity, plasticity, fatigue, fracture and creep, constitutive relations and modeling tools as well as the special properties of various materials related to their composition and microstructures. It provide a systematical view of engineering materials for product design and manufacturing or material selection for an engineering system at both macro and micro/nano scales.

ME 658   Advanced Mechanics of Solids   (3 - 3 - 0)

Torsion, bending and shear of beams with solid or thin-walled sections; curved beams; shrink fits, pressure vessels, spinning discs; experimental techniques, strain rosettes; buckling of bars, beams, rings, boiler tubes; thermal stress problems; introduction to theory of elasticity.

ME 659   Advanced Structural Design   (3 - 3 - 0)

This course deals with methodologies for designing modern structures and other performance-driven products. The course entails aspects of computer-aided engineering (CAE), integration of CAE and design, methodologies for failure and stability analysis, designing with anisotropic materials such as composites, modeling process-material-performance relationships and the use of such models in design, multidisciplinary design optimization and integrated product design automation. Prerequisites: ME 663, ME 641, ME 658, ME 661

ME 660   Medical Devices Manufacturing   (3 - 3 - 0)

Technical tools and knowledge required to operate and manage in medical devices manufacturing environment. Current requirements in medical devices regulations, quality systems, and design elements related to manufacturing steps to assure patients health and safety. Requirements concerning selection and supply of raw materials and components for manufacturing; design and qualification of facilities, equipment, and process systems; testing, controls and inspection for compliance. Combination products, validation, external contractors, and case studies. Focus on understanding the principles and methods required in a medical devices manufacturing environment in compliance with GMP regulations. Cross-listed with: PME 660

ME 661   Advanced Stress Analysis   (3 - 3 - 0)

Stress analysis of axisymmetric bodies; beams on elastic foundations; introduction to plate theory and fracture mechanics; plasticity; creep and fatigue of engineering materials. Prerequisites: ME 663, ME 641, ME 658

ME 663   Finite-Element Methods   (3 - 3 - 0)

Development of the fundamental equations of finite-element theory, using the matrix displacement approach. Detailed case studies of one-dimensional (truss and beam), two-dimensional (plane stress/strain and axisymmetric solid), k and plate-bending elements are explained. Applications include interactive model building and solutions. Prerequisites: ME 641, ME 658

ME 664   Special Topics in Applied Finite-Element Methods   (3 - 3 - 0)

This course covers the development and application of finite-element theory to (1) fluid structure interaction, (2) large deformations of incompressible material, (3) electromechanical coupling problems, and (4) nonlinear heat transfer with phase change. Prerequisite: ME 663

ME 665   Advanced Product Development   (3 - 3 - 0)

This course addresses methodologies and tools to define product development phases and also provides experience working in teams to design high-quality competitive products. Primary goals are to improve ability to reason about design, material and process alternatives and apply modeling techniques appropriate for different development phases, as well as development of competitive product design and plans for its manufacture along with facilities layout simulation, testing and service. Topics covered are: user requirements gathering, quality function deployment (QFD), design for assembly, design for materials and manufacturing processes, optimizing the design for cost and producibility, manufacturing process specifications and planning, process control and optimization, SPC and six sigma process, tolerance analysis, flexible manufacturing, product testing and rapid prototyping.

ME 668   Engineering Fracture Mechanics   (3 - 3 - 0)

Fracture energy, linear elastic fracture mechanics, stress intensity factor, crack opening displacement (COD), fracture mechanics in design, elastic plastic fracture mechanics, numerical methods in fracture mechanics, introduction to fatigue, fatigue crack initiation, fatigue crack propagation.

ME 669   Theory of Plasticity   (3 - 3 - 0)

Fundamentals of elasticity and plasticity, yield criteria, plastic stress-strain relations, theories of work hardening. Extremum principles. Application to problems of bending, torsion, plane stress and plane strain. Slip line and limit analysis. Prerequisite: ME 658

ME 674   Fluid Dynamics   (3 - 3 - 0)

Stress in a continuum; kinematics of fluid motion; rate of strain and vorticity; relation between stress and rate of strain; the Navier-Stokes equations; inviscid flow; stream function, velocity potential and circulation; Kelvin and Helmholtz theorems; two-dimensional incompressible flows; the Kuta-Joukowski theorem; introduction to compressible flows, boundary layers and drag-on bodies. Prerequisite: ME 641

ME 675   Computational Fluid Dynamics and Heat Transfer   (3 - 3 - 0)

Computational techniques for solving problems in fluid flow and heat transfer; review of governing equations for fluid flow, special topics in numerical analysis, algorithms for incompressible flow, treatment of complicated geometrical constraints. Prerequisites: ME 594, ME 674

ME 678   Viscous and Turbulent Flows   (3 - 3 - 0)

Fundamental equations of viscous flow; solutions of the Newtonian viscous flow equations; laminar boundary layers; stability of laminar flows; fluid turbulence and approximate solutions.

ME 679   Mechanics of Compressible Fluids   (3 - 3 - 0)

Pressure wave propagation; one-dimensional flow; isentropic flow, adiabatic flow, diabatic flow, real and ideal flow in nozzles and diffusers; normal shock, Rankine-Hugoniot relation; flow in constant area ducts with friction; flow in ducts with heating and cooling; Fanno, Rayleigh and Busemann lines; generalized one-dimensional continuous flow; unsteady one-dimensional flow; method of characteristics.

ME 680   Fundamentals of Micro/Nano Fluidics   (3 - 3 - 0)

As an introduction to micro/nano fluidics, course topics include basic fluid mechanical theories, experimental techniques, fabrication techniques and applications of micro/nano fluidics. The theory part will cover continuum fluid mechanics at micro/nano scales, molecular approaches, capillary effects, electrokinetic flows, acoustofluidics and optofluidics. The experimental part will cover micro/nano rheology and particle image velocimetry. The fabrication part will cover materials and machining techniques for micro/nano fluidic devices. The application part will cover micro/nano fluidic devices for flow control, life sciences and chemistry. As a term project, individual students are required to perform a case study for their own selected topic in micro/nano fluidics, to conduct a literature survey/summary and to propose/analyze their own new design idea of a micro/nano fluidic devices by utilizing the knowledge obtained throughout the course. Cross-listed with: NANO 680

ME 681   Applications of Advanced Micro/Nano Materials, Structures and Devices   (3 - 3 - 0)

The goals of this course are to go beyond the introduction stage in Micro-Electro-Mechanical Systems (MEMS) and Nano-Electro-Mechanical Systems (NEMS) to provide students with a strong background in the design and characterization of micro- and nano-scale sensors and actuators with a broad range of applications in VNT-based sensors, actuators and devices, biomedical systems, micro- and nanoscale manipulation, adaptive optics, and microfluidics. The main focus is on the fundamental challenges and limitations involved in designing and demonstrating micro and nano devices and systems. Prerequisites: ME 573, ME 581 or equivalents

ME 682   Advanced Nanofabrication for Nanoelectronics   (3 - 3 - 0)

This course will address the basic concepts of nanoelectronics, including fundamental principles, novel electronic materials, novel fabrication techniques and devices. In particular, it will focus on novel nanofabrication techniques including nanolithography, growth and assembly processes, and characterization techniques to validate its fabrication process related to the area of Nanoelectronics. It will also address the technical issues to develop nano-scale elements/devices including single electron devices, carbon nanotubes as interconnects or transistors, nanowires, graphene materials and devices, spintronic applications and eventually complex organic molecules as memory and logic units. Prerequisite: ME 573

ME 684   Multiphase Flows   (3 - 3 - 0)

Fundamental principles of two-phase gas-liquid flow and associated heat transfer as applied to power, chemical, petrochemical, and process industries; topics include: flow patterns, homogeneous and separated flow models, two-phase pressure drops, drift-flux model, critical flow, flooding, nucleation theory, pool and flow boiling, critical heat flux, post-critical heat flux, heat transfer, condensation, and thermal-hydraulic instabilities. Prerequisites: ME 674, ME 601

ME 690   Cell Mechanics   (3 - 3 - 0)

This course is designed to introduce the students to the theoretical and experimental approaches to understanding the architecture and mechanics of cellular biology. Emphasis is placed on the mechanical analysis of cytoskeletal filaments, membranes and adhesions as well as the various instrumentation tools used for in vitro characterization of these cell components and phenomena. Also explored are the various models used to describe cell mechanics and the role of converting a mechanical perturbation into a biological cell response, i.e. mechanotransduction in normal physiology. Knowledge of basic cell biology is not assumed and will be systematically reviewed.

ME 691   Additive Manufacturing for Biological Systems   (3 - 3 - 0)

Computer-Aided Tissue Engineering is designed for engineering students interested in acquiring the knowledge and skills necessary to implement enabling computer-aided tools for medical implant design, manufacturing and tissue engineering applications. The students will be introduced to topics on how engineering and biology intersect in biomedical implant design and manufacturing. The 3D modeling, image-based reconstruction and analysis exercises will prepare the student with hands-on sessions on state-of-the-art software and hardware technologies used by leading medical device companies and by the tissue engineering research community. No knowledge in biology is required for this course.

ME 692   Biomechanics of the Brain   (3 - 3 - 0)

The brain is our most complex organ, yet it is also the least well-understood. Especially the role of mechanics remains understudied despite several relevant applications, including brain growth and folding during development, traumatic brain injury, surgical intervention, and structural changes associated with aging and neurodegenerative diseases. In this course, fundamental concepts of mechanics such as continuum mechanics, viscoelasticity, growth, buckling, and mechanical experimentation will be used to understand the relation between brain function and form in health and disease. Students will be exposed to advanced concepts of the physiology and mechanical assessment of the nervous system. Learning materials will include lecture presentations, literature reviews, experimental data, and homework assignments. The course will conclude with a final project that may be a literature review, experimental study, or computational study and includes a project report. Cross-listed with BME 692

ME 700   Seminar in Mechanical Engineering   (0 - 1 - 0)

Presentations and discussions by advanced graduate students on selected topics.

ME 701   ME Co-Op Education Project   (0 - 0 - 0)

This course is for ME graduate students who are on Co-Op assignment.

ME 702   Curriculum Practical Training   (1 - 0 - 0)

International graduate students may arrange an internship or paying position off campus and receive Curricular Practical Training (CPT) credit via this course provided that the course constitutes and integral part of their educational program. Students must maintain their full time status while receiving CPT. Prior approval of the program director is required for enrollment. To justify enrollment, the student must have a concrete commitment from a specific employer for a specific project, and must provide to the program director for his/her approval a description of the project plus a statement from the employer that he/she intends to employ the student. This information must be provided to the program director with sufficient advance notice so that the program director has time to review the materials and determine if the project is appropriate. During the semester, the student must submit written progress reports. At the end of the semester, the student must submit for grading a written report that describes his/her activities during that semester, even if the activity remains ongoing. This is a one-credit course that may be repeated up to a total of three credits.

ME 799   Practicum for Graduate Students   (1 - 0 - 0)

Special problem intended for students pursuing Curricular Practical Training.

ME 800   Special Problems in Mechanical Engineering (ME)

3 credits for the degree of Master of Engineering (Mechanical).

ME 801   Special Problems in Mechanical Engineering (PhD)

3 credits for the degree of Doctor of Philosophy.

ME 802   Special Problems in Mechanical Engineering (Deg ME)

3 credits for the degree of Mechanical Engineer.

ME 810   Special Topics in Mechanical Engineering   (3 - 3 - 0)

A participating seminar on topics of current interest and importance in Mechanical Engineering.

ME 900   Thesis in Mechanical Engineering

For the degree of Master of Engineering (Mechanical). Hours and credits to be arranged.

ME 950   Mechanical Engineering Design Project

Design project for the degree of Mechanical Engineer. 12 credits with advisor approval.

ME 960   Research in Mechanical Engineering

Original work, which may serve as the basis for the dissertation, required for the degree of Doctor of Philosophy. Hours and credits to be arranged.

Integrated Product Development

IPD 601   Integrated Product Development I   (3 - 3 - 0)

The first IPD course addresses methodologies and tools to define product development phases and also provides experience working in teams to design high-quality competitive products. Primary goals are to improve ability to reason about design, material, and process alternatives and apply modeling techniques appropriate for different development phases. Topics covered are: user requirements gathering, quality function deployment (QFD), design for assembly, design for materials and manufacturing processes, and optimizing the design for cost and producibility.

IPD 602   Integrated Product Development II   (3 - 3 - 0)

This course builds on the product definition and development processes. It focuses on the implementation of competitive product design and plans for its manufacture along with facilities layout simulation, testing, and service. Project deliverables are comprehensive product, process and testing specifications. Topics include: manufacturing process specifications and planning, process control and optimization, SPC and six sigma process, tolerance analysis, flexible manufacturing, product testing, and rapid prototyping. Prerequisite: IPD 601

IPD 611   Modeling and Simulation   (3 - 3 - 0)

This course emphasizes the development of modeling and simulation concepts and analysis skills necessary to design, program, implement and use computers to solve complex systems/products analysis problems. The key emphasis is on problem formulation, model building, data analysis, solution techniques and evaluation of alternative designs/processes in complex systems/products. Overview of modeling techniques and methods used in decision analysis, including multi-attribute utility models, decision trees, and optimization methods are discussed. Cross-listed with: ME 635

IPD 612   Project Management and Organizational Design   (3 - 3 - 0)

This project-based course exposes students to tools and methodologies useful for forming and managing an effective engineering design team in a business environment. Topics covered will include: personality profiles for creating teams with balanced diversity; computational tools for project coordination and management; real time electronic documentation as a critical design process variable; and methods for refining project requirements to ensure that the team addresses the right problem with the right solution. Cross-listed with: ME 636

IPD 810   Special Topics in Integrated Product Development   (3 - 3 - 0)

A participating seminar on topics of current interest and importance in Integrated Product Development.

Pharmaceutical Manufacturing

PME 530   Introduction to Pharmaceutical Manufacturing   (3 - 3 - 0)

Pharmaceutical manufacturing is vital to the success of the technical operations of a pharmaceutical company. This course is approached from the need to balance company economic considerations with the regulatory compliance requirements of safety, effectiveness, identity, strength, quality, and purity of the products manufactured for distribution and sale by the company. Overview of chemical and biotech process technology and equipment; dosage forms and finishing systems; facility engineering; health, safety, and environment concepts; and regulatory issues. Cross-listed with: ME 530, CHE 530

PME 531   Process Safety Management   (3 - 3 - 0)

This course reviews the 12 elements of the Process Safety Management (PSM) model created by the Center for Chemical Process Safety of the American Institute of Chemical Engineers. PSM systems were developed as an expectation/demand of the public, customers, in-plant personnel, stockholders, and regulatory agencies because reliance on chemical process technologies were not enough to control, reduce, and prevent hazardous materials incidents. PSM systems are comprehensive sets of policies, procedures, and practices designed to ensure that barriers to major incidents are in place, in use, and effective. The objectives of this course are to: define PSM and why it is important, describe each of the 12 elements and their applicability, identify process safety responsibilities, give real examples and practical applications to help better understand each element, share experiences and lessons learned of all participants, and assess the quality and identify enhancements to a student's site PSM program. Cross-listed with: CHE 531 and ME 531

PME 535   Good Manufacturing Practice in Pharmaceutical Facilities Design   (3 - 3 - 0)

Current Good Manufacturing Practice compliance issues in design of pharmaceutical and biopharmaceutical facilities; issues related to process flow, material flow and people flow, and A&E mechanical, industrial, HVAC, automation, electrical, and computer; bio-safety levels; developing effective written procedures so that proper documentation can be provided, and then documenting through validation that processes with a high degree of assurance do what they are intended to do; levels I, II, and III policies; clinical phases I, II, and III, and their effect on plant design; defending products against contamination; and building quality into products. Cross-listed with: ME 535 and CHE 535

PME 540   Validation in Life Sciences Manufacturing   (3 - 3 - 0)

Validation of a pharmaceutical manufacturing process is an essential requirement with respect to compliance with Good Manufacturing Practices (GMP). Course covers: validation concepts for process, equipment, facility, cleaning, sterilization, filtration, analytical methods and computer systems; validation Master Plans, IQ, OQ, and PPQ protocols; and validation for medical devices. Cross-listed with: ME 540, CHE 540

PME 541   Validation of Computerized Systems   (3 - 3 - 0)

Computers and computerized systems are ubiquitous in pharmaceutical manufacturing. Validation of these systems is essential to assure public safety and compliance with appropriate regulatory issues regarding validation: GMP, GCP, 21CFR Part 11, etc. This course covers validation concepts for various classes of computerized systems and applications used in the pharmaceutical industry; importance of requirements engineering in validation; test protocols and design; organizational maturity considerations. Cross-listed with: ME 541 Prerequisite: PME 540

PME 542   Global Regulation and Compliance in Life Science Industries   (3 - 3 - 0)

This course explores the economic theory of regulation in general, and the US and international regulatory environments that govern the pharmaceutical and biotechnology industries with particular focus on the US Food and Drug Administration, the European Agency for the Evaluation of Medical Products and the Japanese Ministry of Health, Labor and Welfare. The essential components of Good Laboratory Practices, Good Clinical Practices, and Good Manufacturing Practices regulations will be covered. Students will develop an understanding of the formulation and execution of regulatory strategy and key ethical issues in medical research and production. Where appropriate, case studies will be used to illustrate the challenges and issues associated with compliance as well as the consequences of noncompliance. Ethical issues and the potential consequences of ethical lapses will also be explored. Current events will be used to illustrate key ethical principles and serve as a basis for discussion.

PME 555   Lean Six Sigma   (3 - 3 - 0)

Course explores the current application of Lean Six Sigma in Manufacturing. Topics covered include: Lean Six Sigma Concepts and Techniques, Project and Team Dynamics, Tools of Lean Six Sigma and their Application, and Designing Manufacturing Processes for Lean Six Sigma. Emphasis is on DMAIC, including Define, Measure, Analyze, Improve, and Control methodology, with the students' skill set developed through case studies and project work on actual manufacturing processes using statistical software (Minitab). At the conclusion of this course, students will understand the concepts and principles of Lean Six Sigma, be competent with Minitab software and be able to apply these techniques to manufacturing processes. Cross-listed with: ME 555

PME 560   Quality in Life Sciences Manufacturing   (3 - 3 - 0)

This course provides a detailed exploration of quality programs with specific application to the particular requirements of the pharmaceutical industry. Students will develop an understanding of the quality philosophy which drives the industry from discovery through manufacturing, and of the systems and tools that are employed to implement and maintain a sustainable and successful quality system. Application of quality strategies in research and development, commercial production, computer systems, post-marketing, and other areas will be included. Where appropriate, case studies will be used to illustrate the challenges and issues associated with quality system deployment.

PME 580   Medical Device Design and Technology   (3 - 3 - 0)

Early history of medical devices and procedures. Minimally invasive and open procedures, techniques and devices, including mechanical and electrosurgical devices. Manufacturing methods for catheters, balloons, plastic and metal components. Design of metal device components including material selection and strength and deformation adequacy using material properties and classical mechanics. Selection of insulation materials for and testing of electrosurgical devices. Selection of medical plastics and design elements. Balloon and catheter burst strength. The Poiseuille flow equation and its use for fluid flow through catheters and vessels. Rapid prototyping techniques, advantages and limitations. Understanding of biocompatibility testing and accelerated age testing using the Arrhenius equation. Device sterilization methods and testing. Developing a project plan from brainstorming to product release for a new device. Cross-listed with: ME 580

PME 600   Engineering Economics and Cost Analysis   (3 - 3 - 0)

This course presents advanced techniques and analysis designed to permit managers to estimate and use cost information in decision making. Topics include: historical overview of the management accounting process, statistical cost estimation, cost allocation, and uses of cost information in evaluating decisions about pricing, quality, manufacturing processes (e.g., JIT, CIM), investments in new technologies, investment centers, the selection process for capital investments, both tangible and intangible, and how this process is structured and constrained by the time value of money, the source of funds, market demand, and competitive position. Cross-listed with: EM 600

PME 602   Statistical Methods in Life Science Industries   (3 - 3 - 0)

This course is focused on the application of statistics and statistical reasoning in pharmaceutical manufacturing, particularly in production, quality assurance, quality control, validation and analytical laboratories. Basic statistical definitions and concepts are described. Students will learn various measures of central tendency and spread of data, how to present data graphically and be introduced to the probability distributions most commonly encountered in pharmaceutical manufacturing. Approaches to choosing samples for analysis, statistical inference, sample size and power will be discussed. The course also covers regression and correlation, analysis of variance, gage repeatability and reproducibility, statistical process control, process capability analysis and design of experiments as applied to pharmaceutical manufacturing. Students will learn to apply statistical software to analyze common problems that arise in pharmaceutical manufacturing operations, including evaluation of dosage form weight and content uniformity, potency, dissolution, bio-equivalency and other product quality attributes.

PME 609   Introduction to Project Management   (3 - 3 - 0)

This course deals with the problems of managing a project, which is defined as a temporary organization of human and non-human resources, within a permanent organization, for the purpose of achieving a specific objective; both operational and conceptual issues will be considered. Operational issues include definition, planning, implementation, control and evaluation of the project. Conceptual issues include project management vs. hierarchical management, matrix organization, project authority, motivation and morale. Cases will be used to illustrate problems in project management and how to resolve them.

PME 626   Manufacturing of Biopharmaceutical Products   (3 - 3 - 0)

This course is focused on topics related to the technology, design and operations of modern biopharmaceutical facilities. It covers process, utilities and facility design issues and encompasses all major manufacturing areas, such as fermentation, harvest, primary and final purification, media and buffer preparation, equipment cleaning and sterilization, critical process utilities, unit operations including cell culture, centrifugation, conventional and tangential flow filtration, chromatography, solution preparation, and bulk filling. The application of current Good Manufacturing Practices and Bioprocessing Equipment Standards will be discussed. Prerequisite: PME 530 or ME 530 or CHE 530

PME 628   Manufacturing and Packaging of Pharmaceutical Oral Solid Dosage Products   (3 - 3 - 0)

The course covers oral solid dosage (OSD) manufacturing and packaging in the pharmaceutical industry. Production unit operations include blending, granulation, size reduction, drying, compressing, and coating for tablets, as well as capsule filling. Packaging aspects reviewed include requirements for primary and secondary containers and labeling, package testing. The course emphasizes design, scale-up, trouble-shooting, validation, and operation of typical OSD manufacturing and packaging facilities, including equipment, material flow, utilities, and quality assurance. Topics related to cGMP, process validation, manufacturing and packaging documentation, QA and QC in OSD manufacturing will be presented. The term project required for this course involves conceptual design of a contract manufacturing and packaging facility for OSD products, including equipment selection, development of the process flow diagrams, room layouts and other design elements, as well as preparation of Standard Operating Procedures for various unit operations. Cross-listed with: ME 628 Prerequisites: PME 530, ME 530, CHE 530

PME 629   Manufactoring of Sterile Pharmaceuticals   (3 - 3 - 0)

This course is focused on the special characteristics and types of sterile dosage forms and the technologies for their manufacturing. Topics such as environmental and contamination controls, facility design, water and air quality, personnel and other requirements for sterile manufacturing are covered. Sterilization methods for the equipment, components, intermediate and finished products are reviewed. Terminal sterilization and aseptic processing technologies including blow-fill-seal and barrier isolation systems are discussed. The course also includes topics such as Good Manufacturing Practices (GMP) regulations and guidance on aseptic manufacturing, quality assurance and control, stability, storage and distribution applicable to sterile dosage forms manufacturing. Prerequisite: CHE 530 or ME 530 or PME 530

PME 639   Modeling and Simulation of Pharmaceutical Manufacturing Systems   (3 - 3 - 0)

This course will introduce students to modeling and simulation applications in pharmaceutical manufacturing. The fundamentals of discrete event simulation and the use of commercially available software to develop models of various manufacturing and service systems will be introduced. Approaches to the development of conceptual and computer models, data collection and analysis, model verification and validation, and simulation output analysis will be discussed. The modeling of chemical, biochemical and separation processes in pharmaceutical manufacturing using process simulation software will be presented. Material balances, stream reports, operations and equipment Gantt charts will be developed and process debottlenecking and cost analysis will be conducted. Cross-listed with: ME 639, CHE 639

PME 647   Environmental Systems (HVAC) in Healthcare Manufacturing

Proven techniques and creative tools presented for design, development, and delivery of Environmental Systems necessary for the control and monitoring of classified spaces to manufacture drugs, medical devices, and research labs with potent or biologic compounds. Obtain knowledge of pharmaceutical environmental requirements, understanding of theories and principles of operation for Heating, Ventilating, and Air Conditioning (HVAC) equipment and system configurations to satisfy regulatory acceptance criteria, gaining practical knowledge of environmental system design and implementation including validation that suppots drug production. Course also incudes Building Automation Systems conceptual design and application for controlling and monitoring a regulated production environment. Exploring new trends and tehnologies of HVAC systems and design for sterile and aseptic manufacturing, barrier and isolation technologies, containment of potent compounds, specific extraction, flammable solvent handling, and using HVAC system as secondary protection of products and operators. Cross-listed with: ME 647, CHE 647

PME 660   Medical Devices Manufacturing   (3 - 3 - 0)

Technical tools and knowledge required to operate and manage in medical devices manufacturing environment. Current requirements in medical devices regulations, quality systems, and design elements related to manufacturing steps to assure patients health and safety. Requirements concerning selection and supply of raw materials and components for manufacturing; design and qualification of facilities, equipment, and process systems; testing, controls and inspection for compliance. Combination products, validation, external contractors, and case studies. Focus on understanding the principles and methods required in a medical devices manufacturing environment in compliance with GMP regulations. Cross-listed with: ME 660 Prerequisites: PME 530, and PME 535

PME 701   PME Co-Op Education Project   (0 - 0 - 0)

This course is for PME graduate students who are on Co-Op assignment.

PME 800   Specical Problems in Pharmaceutical Manufacturing and Engineering

A participating seminar on topics of current interest and importance in Pharmaceutical Manufacturing Practices

PME 810   Special Topics in Pharmaceutical Manufacturing Practices

A participating seminar on topics of current interest and importance in Pharmaceutical Manufacturing Practices

PME 900   Thesis in Pharmaceutical Manufacturing and Engineering

Under the supervision of a faculty advisor, students are responsible for the preparation and completion of an independent thesis project. Hours and credits to be arranged.

Department of Physics

FACULTY

TING YU, PH.D.
DEPARTMENT CHAIR

Yuping Huang, Ph.D.
Associate Professor

Wei Li, M.S.
Research Associate Professor

Ting Lu, Ph.D.
Lecturer

Vladimir Lukic, Ph.D.
Associate Teaching Professor

Svetlana Malinovskaya, Ph.D.
Associate Professor

Rainer Martini, Ph.D.
Associate Professor and
Associate Dean for Graduate Studies

Robert Pastore, Ph.D.
Senior Lecturer

Igor Pikovski, Ph.D.
Assistant Professor

Xiaofeng Qian, Ph.D.
Assistant Professor

Chunlei Qu, Ph.D.
Assistant Professor

Christopher Search, Ph.D.
Associate Professor and
Associate Chair for Undergraduate Studies

Knut Stamnes, Ph.D.
Professor

Stefan Strauf, Ph.D.
Professor

Edward Whittaker, Ph.D.
Professor

EMERITUS FACULTY

James Anderson, Ph.D.
Professor Emeritus

E. Brucker, Ph.D.
Professor

Norman Horing, Ph.D.
Professor Emeritus

Earl Koller, Ph.D.
Professor Emeritus

UNDERGRADUATE PROGRAMS

The laws of physics govern the universe from the formation of stars and galaxies, to the processes in the Earth's atmosphere that determine our climate, to the elementary particles and their interactions that hold together atomic nuclei. Physics also drives many rapidly-advancing technologies, such as information technology, telecommunication, nanoelectronics, and medical technology, including MRI imaging and laser surgery.

The physics program at Stevens combines classroom instruction with hands-on research experience in one of several state-of-the-art research laboratories (Laboratory for Quantum Enhanced Systems and Technology, Photonics Science and Technology, Optical Communication and Nanodevices, Quantum Electron Science and Technology, NanoPhotonics, Light and Life, or Ultrafast Spectroscopy and Communication). Perhaps the most differentiating feature of the Stevens physics curriculum is SKIL (Science Knowledge Integration Ladder), a six-semester sequence of project-centered courses. This course sequence lets students work on projects that foster independent learning, innovative problem solving, collaboration and team work, and knowledge integration under the guidance of a faculty advisor. The SKIL sequence starts in the sophomore year with projects that integrate basic scientific knowledge and simple concepts. In the junior and senior years, the projects become more challenging and the level of independence increases.

Bachelor of Science in Physics

Our Bachelor of Science in Physics is accredited by the Middle States Accreditation Board. Our graduates have a wide range of career opportunities beyond the pursuit of a traditional graduate degree in physics, including employment in a variety of other industries, such as telecommunications, optics, finance, medical technology, or defense. Those who choose to further their education pursue graduate studies both in physics and engineering. Qualified students are encouraged to participate in faculty-supervised research projects.

Possible technical electives during the later semesters to ensure a complete undergraduate curriculum:

- PEP 501 Fundamentals of Atomic Physics (3-0-3)
- PEP 503 Introduction to Solid State Physics (3-0-3)
- PEP 506 Modern Astrophysics and Cosmology (3-0-3)
- PEP 507 Introduction to Microelectronics and Photonics (3-0-3)
- PEP 509 Intermediate Waves and Optics (3-0-3)
- PEP 510 Modern Optics Lab (0-3-3)
- PEP 520 Computational Physics (3-0-3)
- PEP 555 Statistical Physics and Kinetic Theory (3-0-3)
- PEP 552 Theory of Relativity (3-0-3)
- PEP 556 Introduction to Quantum Control (3-0-3)
- PEP 557 Quantum Information and Quantum Computation (3-0-3)
- PEP 577 Laser Theory and Design (3-0-3)
- PEP 578 Laser Applications and Advanced Optics (3-0-3)
- PEP 579 Nonlinear Optics (3-0-3)

Other physics courses, needed in order to complete a concentration, may be substituted with the consent of your advisor.

Physics Curriculum

Term I

Course #	Course Name	Lecture	Lab	Study	Credit
CH 115	General Chemistry I	3	0	6	3
CH 117	General Chemistry Laboratory I	0	3	1	1
CS 105	Introduction to Scientific Computing[1]	2	2	6	3
MA 121; MA 122	Differential Calculus; Integral Calculus	4	0	8	4
PEP 111	Mechanics	3	0	6	3
CAL 103	Writing And Communications Colloquium	3	0	6	3
	Total	**15**	**5**	**33**	**17**

Term II

Course #	Course Name	Lecture	Lab	Study	Credit
CH 116	General Chemistry II	3	0	6	3
CH 118	General Chemistry Laboratory II	0	3	1	1
BIO 281	Biology and Biotechnology	3	0	6	3
MA 123; MA 124	Series, Vectors, Functions, and Surfaces; Calculus of Two Variables	4	0	8	2
PEP 112	Electricity and Magnetism	3	0	6	3
CAL 105	CAL Colloquium: Knowledge, Nature, Culture	3	0	6	3
	Total	**16**	**3**	**33**	**17**

Term III

Course #	Course Name	Lecture	Lab	Study	Credit
	Humanities[4]	3	0	6	3
MA 221	Differential Equations	4	0	8	4
PEP 209	Modern Optics	3	0	6	3
PEP 221	Physics Lab I for Scientists	0	3	1	1
PEP 297	SKIL I	1	3	4	2
E 245	Circuits and Systems[2]	2	3	7	3
PE 200	Physical Education I	0	2	0	0
	Total	**13**	**11**	**32**	**16**

Term IV

Course #	Course Name	Lecture	Lab	Study	Credit
	Humanities[4]	3	0	6	3
MA 227	Multivariable Calculus	3	0	6	3
PEP 222	Physics Lab II for Scientists	0	3	1	1
PEP 242	Modern Physics	3	0	6	3
PEP 298	SKIL II	1	3	4	2
PEP 330	Intro to Thermal & Statistical Physics	3	0	0	3
MA 222	Probability and Statistics	3	0	6	3
	Total	**16**	**6**	**29**	**18**

Term V

Course #	Course Name	Lecture	Lab	Study	Credit
	Humanities[4]	3	0	6	3
PEP 527	Math Methods for Science and Engineering I	3	0	6	3
PEP 538	Introduction to Mechanics[2]	3	0	0	3
PEP 397	SKIL III	1	6	0	3
G.E.	General Elective[5]	3	0	6	3
	Total	**13**	**6**	**18**	**15**

Term VI

Course #	Course Name	Lecture	Lab	Study	Credit
	Humanities[4]	3	0	6	3
PEP 542	Electromagnetism	3	0	6	3
PEP 398	SKIL IV	1	6	5	3
G.E.	General Elective[5]	3	0	6	3
BT 243 Or BT 244	Macroeconomics Or Microeconomics	3	0	6	3
	Total	**13**	**6**	**29**	**15**

Term VII

Course #	Course Name	Lecture	Lab	Study	Credit
	Humanities[4]	3	0	6	3
PEP 553	Quantum Mechanics and Engineering Applications	3	0	6	3
PEP 497	SKIL V[2,3]	1	6	5	3
G.E.	General Elective[5]	3	0	6	3
T.E.	Technical Elective[2]	3	0	3	3
	Total	**13**	**6**	**26**	**15**

Term VIII

Course #	Course Name	Lecture	Lab	Study	Credit
	Humanities[4]	3	0	6	3
T.E.	Technical Elective[2]	3	0	6	3
PEP 498	SKIL VI[2,3]	1	6	5	3
T.E.	Technical Elective[2]	3	0	3	3
T.E.	Technical Elective[2]	3	0	6	3
	Total	13	6	26	15

(1) Or CS 115, Intro. to Computer Science.

(2) PEP 497 and PEP 498 are recommended technical electives that may be replaced with other technical electives in consultation with an advisor.

(3) SKIL V and SKIL VI can be a year-long Senior Project resulting in a final report or a thesis.

(4) Humanities electives can be found on pages 568-569.

(5) General Elective: chosen by the student- can be used towards a minor or option- can be applied to research or approved international studies

Bachelor of Science in Engineering Physics (EP)

The Department of Physics and Engineering Physics also offers an undergraduate Engineering Physics (EP) Program, which leads to a Bachelor of Science in Engineering Physics in three concentrations: Applied Optics, Microelectronics and Photonics, and Atmospheric and Environmental Science. The program aims to attract students who are intrigued by the possibility of combining a mastery of basic physics concepts with exposure to state-of-the-art engineering technology in selected high-tech areas. The EP Program is a special program that was developed jointly by the Department of Physics and Engineering Physics and the School of Engineering and Science. Students in the EP Program follow a special core curriculum that provides the basic concepts of engineering together with a basic understanding of physical phenomena at a microscopic level and lets them explore the relation of the physics concepts to practical problems of engineering in one of three high-tech areas of concentration: These concentrations represent areas of significant current local and global technological and economic interest. The PEP department has both research strengths and educational expertise in these areas where there is significant growth potential. For all concentrations, required and/or elective courses offered by other departments (EE, EN, and MT) can be used to complement departmental course offerings, which provide the students in the program with the necessary diversity, breadth, and depth of educational offerings and research opportunities. The following curriculum shows the common two years and then the final two years separately for each concentration.

Engineering Physics (EP) - Applied Optics Curriculum

Term I

Course #	Course Name	Lecture	Lab	Study	Credit
CH 115	General Chemistry I	3	0	6	3
CH 117	General Chemistry Laboratory I	0	3	1	1
PEP 111	Mechanics	3	0	6	3
E 115	Introduction to Programming	1	2	3	2
E 120	Engineering Graphics	0	2	1	1
E 121	Engineering Design I: Introduction to Systems Thinking	0	3	2	2
MA 121; MA 122	Differential Calculus; Integral Calculus	4	0	8	4
CAL 103	Writing And Communications Colloquium	3	0	6	3
	Total	**14**	**10**	**33**	**19**

Term II

Course #	Course Name	Lecture	Lab	Study	Credit
CH 116	General Chemistry II	3	0	6	3
CH 118	General Chemistry Laboratory II	0	3	1	1
PEP 112	Electricity and Magnetism	3	0	6	3
MA 123; MA 124	Series, Vectors, Functions, and Surfaces; Calculus of Two Variables	4	0	8	2
E 122	Engineering Design II: Field Sustainable Systems with Sensors	0	3	3	2
CAL 105	CAL Colloquium: Knowledge, Nature, Culture	3	0	6	3
	Total	**13**	**6**	**30**	**16**

Term III

Course #	Course Name	Lecture	Lab	Study	Credit
	Humanities	3	0	6	3
MA 221	Differential Equations	4	0	8	4
E 245	Circuits and Systems	2	3	7	3
PEP 221	Physics Lab I for Scientists	0	3	1	1
PEP 209	Modern Optics	3	0	6	3
PEP 297	SKIL I	1	3	4	2
	Total	**13**	**9**	**32**	**16**

Term IV

Course #	Course Name	Lecture	Lab	Study	Credit
	Humanities	3	0	6	3
MA 227	Multivariable Calculus	3	0	6	3
PEP 222	Physics Lab II for Scientists	0	3	1	1
PEP 242	Modern Physics	3	0	6	3
PEP 298	SKIL II	1	3	4	2
PEP 330	Intro to Thermal & Statistical Physics	3	0	0	3
	Total	**13**	**6**	**23**	**15**

Term V

Course #	Course Name	Lecture	Lab	Study	Credit
	Humanities	3	0	6	3
PEP 527	Math Methods for Science and Engineering I	3	0	6	3
PEP 538	Introduction to Mechanics	3	0	0	3
PEP 397	SKIL III	1	6	0	3
E 243	Probability and Statistics for Engineers	3	0	6	3
C.T.E.	Concentration Technical Elective[1]	3	0	3	3
	Total	**16**	**6**	**21**	**18**

Term VI

Course #	Course Name	Lecture	Lab	Study	Credit
PEP 542	Electromagnetism	3	0	6	3
PEP 509	Intermediate Waves and Optics	3	0	6	3
PEP 398	SKIL IV	1	6	5	3
	Humanities	3	0	6	3
BT 243 Or BT 244	Macroeconomics Or Microeconomics	3	0	3	3
	Total	**13**	**6**	**26**	**15**

Term VII

Course #	Course Name	Lecture	Lab	Study	Credit
	Humanities	3	0	6	3
PEP 553	Quantum Mechanics and Engineering Applications	3	0	6	3
PEP 510	Modern Optics Lab	3	0	0	3
PEP 577	Laser Theory and Design	3	0	0	3
PEP 497	SKIL V	1	6	5	3
	Total	**13**	**6**	**17**	**15**

Term VIII

Course #	Course Name	Lecture	Lab	Study	Credit
	Humanities	3	0	6	3
C.T.E.	Concentration Technical Elective[1]	3	0	6	3
C.T.E.	Concentration Technical Elective[1]	3	0	0	3
PEP 498	SKIL VI	1	6	5	3
G.E.	General Elective	3	0	6	3
	Total	**13**	**6**	**23**	**15**

(1) Possible concentration technical electives (C.T.E.'s): PEP 515, PEP 516, PEP 528, PEP 554, PEP 570, PEP 578, PEP 579, PEP 679, PEP 680, EE 626 (with consent of the instructor) and PEP 678 (with consent of the instructor).

Microelectronics and Photonics Curriculum

Term V

Course #	Course Name	Lecture	Lab	Study	Credit
PEP 507	Introduction to Microelectronics and Photonics	3	0	0	3
PEP 527	Math Methods for Science and Engineering I	3	0	0	3
PEP 538	Introduction to Mechanics	3	0	0	3
PEP 397	SKIL III	1	6	0	3
E 243	Probability and Statistics for Engineers	3	0	6	3
	Humanities	3	0	6	3
	Total	**16**	**6**	**12**	**18**

Term VI

Course #	Course Name	Lecture	Lab	Study	Credit
PEP 542	Electromagnetism	3	0	6	3
PEP 596	Micro-Fabrication Techniques	3	0	6	3
PEP 398	SKIL IV	1	6	5	3
BT 243 Or BT 244	Macroeconomics Or Microeconomics	3	0	3	3
	Humanities	3	0	6	3
	Total	**13**	**6**	**26**	**15**

Term VII

Course #	Course Name	Lecture	Lab	Study	Credit
	Humanities	3	0	6	3
PEP 553	Quantum Mechanics and Engineering Applications	3	0	6	3
PEP 515	Photonics I	3	0	0	3
PEP 561	Solid State Electronics for Engineering I	3	0	0	3
PEP 497	SKIL V	1	6	5	3
	Total	**13**	**6**	**17**	**15**

Term VIII

Course #	Course Name	Lecture	Lab	Study	Credit
	Humanities	3	0	6	3
PEP 516	Photonics II[1]	3	0	0	3
PEP 562	Solid State Electronics for Engineering II[1]	3	0	6	3
PEP 498	SKIL VI	1	6	5	3
G.E.	General Elective	3	0	6	3
	Total	**13**	**6**	**23**	**15**

(1) May be substituted with the following concentration technical electives: PEP 503, PEP 595, PEP 628, and PEP 678 (with consent of the instructor)

Atmospheric and Environmental Science Curriculum

Term V

Course #	Course Name	Lecture	Lab	Study	Credit
C.T.E.	Concentration Technical Elective[1]	3	0	3	3
PEP 538	Introduction to Mechanics	3	0	0	3
PEP 397	SKIL III	1	6	0	3
	Humanities	3	0	6	3
PEP 527	Math Methods for Science and Engineering I	3	0	0	3
E 243	Probability and Statistics for Engineers	3	0	6	3
	Total	**16**	**6**	**15**	**18**

Term VI

Course #	Course Name	Lecture	Lab	Study	Credit
PEP 542	Electromagnetism	3	0	6	3
EN 550	Environmental Chemistry of Atmospheric Processes	3	0	0	3
PEP 398	SKIL IV	1	6	5	3
	Humanities	3	0	6	3
BT 243 Or BT 244	Macroeconomics Or Microeconomics	3	0	6	3
	Total	**13**	**6**	**23**	**15**

Term VII

Course #	Course Name	Lecture	Lab	Study	Credit
	Humanities	3	0	6	3
PEP 553	Quantum Mechanics and Engineering Applications	3	0	6	3
PEP 575	Fundamentals of Atmospheric Radiation and Climate	3	0	0	3
C.T.E.	Concentration Technical Elective[1]	3	0	3	3
PEP 497	SKIL V	1	6	5	3
	Total	**13**	**6**	**20**	**15**

Term VIII

Course #	Course Name	Lecture	Lab	Study	Credit
	Humanities	3	0	6	3
C.T.E.	Concentration Technical Elective[1]	3	0	6	3
EN 506	Air Pollution Principles and Control	3	0	6	3
PEP 498	SKIL VI	1	6	5	3
G.E.	General Elective	3	0	6	3
	Total	**13**	**6**	**29**	**15**

(1) Possible C.T.E.s: PEP 509, PEP 510, PEP 520, PEP 554, EN 505, EN 541, EN 545 and EN 570

B.E. in Engineering (Concentration in Optical Engineering)

The concentration in Optical Engineering covers a broad range of technologies that involve the generation, manipulation, and measurement of light. This includes but is not limited to the following areas - optical imaging, light sources and displays, sensors and detectors, metrology, fiber optics and optical networking, integrated optics, and nonlinear optics.

Optics is essential to almost all areas of modern technology including manufacturing, defense, medicine, telecommunications, computing, and aerospace and is ubiquitous in devices that we use daily ranging from smartphones to automobiles. Optical engineers utilize physics and mathematics to design and model optical systems and devices.

Optical Engineering Concentration Mission and Objectives

The mission of this concentration is to prepare a next generation of engineers with a deep background in optics and optical design. The mission of the program is to prepare students for careers in many emerging areas of technology such as machine vision and lidar for autonomous vehicles and robots, additive manufacturing, next generation laser and optics based weapons systems, quantum computing and communication, biomedical optics, renewable energy, and new lighting and display technologies. The educational program emphasizes optical physics and hands on laboratory training along with design.

The concentration-specific objectives of this program are:

1. Graduates will demonstrate a solid foundation in the basic principles of optics, mathematics, and physics necessary to understand a broad range of optical systems.

2. Graduates will be able to apply both independently and as part of multidisciplinary teams engineering tools and techniques to design, analyze, build, and test technological systems that employ optical physics.

3. Graduates will be able to pursue careers that span physics, electrical and computer engineering, systems engineering, and broad application oriented careers.

Engineering (with a concentration in Optical Engineering) Curriculum

Term I

Course #	Course Name	Lecture	Lab	Study	Credit
CH 115	General Chemistry I	3	0	6	3
CH 117	General Chemistry Laboratory I	0	3	1	1
MA 121	Differential Calculus	2	0	4	2
MA 122	Integral Calculus	2	0	4	2
E 101	Engineering Experiences I	1	0	0	1
E 121	Engineering Design I	0	3	2	2
E 120	Engineering Graphics	0	2	1	1
E 115	Introduction to Programming	1	2	3	2
CAL 103	Writing And Communications Colloquium	3	0	6	3
	Total:	**12**	**10**	**27**	**17**

Term II

Course #	Course Name	Lecture	Lab	Study	Credit
S.E.	Science Elective I	3	0	6	3
PEP 111	Mechanics	3	0	6	3
E 122	Engineering Design II	0	3	3	2
CAL 105	Knowledge, Nature, Culture	3	0	6	3
MA 123	Series, Vectors, Functions, and Surfaces	2	0	4	2
MA 124	Calculus of Two Variables	2	0	4	2
MGT 103	Introduction to Entrepreneurial Thinking	1	2	0	2
	Total	**14**	**5**	**29**	**17**

Term III

Course #	Course Name	Lecture	Lab	Study	Credit
MA 221	Differential Equations	4	0	8	4
PEP 112	Electricity and Magnetism	3	0	6	3
E 126	Mechanics of Solids	4	0	8	4
E 245	Circuits and Systems	2	3	7	3
E 231	Engineering Design III	0	3	2	2
Hum	Humanities	3	0	6	3
	Total	**16**	**6**	**37**	**19**

Term IV

Course #	Course Name	Lecture	Lab	Study	Credit
MA 227	Multivariable Calculus	3	0	6	3
E 232	Engineering Design IV	2	3	7	3
PEP 330	Intro. to Thermal and Statistical Physics[1]	3	0	0	3
PEP 201	Physics III for Engineers (S.E. II)	3	2	3	3
PEP 209	Modern Optics (T.E.)	3	0	6	3
Hum	Humanities	3	0	6	3
	Total	**17**	**5**	**28**	**18**

Term V

Course #	Course Name	Lecture	Lab	Study	Credit
EE 471	Transport Phenomena in Solid State Devices[1]	4	0	4	4
E 344	Materials Processing	3	0	6	3
E 321	Engineering Design V	0	3	2	2
T.E.	Technical Elective	3	0	6	3
T.E.	Technical Elective	3	0	6	3
E 243	Probability and Statistics for Engineers	3	0	6	3
	Total	**16**	**3**	**30**	**18**

Term VI

Course #	Course Name	Lecture	Lab	Study	Credit
E 355	Engineering Economics	3	3	6	4
E 345	Modeling and Simulation[2]	3	0	6	3
E 322	Engineering Design VI	1	3	2	2
PEP 509	Intermediate Waves and Optics (T.E.)	3	3	0	3
PEP 510	Modern Optics Lab (T.E.)	3	3	0	3
HUM	Humanities	3	0	6	3
IDE 400	Senior Innovation I: Project Planning	1	0	2	1
	Total	**17**	**12**	**22**	**19**

Term VII

Course #	Course Name	Lecture	Lab	Study	Credit
PEP 423	Engineering Design VII	1	7	4	3
PEP 577	Laser Theory and Design (T.E.)	3	0	0	3
PEP 515	Photonics I (T.E.)	3	3	0	3
IDE 401	Senior Innovation II: Value Proposition	1	0	2	1
Hum	Humanities	3	0	6	3
G.E.	General Elective	3	0	6	3
	Total	**14**	**10**	**18**	**16**

Term VIII

Course #	Course Name	Lecture	Lab	Study	Credit
PEP 424	Engineering Design VIII	1	7	4	3
T.E.	Technical Elective	3	0	6	3
PEP516	Photonics II (T.E.)	3	3	0	3
IDE 402	Senior Innovation III: Venture Planning and Pitch	1	0	2	1
G.E.	General Elective	3	0	6	3
G.E.	General Elective	3	0	6	3
	Total	**14**	**10**	**24**	**16**

(1) Discipline specific course.
(2) Discipline specific course. Students in optical engineering should take either EE345 or ME345.

Minors

A minor represents a coherent program of study in a discipline other than the student's major degree program. Successful completion of a minor program is recognized on the transcript and with a Minor Certificate at graduation. Recognition is thus provided for a significant educational experience in another discipline.

General requirements for minor programs in engineering or science:

▸ Entry to a minor program requires a minimum cumulative GPA of 2.5.

▸ A student wishing to pursue a minor program must complete a Minor Program Study Plan signed by a Minor Advisor from the relevant discipline. Each minor requires a separate study plan and a student can earn no more than two minors in engineering and science.

▸ The minor program must be in a discipline other than that of a student's major program of study. As such, minors are distinguished from options within the major discipline or concentrations within the chosen major program.

▸ The minor program will consist of a coherent sequence of at least six courses. A minimum of two courses (minimum six credits) must be in addition to those courses required to complete a student's major degree program (which includes general education courses).

▸ In order for a course to count towards a minor, a grade of C or above must be achieved. At the discretion of the Minor Advisor, transfer credits may be applied to a minor, but these must constitute fewer than half of those applied to the minor program.

▸ To receive the minor at graduation, the student must complete a Minor Candidacy Form signed by the Minor Advisor after all minor requirements are fulfilled.

For more information regarding the School of Engineering and Science requirements for minor programs, please see the Guidelines for Science Minor Programs on page 82.

Physics

Required courses for a Minor in Physics:

▸ PEP 242 Modern Physics Or PEP 201 Physics III for Engineers

▸ PEP 538 Introduction to Mechanics

▸ PEP 542 Electromagnetism

▸ PEP 553 Quantum Mechanics and Engineering Applications

Plus any two of the following courses:

▸ PEP 209 Modern Optics

▸ PEP 330 Introduction to Thermal and Statistical Physics

▸ PEP 336 Introduction to Astrophysics and Cosmology

▸ PEP 501 Fundamentals of Atomic Physics

▸ PEP 503 Introduction to Solid State Physics

▸ PEP 509 Intermediate Waves and Optics

▸ PEP 510 Modern Optics Lab

▸ PEP 520 Computational Physics

▸ PEP 527 Mathematical Methods of Science and Engineering I

▸ PEP 552 Theory of Relativity

▸ PEP 554 Quantum Mechanics I

▸ PEP 555 Statistical Physics and Kinetic Theory

The following are prerequisites needed to undertake the minor program:

▸ PEP 111 Mechanics

▸ PEP 112 Electricity and Magnetism

Astronomy

Required courses for a Minor in Astronomy:

▸ PEP 151 Introduction to Astronomy

▸ PEP 336 Introduction to Astrophysics and Cosmology

Plus four of the following courses:

▸ PEP 209 Modern Optics

▸ PEP 351 Introduction to Planetary Science

▸ PEP 337 Observational Astrophysics

▸ PEP 440 Astrophysical Flows: Planets, Stars, and Accretion Disks

▸ PEP 445 Black Holes, White Dwarfs, and Neutron Stars

▸ PEP 506 Modern Astrophysics and Cosmology

▸ PEP 552 Theory of Relativity

The following are prerequisites needed to undertake the minor program:

▸ PEP 111 Mechanics

▸ PEP 112 Electricity and Magnetism

Photonics

Required courses for a Minor in Photonics:

▸ PEP 209 Modern Optics

▸ PEP 509 Intermediate Waves and Optics

▸ PEP 510 Modern Optics Lab

▸ PEP 542 Electromagnetism

Plus two of the following courses:

▸ PEP 515 Photonics I

▸ PEP 516 Photonics II

▸ PEP 570 Guided Wave Optics

▸ PEP 577 Laser Theory and Design

‣ PEP 578 Laser Applications and Advanced Optics

‣ PEP 507 Introduction to Microelectronics and Photonics

The following are prerequisites needed to undertake the minor program:

‣ MA 221 Differential Equations

‣ PEP 112 Electricity and Magnetism

GRADUATE PROGRAMS

The graduate program in physics is designed for the student who desires to master fundamental concepts and techniques, who is interested in studying applications in various areas of technology and science, and who wishes to keep abreast of the latest experimental and theoretical innovations in these areas. We offer a varied curriculum consisting of either highly specialized courses or broad training in diverse areas.

When you seek an advanced degree, you can gain both breadth and specialization. The required degree courses provide broad skills in basic physics; the elective choices give highly specialized training in a variety of different areas. The Department of Physics and Engineering Physics is large enough to offer rich and varied programs in pure and applied physics, yet it is small enough to sustain the sense of a coherent community in search of knowledge.

Admissions Requirements

‣ For all graduate programs in physics a B.S. degree is required, which includes the following course work: calculus-based three- or four-semester introductory physics sequence in thermodynamics, electricity and magnetism, mechanics, quantum mechanics, and mathematical methods.

‣ Ph. D, applicants lacking the above courses are required to take the indicated courses for no graduate credit.

Master of Science - Physics

The Master of Science degree prepares you optimally for further continuation to a Ph.D. program in physics. It is awarded after completion of 30 credits of graduate coursework which include the following required courses:

‣ PEP 642 Mechanics

‣ PEP 643/644 Electricity and Magnetism I and II

‣ PEP 554 Quantum Mechanics I

‣ PEP 528 Mathematical Methods of Science and Engineering I

‣ PEP 555 Statistical Physics and Kinetic Theory

‣ PEP 510 Modern Optics Lab (or another lab equivalent)

‣ One 600-level advanced quantum mechanics course

and two additional elective courses, chosen in consultation with an academic advisor. These courses may be used to conduct research to graduate with an MS Thesis (PEP 900.) Courses with material already covered in undergraduate preparation must be replaced in consultation with an academic advisor.

Master of Engineering - Engineering Physics

The Master of Engineering - Engineering Physics degree program has three options. Students enrolled in a particular option develop a course of study in conjunction with their academic advisor. In contrast to the Master of Science in Physics, the Master of Engineering option is intended to provide the student with deeper insight into the specific area of their choice.

Students wanting to continue their education towards a doctoral degree will be optimally prepared for interdisciplinary physics research yet may have to take several additional courses to fulfill the requirements for a Ph.D. in Physics.

The Applied Optics option seeks to extend and broaden training in areas pertinent to the field of optics and optical engineering. A bachelor's degree in either science or engineering from an accredited institution is required.

Core Courses in Engineering Physics (Applied Optics)

- PEP 509 Intermediate Waves and Optics
- PEP 510 Modern Optics Lab
- PEP 515-516 Photonics I-II
- PEP 527 Mathematical Methods of Science and Engineering I
- PEP 542 Electromagnetism
- PEP 553 Introduction to Quantum Mechanics
- PEP 554 Quantum Mechanics I

And two courses out of the following seven courses:
- PEP 570 Guided-Wave Optics
- PEP 577 Laser Theory and Design
- PEP 578 Laser Applications and Advanced Optics
- PEP 579 Nonlinear Optics
- PEP 678 Physics of Optical Communication Systems
- PEP 679 Fourier Optics
- PEP 680 Quantum Optics

The Solid State Physics option in Solid State Physics seeks to extend and broaden training in those areas pertinent to the field of solid state device engineering. A bachelor's degree in either science or engineering from an accredited institution is required.

Core Courses in Engineering Physics (Solid State Physics)

- EE 619 Solid State Devices
- PEP 503 Introduction to Solid State Physics
- PEP 510 Modern Optics Lab
- PEP 527 Mathematical Methods of Science and Engineering I
- PEP 538 Introduction to Mechanics
- PEP 542 Electromagnetism
- PEP 553 Intro. to Quantum Mechanics
- PEP 554 Quantum Mechanics I
- PEP 555 Statistical Physics and Kinetic Theory
- PEP 680 Quantum Optics

Courses with material already covered in undergraduate preparation must be replaced in consultation with an academic advisor.

Master of Engineering - Engineering Physics with a Concentration in Quantum Engineering

The degree concentration in Quantum Engineering prepares physics and applied physics students to launch a career in industries utilizing quantum information science and quantum technology. The program also prepares students for further continuation to a PhD in physics and quantum technology. Students will gain a deeper insight into the new quantum resources underlining the current quantum technologies that are crucial to the demands of the fast and reliable communication technology. The program will develop both specialized and general expertise through advanced areas of study and initiatives including class learning as well as in form of a unique hands-on laboratory course in experimental quantum information. The curriculum is designed to be flexible to satisfy the needs of both full and part-time students.

Core Courses Required:

- PEP 544 Quantum Mechanics
- PEP 579 Nonlinear Optics
- PEP 680 Quantum Optics
- PEP 511 Experimental Quantum Information
- PEP 557 Quantum Information and Quantum Computation
- PEP 678 Physics of Optical Communication Systems
- PEP 556 Introduction to Quantum Control

In addition to the core courses, the student has to complete three additional courses out of the PEP program (elective courses) in consultation with the advisor. As an option, candidates may choose to executive a master's thesis with an academic advisor for up to six credits to be counted towards the degree in replacement of elective courses.

Master of Engineering Physics - Concentration Nanotechnology

The Nanotechnology option seeks to extend and broaden training in a largely interdisciplinary learning environment with a focus on fundamentals and applications of Nanotechnology. A bachelor degree in either science or engineering from an accredited institution is required. The M.E. degree in nanotechnology will be awarded after completion of 30 credits of graduate coursework with the following requirements:

Core courses required:

- PEP 538 Introduction to Mechanics
- PEP 542 Electromagnetism
- NANO/PEP 553 Introduction to Quantum Mechanics or NANO/PEP 554 Quantum Mechanics I*
- NANO/PEP 503 Introduction to Solid State Physics
- NANO/PEP 555 Statistical Physics and Kinetic Theory
- NANO 600 Nanoscale science and technology
- NANO 525/625 Techniques of surface and nanostructure characterization
- Regular attendance of the seminar series in the Nanotechnology Curriculum (NANO 700).

In addition to the core courses, the student has to complete three additional courses out of the PEP or NANO program (elective courses) selected in consultation with the adviser. As an option, candidates may choose to execute a Master thesis in the realm of nanotechnology in consultation with an academic advisor for up to six credits to be counted towards the degree in replacement of elected courses.

* Students with a background in Quantum Mechanics should take directly PEP/NANO554 after consultation with the adviser.

The Physics and Engineering Physics program offers, jointly with Electrical and Computer Engineering (ECE) and Materials Engineering, a unique interdisciplinary concentration in Microelectronics and Photonics Science and Technology. Intended to meet the needs of students and of industry in the areas of design, fabrication, integration, and applications of microelectronic and photonic devices for communications and information systems, the program covers fundamentals, as well as state-of-the-art industrial practices. Designed for maximum flexibility, the program accommodates the background and interests of students with either a master's degree or graduate certificate.

Interdisciplinary Concentration Microelectronics and Photonics Science and Technology

▸ PEP 507 Introduction to Microelectronics and Photonics* plus three additional courses from The Applied Optics on Solid State Concentration.

Six electives are required from the courses offered below by Materials Engineering, Physics and Engineering Physics, and Electrical Engineering. Three of these courses must be from Physics and Engineering Physics and at least one must be from each of the other two departments. Ten courses are required for the degree.

*Cross-listed as EE 507 and MT 507

Required Concentration Electives

▸ PEP 503 Introduction to Solid State Physics

▸ PEP 515 Photonics I

▸ PEP 516 Photonics II

▸ PEP 561 Solid State Electronics for Engineering I

▸ MT 562 Solid State Electronics for Engineering II

▸ MT 595 Reliability and Failure of Solid State Devices

▸ MT 596 Micro-Fabrication Techniques

▸ EE 585 Physical Design of Wireless Systems

▸ EE 626 Optical Communication Systems

▸ CPE 690 Introduction to VLSI Design

Doctoral Program - Physics

Doctoral students conduct exciting and cutting-edge research with faculty who are leaders in the field. Ph.D. students must pass a qualifying examination, which consists of two oral examinations. The first oral examination tests mastery of a set of core physics topics (based on core courses PEP 538, 542, 553, 555) while the second oral examination tests the student's ability to discuss physics problems and current research topics with an examining committee of three faculty members. Candidates have two opportunities to pass each examination. The first attempt must be made within the first two years of study at Stevens. Upon successful completion of both examinations, the student becomes a qualified Ph.D. candidate.

Within six weeks after passing the qualification examination a Ph.D. advisory committee shall be formed for each Ph.D. student, consisting of a major advisor on the physics department faculty, an additional physics department faculty member, and a third Stevens faculty member from any department other than Physics. Additional committee members from Stevens or elsewhere may also be included.

Ph.D. candidates are required to have competency in using computer-based methods of calculation and analysis. Students lacking this competency are encouraged to take PEP 520 Computational Physics, or equivalent.

In addition to the core courses required in the 30-credit Master of Science in physics degree (PEP 642, PEP 643, PEP 644, PEP 554, PEP 528, PEP 555, and PEP 510 and one 600-level advanced quantum mechanics course), completion of the following coursework will be required for the Ph. D.

- PEP 667 Statistical Mechanics

- One 600-level quantum mechanics application course

- Two 700-level courses chosen in consultation with an academic advisor

- Three Ph.D. signature credits (can be in one or multiple approved courses)

The student will carry out an original research program under the supervision of the major advisor and advisory committee. The results of the research will be presented in a written dissertation. Upon approval of the advisory committee, the written dissertation will be defended by the student in an oral defense. A minimum of 84 credits beyond the baccalaureate degree is required for the Ph.D. degree. Required coursework represents at least 18 credits. At least 12 of the remaining 66 credits must be for the Ph.D. research (PEP 960).

Applications are welcome from students who have already earned a master's degree elsewhere. Applicants with the equivalent of the Stevens Master of Science in physics degree are eligible to take the qualifying exam immediately and become candidates without additional course requirements. Nevertheless, they have to fulfill all described requirements including doctoral coursework, research, any core courses of the Stevens Master of Science in physics which they have not taken in the course of their previous Masters degree, and a total of 54 credits beyond the master's degree.

Applicants with a non-physics master's degree may be required to complete sufficient coursework to meet the requirements for a physics degree in addition to the remaining doctoral requirements outlined above. The details of the makeup work are determined by the department's Graduate Academic Standards and Curriculum committee.

Doctoral Program - Interdisciplinary

In addition to the Ph.D. program in Physics the Department of Physics and Engineering Physics offers an interdisciplinary Ph.D. program in cooperation with other departments in Stevens Institute of Technology. This program aims to address the increasingly cross-cutting nature of doctoral research. The interdisciplinary Ph.D. program aims to take advantage of the complementary educational offerings and research opportunities in multiple areas. Any student who wishes to enter an interdisciplinary program needs to obtain the consent of the participating departments and the subsequent approval of the Dean of Graduate Studies. The student will follow a study plan designed by his/her faculty advisor. In particular, the student must declare which department will be the home department (i.e. the department where the majority of courses is being taken), and arrange for written consent of advisors in both departments involved.

The student will be granted official candidacy in the program upon successful completion of a qualifying exam that will be administered according to the applicable guidelines of the Office of Graduate Studies. For all interdisciplinary programs involving the physics department as either home or secondary department the student is required to pass the first part of the regular Ph.D. qualifying exam of the Physics Department (general physics, based on core courses PEP 538, 542, 553, 555) as well as the corresponding qualifying exam of the other participating department.

All policies of the Office of Graduate Studies that govern the credit and thesis requirements apply to students enrolled in this interdisciplinary program. Identical to the Physics Ph.D. program the interdisciplinary Ph.D. program requires 84 credits. For student with the Physics Department as the home department the following additional guidelines apply:

- A master's degree comparable to the Stevens' Master of Engineering Physics will be recognized and be accounted for with up to 30 credits, whereby the following courses (or equivalent) must be part of the Masters PEP 542 and PEP 554.

- Required core courses of an interdisciplinary Ph.D. if PEP is the home department:

- NANO / PEP 555 Statistical Physics and Kinetic Theory

- PEP642 Mechanics

- PEP 643 Electricity and Magnetism I

- PEP 644 Electricity and Magnetism II

- And Two 600-level courses (in the PEP or secondary department)

- One 700-level course (in the PEP or secondary department)

These requirements allow a student to obtain an Interdisciplinary Ph.D. degree with a designated concentration in nanotechnology and the PEP Department as home department following the requirement of the Nanotechnology Graduate Program (NGP). To qualify for the nanotechnology concentration, the student has to satisfy all the above requirements for an interdisciplinary PhD and must additionally complete the NGP common core courses (NANO 600 and NANO525/625), a minimum of five elective NANO courses, as well as regularly attend the seminar series in the Nanotechnology Curriculum (NANO 700). Note that the requirement for five elective NANO courses are allowed to overlap with the requirements for an interdisciplinary PhD involving the PEP department, in particular, courses NANO/PEP553, NANO/PEP554, NANO/PEP555 are cross-listed with the NPG program. In addition, a Ph.D. candidate must successfully execute a doctoral dissertation in the realm of nanotechnology. Interested students should follow the normal graduate application procedures through the Dean of Graduate Studies.

Graduate Certificate Programs

The Department of Physics and Engineering Physics offers five Graduate Certificate programs to students meeting the regular admission requirements for the master's program. Each Graduate Certificate program is self-contained and highly focused, carrying 12 graduate credits. All of the courses may be used toward the master's degree, as well as for the certificate.

Applied Optics

- PEP 577 Laser Theory and Design

- PEP 578 Laser Applications and Advanced Optics or PEP 678 Physics of Optical Communications Systems

- and two out of the following four courses:

- PEP 515 Photonics I *or* PEP 516 Photonics II

- PEP 570 Guided-Wave Optics

- PEP 679 Fourier Optics

Atmospheric and Environmental Science and Engineering
(Interdisciplinary with Civil, Ocean, and Environmental Engineering)

- PEP 575 Fundamentals of Atmospheric Radiation and Climate

- CE 591 Dynamic Meteorology

- ME 532/EN 506 Air Pollution Principles and Control

- EN 550 Environmental Chemistry of Atmospheric Processes

This graduate certificate program is offered as a campus-based program, as well as a web-based distance learning program.

Microdevices and Microsystems

- ▸ EE/MT/PEP 507 Introduction to Microelectronics and Photonics
- ▸ EE/MT/PEP 595 Reliability and Failure of Solid State Devices
- ▸ EE/MT/PEP 596 Micro-Fabrication Techniques
- ▸ EE/MT/PEP 685 Physical Design of Wireless Systems

Microelectronics

- ▸ EE/MT/PEP 507 Introduction to Microelectronics and Photonics
- ▸ EE/MT/PEP 561 Solid State Electronics I
- ▸ EE/MT/PEP 562 Solid State Electronics II
- ▸ CPE/MT/PEP 690 Introduction to VLSI Design

Photonics

- ▸ EE/MT/PEP 507 Introduction to Microelectronics and Photonics
- ▸ EE/MT/PEP 515 Photonics I
- ▸ EE/MT/PEP 516 Photonics II
- ▸ EE/MT/PEP 626 Optical Communication Systems

EE course descriptions can be found in the Electrical and Computer Engineering section of the catalog.

COURSE OFFERINGS

Physics and Engineering Physics

PEP 111   Mechanics   (3 - 3 - 0)

Vectors, kinetics, Newton's laws, dynamics or particles, work and energy, friction, conserverative forces, linear momentum, center-of-mass and relative motion, collisions, angular momentum, static equilibrium, rigid body rotation, Newton's law of gravity, simple harmonic motion, wave motion and sound. Corequisite: MA115 or MA121

PEP 112   Electricity and Magnetism   (3 - 3 - 0)

Coulomb's law, concepts of electric field and potential, Gauss' law, capacitance, current and resistance, DC and R-C transient circuits, magnetic fields, Ampere's law, Faraday's law of induction, inductance, A/C circuits, electromagnetic oscillations, Maxwell's equations and electromagnetic waves. Prerequisites: MA115 or MA122, PEP111

PEP 123   Physics for Business & Technology I   (3 - 3 - 0)

This is the first course of a two-course algebra-based introductory physics sequence for students outside of the engineering or science curriculum. This course covers the basic principles and applications of classical mechanics as well as simple thermodynamics. Recitations include a laboratory component.

PEP 124   Physics for Business & Technology II   (3 - 3 - 0)

This is the second course of a two course algebra-based introductory physics sequence for students outside of the engineering or science curriculum. This course covers the basic principles and applications of electricity and magnetism, oscillations and waves, and optics. Recitations include a laboratory component. Prerequisite: PEP 123

PEP 151   Introduction to Astronomy   (3 - 3 - 0)

The course is designed to fulfill a science requirement credit for the general student population. The main objective of the course is to present a coherent introduction to the methods of study and physical properties of astronomical objects. Throughout the course complex objects will be reduced to their essential fetures that explain the observed phenomena. Current and historic observations will be used as the moivation. Data analysis assignments will be given from real observational data (listed as 'Lab' in the syllabus). A set of semester-long group projects in astro-photography will give students a hands-on expereince in imaging astronomical phenomena using everyday digital cameras(listed as'Project' in the syllabus). The course will include an evening demonstration on campus and a visit to the planetarium. In terms of general education, astronomy will be used as a vehicle to introduce the essentials of model-building, justified simplifications, physical reasoning and self-correcting nature of scientific method.

PEP 181   Honors Mechanics   (5 - 4 - 1)

Newtonian mechanics. The course, however, begins with an exploration of high energy particle physics, using the relatistically correct conservation laws as the fundamental organizing principle. Bubble chamber "photograph" of high energy collisions and decays are analyzed. Standard topics in particle dynamics, rotational dynamics of extended bodies, work-energy theorem, angular momentum conservation as well as other less traditional topics such as relativistic coordinate transformation, center-of-mass reference frames, and harmonic oscillatory motion will be explored in depth.

PEP 182   Honors Electricity and Magnetism   (5 - 4 - 0)

Introduction in classical electricity and magnetism, this course emphasizes the interdependence of electromagnetic phenomena. It begins with Maxwell's equations in integral form, and dissects each equation carefully, showing how it is used as well as the experimental evidence for its derivation. Topics such as electrostatic and magnetostatic fields, capacitors, inductors, electromagnetic radiation, waveguide propagation, microwave cavities, dielectrics, and magnetic materials are explored using Maxwell's equations. The transformations of the fields to equivalent inertial reference frames using some ideas from Special Relativity is also explored. The concept of symmetry and its' applications will be studied in depth. Prerequisite: PEP181

PEP 187   Seminar in Physical Science I   (1 - 1 - 0)

Selected topics in modern physics and applications. By invitation only. Corequisites: MA115 or MA121, PEP111

PEP 201   Physics III for Engineers   (3 - 2 - 3)

Simple harmonic motion, oscillations and waves; wave-particle dualism; the Schrödinger equation and its interpretation; wave functions; the Heisenberg uncertainty principle; quantum mechanical tunneling and application; quantum mechanics of a particle in a "box," the hydrogen atom; electronic spin; properties of many electron atoms; atomic spectra; principles of lasers and applications; electrons in solids; conductors and semi-conductors; the n-p junction and the transistor; properties of atomic nuclei; radioactivity; fusion and fission. Prerequisite: PEP112 Corequisite: MA221

PEP 209   Modern Optics   (3 - 3 - 0)

Concepts of geometrical optics for reflecting and refracting surfaces, thin and thick lens formulations, optical instruments in modern practice, interference, polarization and diffraction effects, resolving power of lenses and instruments, X-ray diffraction, introduction to lasers and coherent optics, principles of holography, concepts of optical fibers, optical signal processing. Prerequisite: PEP 112

PEP 211   Physics Lab for Engineers   (0 - 0 - 2)

An introduction to experimental physics. Students learn to use a variety of techniques and instrumentation, including computer controlled experimentation and analysis, error analysis and statistical treatment of data. Experiments include basic physical and electrical measurements, mechanical, acoustical, and electromagnetic oscillation and waves, and basic quantum physics phenomena.

PEP 221   Physics Lab I for Scientists   (1 - 0 - 3)

An introduction to experimental measurements and data analysis. Students will learn how to use a variety of measurement techniques, including computer-interfaced experimentation, virtual instrumentation, and computational analysis and presentation. First semester experiments include basic mechanical and electrical measurements, motion and friction, RC circuits, the physical pendulum, and electric field mapping. Second semester experiments include the second order electrical system, geometrical and physical optics and traveling and standing waves. Prerequisite: PEP 111 Corequisite: PEP 112

PEP 222   Physics Lab II for Scientists   (1 - 0 - 3)

An introduction to experimental measurements and data analysis. Students will learn how to use a variety of measurement techniques, including computer-interfaced experimentation, virtual instrumentation, and computational analysis and presentation. First semester experiments include basic mechanical and electrical measurements, motion and friction, RC circuits, the physical pendulum, and electric field mapping. Second semester experiments include the second order electrical system, geometrical and physical optics and traveling and standing waves. Prerequisite: PEP 221

PEP 242   Modern Physics   (3 - 3 - 0)

Simple harmonic motion, oscillations and pendulums; Fourier analysis; wave properties; wave-particle dualism; the Schrödinger equation and its interpretation; wave functions; the Heisenberg uncertainty principle; quantum mechanical tunneling and application; quantum mechanics of a particle in a "box," the hydrogen atom; electronic spin; properties of many electron atoms; atomic spectra; principles of lasers and applications; electrons in solids; conductors and semiconductors; the n-p junction and the transistor; properties of atomic nuclei; radioactivity; fusion and fission. Prerequisite: PEP112 Co-requisite: MA221

PEP 297   SKIL I   (2 - 0 - 3)

SKIL (Science Knowledge Integration Ladder) is a six-semester sequence of project-centered courses. This course introduces students to the concept of working on projects that foster independent learning, innovative problem solving, collaboration and teamwork, and knowledge of integration under the guidance of a faculty advisor. SKIL I familiarizes the student with the ideas and realization of project-based learning using simple concepts and basic scientific knowledge. Specific emphasis is put on the development of "Guesstimates" skills, application and recognition of scaling laws as well as fundamental measurement techniques. Prerequisite: PEP 112

PEP 298   SKIL II   (2 - 0 - 3)

Continuation and extension of SKIL I to complex projects. Prerequisite: PEP 297

PEP 330   Intro to Thermal & Statistical Physics   (3 - 3 - 0)

An introduction to statistical mechanics including classical thermodynamics and their statistical foundation. Essential concepts in both classical and quantum statistical mechanics are developed along with their relations to thermodynamics. Topics covered include: laws of thermodynamics, entropy, thermal processes including Carnot engine and refrigerators, basic concepts of probability theory, statistical description of systems of particles, microscopic description of macroscopic quantities such as temperature and entropy, ideal and real gases, Maxwell-Boltzmann distribution, kinetics of classical gases, Bose-Einstein and Fermi-Dirac distributions, blackbody radiation, thermal properties of solids, and phase transitions. Prerequisites: PEP 112, MA124 Corequisite: PEP242 or PEP201

PEP 331   Electromagnetism   (3 - 3 - 0)

Electrostatics; Coulomb-Gauss Law; Poisson-Laplace equations; boundary value problems; image techniques, dielectric media; magnetostatics; multipole expansion, electromagnetic energy, electromagnetic induction, Maxwell's equations, electromagnetic waves, waves in bounded regions, wave equations and retarded solutions, simple dipole antenna radiation theory, transformation law of electromagnetic fields.

PEP 332   Mathematical Methods for Physics   (3 - 3 - 0)

This course is designed to build upon the core mathematics sequence in engineering and thus enable the student to fully utilize quantitative mathematical analysis in the junior and enior level courses in engineering physics. Topics covered will include complex numbers and functions, linear algebra, advanced vector analysis, Fourier series and integrals, special functions for mathematical physics, orthogonal functions solutions to differential equations and elements of tensor analysis. Review of previously covered material will be integrated with topics of greater depth as appropriate. Applications to problems in engineering physics will be stressed throughout. Prerequisite: MA 227

PEP 334   Introduction to Nuclear Physics and Nuclear Reactors   (3 - 3 - 0)

Historical introduction; radioactivity; laws of statistics of radioactive decay; alpha decay; square well model; gamma decay; beta decay; beta energy spectrum; neutrinos; nuclear reactions; relativistic treatment; semi-empirical mass formula; nuclear models; uranium and the transuranic elements; fission; nuclear reactors.

PEP 336   Introduction to Astrophysics and Cosmology   (3 - 3 - 0)

Theories of the universe, general relativity, big bang cosmology and the inflationary universe; elementary particle theory and nucleosynthesis in the early universe. Observational cosmology; galaxy formation and galactic structure; stellar evolution and formation of the elements. White dwarfs, neutron stars and black holes; planetary systems and the existence of life in the universe. Prerequisite: PEP 111

PEP 337   Observational Astrophysics   (3 - 3 - 0)

This course focuses on the detection principles and technology of modern telescopes and observatories. Data analysis and instrumentation projects are an essential component of the course. Topics covered include: propagation of astrophysical information via photons and particles, the Earth's atmosphere, spacecraft design and launch, telescope optics, interferometry techniques, and a systematic survey of detection techniques from radio to gamma-ray telescopes and astro-particle instruments. Prerequisites: PEP 112 and PEP 151 Corequisite: PEP 336

PEP 345   Modeling and Simulation   (3 - 3 - 0)

Development of deterministic and non-deterministic models for physical systems, engineering applications, simulation tools for deterministic and non-deterministic systems, case studies and projects.

PEP 351   Introduction to Planetary Science   (3 - 3 - 0)

This course introduces basic concepts of planetary science through the development of simple physical models. The first part of the course studies the planetary formation and related problems - evolution of the planet-satellite systems, orbital stability and impact events. The second part studies planets as equilibrium sytems - topics include planetary atmospheres, climate cycles, seismic activity, and magnetism. The course concludes with the topics of current interest such as global warming, extra-solar planets, and planetary habitability. Prerequisites: MA 124 and PEP 111

PEP 368   Transport: Theory and Simulation   (3 - 3 - 0)

Numerical solution of ordinary differential equations describing oscillation and/or decay. Formulation of diffusion and heat conduction equations (conservation laws, continuity equation, laws of Fick and Fourier). Numerical solution of heat equation by explicit method. Theory of simulation of sound waves.

PEP 397   SKIL III   (3 - 1 - 6)

Continuation and extension of SKIL II to more complex projects. Projects may include research participation in well defined research projects. Prerequisite: PEP 298

PEP 398   SKIL IV   (3 - 1 - 6)

Continuation and extension of SKIL III to more complex projects. Projects may include research participation in well defined research projects. Prerequisite: PEP 397

PEP 440   Astrophysical Flows: Planets, Stars, and Accretion Disks   (3 - 3 - 0)

Nearly all of the baryonic Universe is fluid, and the study of how these fluids move is central to astrophysics. This course covers the basic concepts needed to understand fluid dynamical processes in astrophysics—such as rotation, compression, and magnetic fields. One of the core aims is to introduce mathematical descriptions (e.g., linear and nonlinear differential equations) as well as techniques for analyzing and understanding them at a mathematically sophisticated, but tractable, level (e.g., approximations, normal modes, and scaling). The students will explore the latest mathematical models and solution techniques and discuss problems in astrophysical flows to reinforce concepts encountered in lectures. Prerequisites: MA 227, PEP 242 or PEP 201

PEP 443   Modern Physics Laboratory I   (3 - 0 - 3)

You may participate in ongoing faculty research activities or select from a variety of experiments illustrating the phenomena of modern physics, such as the Rydberg constant and Balmer series, the Zeeman effect, charge of the electron, the Hall effect, absorption of photons by matter, statistics of counting processes, x-ray diffraction, nuclear magnetic resonance, the Langmuir probe, Rutherford scattering, and blackbody radiation. Prerequisite: PEP 201 or PEP 242. Prerequisites: MA 222, PEP 201 or PEP 242

PEP 444   Modern Physics Laboratory II   (3 - 0 - 6)

You may participate in ongoing faculty research activities or select from a variety of experiments illustrating the phenomena of modern physics, such as the Rydberg constant and Balmer series, the Zeeman effect, charge of the electron, the Hall effect, absorption of photons by matter, statistics of counting processes, x-ray diffraction, nuclear magnetic resonance, the Langmuir probe, Rutherford scattering, and blackbody radiation. Prerequisite: PEP 443

PEP 445   Black Holes, White Dwarfs, and Neutron Stars   (3 - 3 - 0)

Black holes, white dwarfs, and neutron stars—"compact objects" in astrophysics – are fundamental constituents of our Universe. This course introduces the basic physics of compact objects. First, the basic physical properties of compact objects are analyzed in their simplest states. Then, the effects of rotation, magnetic fields, and particle and (electromagnetic and gravitational) wave emissions are considered. Some of the topics to be covered include the Chandrasekhar limit, classical, magneto-, and super-fluids, pulsars, Schwarzschild and Kerr black holes, accretion disks, and gravitational waves. The students will explore the latest theoretical models and observations and solve and discuss problems to reinforce concepts encountered in lectures. Prerequisites: MA 227, PEP 242 or PEP 201

PEP 497   SKIL V   (3 - 0 - 3)

Continuation of SKIL IV. SKIL V and SKIL VI can be combined into a yearlong senior design project or a research project leading to a thesis. Prerequisite: PEP 398

PEP 498   SKIL VI   (3 - 0 - 3)

Continuation of SKIL V. SKIL V and SKIL VI can be combined into a yearlong senior design project or a research project leading to a thesis. Prerequisite: PEP 497

PEP 500   Physics Review   (3 - 3 - 0)

A review course in the fundamentals of physics, especially in mechanics and electromagnetism; dynamics of a particle; systems of particles and their conservation laws; motion of a rigid body; electrostatics, magnetic fields, and currents; and electromagnetic induction. Prerequisites: introductory mechanics and electromagnetism courses which employ calculus and vector analysis. Typical text: Halliday, Resnick, and Walker, Fundamentals of Physics. No credit for Physics or Engineering Physics majors.

PEP 501   Fundamentals of Atomic Physics   (3 - 3 - 0)

The course will cover the most common atomic and nuclear effects, yet covers it in direct relation to a sophisticated quantum mechanical treatment. It thereby connects the theoretical models with the experimental results, showcasing agreement as well as disagreement to outline the validity range of each model. Topics covered include Brownian motion; charge and mass of electrons and ions; Zeeman effect; photoelectric effect; emission, absorption, reflection, refraction, diffraction, absorption, and scattering of X-rays; Compton effect; diffraction of electrons; uncertainty principle; electron optics; atomic spectra and electron distribution; radioactivity; disintegration of nuclei; nuclear processes; nuclear energy; and fission.

PEP 503   Introduction to Solid State Physics   (3 - 3 - 0)

Description of simple physical models which account for electrical conductivity and thermal properties of solids. Basic crystal lattice structures, X-ray diffraction and dispersion curves for phonons and electrons in reciprocal space. Energy bands, Fermi surfaces, metals, insulators, semiconductors, superconductivity and ferromagnetism. Fall semester. Cross-listed with: EE 503, MT 503, NANO 503 Prerequisites: PEP 242, PEP 542

PEP 506   Introduction to Astrophysics and Cosmology   (3 - 3 - 0)

Theories of the universe, general relativity, Big Bang cosmology, and the inflationary universe; and elementary particle theory and nucleosynthesis in the early universe. Observational cosmology; galaxy formation and galactic structure; and stellar evolution and formation of the elements. White dwarfs, neutron stars and black holes, planetary systems, and the existence of life in the universe. Prerequisites: MA 221, PEP 242

PEP 507   Introduction to Microelectronics and Photonics   (3 - 3 - 0)

An overview of Microelectronics and Photonics Science and Technology. It provides the student who wishes to specialize in the application, physics or fabrication with the necessary knowledge of how the different aspects are interrelated. It is taught in three modules: design and applications, taught by EE faculty; operation of electronic and photonic devices, taught by Physics faculty; fabrication and reliability, taught by the Materials faculty. Cross-listed with: EE 507, MT 507

PEP 509   Intermediate Waves and Optics   (3 - 3 - 0)

The general study of field phenomena; scalar and vector fields and waves; dispersion phase and group velocity; interference, diffraction and polarization; coherence and correlation; geometric and physical optics. Typical text: Hecht and Zajac, Optics. Spring semester. Cross-listed with: EE 509 Prerequisite: PEP 542

PEP 510   Modern Optics Lab   (3 - 3 - 0)

The course is designed to familiarize students with a range of optical instruments and their applications. Included will be the measurement of aberrations in optical systems, thin-film properties, Fourier transform imaging systems, nonlinear optics, and laser beam dynamics.

PEP 511   Experimental Quantum Information   (3 - 3 - 0)

This is a laboratory course covering basic quantum information experiments. It includes experimental training on parametric nonlinear optical processes in waveguides and optical fibers, generation and measurement of single photons and photon pairs, and realizations of quantum communications. Prerequisites: PEP 553 and PEP 579, or instructor approval.

PEP 512   Introduction to Nuclear Physics and Nuclear Reactors   (3 - 3 - 0)

Historical introduction; radioactivity; laws of statistics of radioactive decay; alpha decay; square well model; gamma decay; beta decay; beta energy spectrum; neutrinos; nuclear reactions; relativistic treatment; semiempirical mass formula; nuclear models; uranium and the transuranic elements; fission; and nuclear reactors.

PEP 515   Photonics I   (3 - 3 - 0)

This course will cover topics encompassing the fundamental subject matter for the design of optical systems. Topics will include optical system analysis, optical instrument analysis, applications of thin-film coatings and opto-mechanical system design in the first term. The second term will cover the subjects of photometry and radiometry, spectrographic and spectrophotometric systems, infrared radiation measurement and instrumentation, lasers in optical systems and photon-electron conversion. Typical texts: Military Handbook 141 (U.S. Govt. Printing Office); S.P.I.E Reprint Series (Selected Issues); W.J. Smith, Modern Optical Engineering. Cross-listed with: EE 515, MT 515

PEP 516   Photonics II   (3 - 3 - 0)

This course will cover topics encompassing the fundamental subject matter for the design of optical systems. Topics will include optical system analysis, optical instrument analysis, applications of thin-film coatings and opto-mechanical system design in the first term. The second term will cover the subjects of photometry and radiometry, spectrographic and spectrophotometric systems, infrared radiation measurement and instrumentation, lasers in optical systems and photon-electron conversion. Typical texts: Military Handbook 141 (U.S. Govt. Printing Office); S.P.I.E Reprint Series (Selected Issues); W.J. Smith, Modern Optical Engineering. Cross-listed with: EE 516, MT 516

PEP 520   Computational Physics   (3 - 3 - 0)

Numerical techniques. Numerical methods for integrating Newton's laws, the diffusion equation, Poisson's equation, and the wave equation are discussed. Topics also covered: discrete Fourier transform, stability theory,curve fitting , the diagonalization of matrices, and Monte Carlo methods.

PEP 524   Introduction to Surface Science   (3 - 3 - 0)

A phenomenological and theoretical introduction to the field of surface science, including experimental techniques and engineering applications. Topics will include: thermodynamics and structure of surfaces, surface diffusion, electronic properties and space-charge effects, physisorption, and chemisorption.

PEP 525   Techniques of Surface and Nanostructure Characterization   (3 - 3 - 0)

Lectures, demonstrations and laboratory experiments, selected from among the following topics, depending on student interest: vacuum technology; thin-film preparation; scanning electron microscopy; infrared spectroscopy, ellipsometry: electron spectroscopies-Auger, photoelectron, LEED; ion spectroscopies SIMS, IBS, field emission; surface properties-area, roughness, and surface tension. Alternate years. Cross-listed with: MT 525, NANO 525, CH 525

PEP 527   Mathematical Methods of Science and Engineering I   (3 - 3 - 0)

Fourier series, Bessel functions, and Legendre polynomials as involved in the solution of vibrating systems; tensors and vectors in the theory of elasticity; applications of vector analysis to electrodynamics; vector operations in curvilinear coordinates; numerical methods of interpolation and of integration of functions and differential equations.

PEP 528   Mathematical Methods of Science and Engineering II   (3 - 3 - 0)

Vector and Tensor Fields: transformation properties, algebraic and differential operators and identities, geometric interpretation of tensors, integral theorems. Dirac delta-function and Green's function technique for solving linear inhomogeneous equations. N-dimensional complex space: rotations, unitary and hermitian operators, matrix-dyadic-Dirac notation, similarity transformations and diagonalization, Schmidt orthogonalization. Introduction to functions of a complex variable: analyticity, Cauchy's theorem, Taylor and Laurent expansions, analytic continuation, multiple-valued functions, residue theorem, contour integration, asymptotics. As techniques are developed, they are applied to examples in mechanics, electromagnetism and/ or transport theory. Prerequisite: PEP 527

PEP 538   Introduction to Mechanics   (3 - 3 - 0)

Particle motion in one dimension. Simple harmonic oscillators. Motion in two and three dimensions, kinematics, work and energy, conservative forces, central forces, and scattering. Systems of particles, linear and angular momentum theorems, collisions, linear spring systems, and normal modes. Lagrange's equations and applications to simple systems. Introduction to moment of inertia tensor and to Hamilton's equations. Prerequisite: MA 221

PEP 540   Physical Electronics   (3 - 3 - 0)

Charged particle motions in electric and magnetic fields; electron and ion optics; charged particle velocity and mass spectrometry; electron and ion beam confinement; thermionic emission; the Pierce gun; field emission; secondary emission; photoelectric effect; sputtering; surface ionization; volume ionization; and Townsend discharge.

PEP 541   Physics of Gas Discharges   (3 - 3 - 0)

Charged particle motion in electric and magnetic fields; electron and ion emission; ion-surface interaction; electrical breakdown in gases; dark discharges and DC glow discharges; confined discharge; AC, RF, and microwave discharges; arc discharges, sparks, and corona discharges; non-thermal gas discharges at atmospheric pressure; and discharge and low-temperature plasma generation. Typical texts: J.R. Roth, Industrial Plasma Engineering: Principles, Vol. 1, and Y.P. Raizer, Gas Discharge Physics. Cross-listed with: EE 541

PEP 542   Electromagnetism   (3 - 3 - 0)

Electrostatics; Coulomb-Gauss law; Poisson-Laplace equations; boundary value problems; image techniques;dielectric media; magnetostatics; multipole expansion; electromagnetic energy; electromagnetic induction; Maxwell's equations; electromagnetic waves, radiation, waves in bounded regions, wave equations and retarded solutions; simple dipole antenna radiation theory; transformation law of electromagnetic fields. Spring semester. Typical text: Reitz, Milford and Christy, Foundation of Electromagnetic Theory. Cross-listed with: EE 542 Prerequisite: MA 221

PEP 544   Introduction to Plasma Physics and Controlled Fusion   (3 - 3 - 0)

Plasmas in nature and application of plasma physics; single particle motion; plasma fluid theory; waves in plasmas; diffusion and resistivity; equilibrium and stability; nonlinear effects and thermonuclear reactions; the Lawson condition; magnetic confinement fusion; and laser fusion. Fall semester. Prerequisite: PEP 542

PEP 545   Plasma Processing   (3 - 3 - 0)

Basic plasma physics; some atomic processes; and plasma diagnostics. Plasma production; DC glow discharges and RF glow discharges; magnetron discharges. Plasma-surface interaction; sputter deposition of thin films; reactive ion etching, ion milling, and texturing; electron beam-assisted chemical vapor deposition; and ion implantation. Sputtering systems; ion sources; electron sources; and ion beam handling.

PEP 550   Fluid Mechanics   (3 - 3 - 0)

Description of principle flow phenomena: pipe and channel flows, laminar flow, transition, and turbulence; flow past an object-boundary layer, wake, separation, vortices, and drag; convection in horizontal layers-conduction, convection, and transition from periodic to chaotic behavior. Equations of motion; dynamical scaling; simple viscous flows; inviscid flow; boundary layers, drag, and lift; thermal flows; flow in rotating fluids; hydro-dynamic stability; and transitions to turbulence. Prerequisite: MA 221

PEP 551   Advanced Physics Laboratory I   (3 - 0 - 3)

An experimental presentation of the evidence for atomic and nuclear theories; typical experiments are: excitation potentials; electronic charge; specific charge of the electron; the Balmer series; Zeeman splitting; spectroscopic isotope shifts; the photovoltaic effect; the Hall effect; gamma ray spectrometry; beta ray spectrometry; neutron activation of nuclides; statistics of counting processes; optical and X-ray diffraction; the Langmuir probe; and nuclear magnetic resonance. Fall semester, repeated second semester. By arrangement. Laboratory fee $5. Typical texts: Young, Statistical Treatment of Experimental Data; Melissinos, Experiments in Modern Physics. Prerequisite: PEP 242 or PEP 201

PEP 552   Theory of Relativity   (3 - 3 - 0)

Geometrical foundations of space-time theories, geometrical objects, affine geometry, and metric geometry; structure of space-time theories, symmetry, and conservation laws; Newtonian mechanics; special relativity; foundations of general relativity, Mach's principle, principle of equivalence, principle of general covariance, and Einstein's equations; solution of Einstein's equations; experimental tests of general relativity; conservation laws in general relativity, gravitational radiation, and motion of singularities; and cosmology.

PEP 553   Quantum Mechanics and Engineering Applications   (3 - 3 - 0)

This course is meant to serve as an introduction to formal quantum mechanics as well as to apply the basic formalism to several generic and important applications. Cross-listed with: NANO 553 Prerequisites: MA 221, PEP 242 or PEP 201

PEP 554   Quantum Mechanics I   (3 - 3 - 0)

Basic concepts of quantum mechanics, states, operators; time development of Schrödinger and Heisenberg pictures; representation theory; symmetries; perturbation theory; systems of identical particles, L-S and j-j coupling; fine and hyperfine structure; scattering theory; molecular structure. Cross-listed with: NANO 554 Prerequisite: PEP 538, PEP 553

PEP 555   Statistical Physics and Kinetic Theory   (3 - 3 - 0)

Kinetic theory: ideal gases, distribution functions, Maxwell-Boltzmann distribution, Boltzmann equation, H-theorem and entropy, and simple transport theory. Thermodynamics: review of first and second laws, thermodynamic potentials, Legendre transformation, and phase transitions. Elementary statistical mechanics: introduction to microcanonical, canonical, and grand canonical distributions, partition functions, simple applications, including ideal Maxwell-Boltzmann, Einstein-Bose, and Fermi-Dirac gases, paramagnetic systems, and blackbody radiation. Cross-listed with: NANO 555 Prerequisites: MA 221, PEP 242

PEP 556   Introduction to Quantum Control   (3 - 3 - 0)

Interference phenomena in electromagnetism and quantum mechanics; interaction of light and matter, principles of coherent control; adaptive and optimal algorithms; Rabi flopping in two-level systems; control of three-level systems including STRIRAP and electromagnetically induced transparency; tools for quantum control; various current and proposed applications. Prerequisite: PEP 553

PEP 557   Quantum Information and Quantum Computation   (3 - 3 - 0)

The course will focus on fundamentals of quantum computation. The topics to be covered include: quantum foundation, quantum channel, quantum qubits, noise and decoherence, master equation and Kraus operations, quantum entanglement, quantum circuits, universal quantum gates, quantum algorithms, quantum error correction codes. The course will not only cover the theoretical aspects of quantum computing and quantum information but also cover physical realizations of quantum computers in various physical contexts including quantum optical systems, solid state qubits etc. Prerequisite: PEP 553

PEP 561   Solid State Electronics for Engineering I   (3 - 3 - 0)

This course introduces fundamentals of semiconductors and basic building blocks of semiconductor devices that are necessary for understanding semiconductor device operations. It is for first-year graduate students and upper-class undergraduate students in electrical engineering, applied physics, engineering physics, optical engineering and materials engineering, who have no previous exposure to solid state physics and semiconductor devices. Topics covered will include description of crystal structures and bonding; introduction to statistical description of electron gas; free-electron theory of metals; motion of electrons in periodic lattice-energy bands; Fermi levels; semiconductors and insulators; electrons and holes in semiconductors; impurity effects; generation and recombination; mobility and other electrical properties of semiconductors; thermal and optical properties; p-n junctions; metal-semiconductor contacts. Cross-listed with: EE 561, MT 561

PEP 562   Solid State Electronics for Engineering II   (3 - 3 - 0)

This course introduces operating principles and develops models of modern semiconductor devices that are useful in the analysis and design of integrated circuits. Topics covered include: charge carrier transport in semiconductors; diffusion and drift, injection, and lifetime of carriers; p-n junction devices; bipolar junction transistors; metal-oxide-semiconductor field effect transistors; metal-semiconductor field effect transistors and high electron mobility transistors, microwave devices; light emitting diodes, semiconductor lasers, and photodetectors; and integrated devices. Cross-listed with: MT 562, EE 562

PEP 570   Guided-Wave Optics   (3 - 3 - 0)

Review of electromagnetic theory; derivation of Fresnels' equations; guided-wave propagation by metallic and dielectric waveguides, including step-index optical fibers and graded-index fibers; optical transmission systems; and nonlinear effects in optical fibers, solitons, and fiber-optic gyroscope.

PEP 575   Fundamentals of Atmospheric Radiation and Climate   (3 - 3 - 0)

This course treats scattering, absorption and emission of electromagnetic radiation in planetary media. The radiative transfer equation is derived, approximate solutions are found. Important heuristic models (Lorentz atom, two-level atom, vibrating rotator) as well as fundamental concepts are discussed including reflectance, absorptance, emittance, radiative warming/cooling rates, actinic radiation, photolysis and biological dose rates. A unified treatment of radiative transfer within the atmosphere and ocean is provided, and extensive use of two-stream and approximate methods is emphasized. Applications to the climate problem focus on the role of greenhouse gases, aerosols and clouds in explaining the temperature structure of the atmosphere and the equilibrium temperature of the earth. The course is suitable for beginning graduate and upper-level undergraduate students. Prerequisites: MA 221, PEP 242

PEP 577   Laser Theory and Design   (3 - 3 - 0)

An introductory course to the theory of lasers; treatment of spontaneous and stimulated emission, atomic rate equations, laser oscillation conditions, power output and optimum output coupling; CW and pulsed operation, Q switching, mode selection, and frequency stabilization; excitation of lasers, inversion mechanisms, and typical efficiencies; detailed examination of principal types of lasers, gaseous, solid state, and liquid; chemical lasers, dye lasers, Raman lasers, high power lasers, TEA lasers, gas dynamic lasers. Design considerations for GaAlAs, argon ion, helium neon, carbon dioxide, neodymium YAG and pulsed ruby lasers.

PEP 578   Laser Applications and Advanced Optics   (3 - 3 - 0)

This course covers provides a survey of advanced areas of optics including integrated optics, fiber optics, propagation of light through birefringent crystals, liquid crystals, acousto-optics, electro-optics, nonlinear optics, and ultrafast optics. Particular emphasis is placed on nonlinear optics and wave mixing including harmonic generation, parametric devices, four wave mixing and phase conjugate mirrors, self-phase modulation, solitons, and phase matching.

PEP 579   Nonlinear Optics   (3 - 3 - 0)

This course is dedicated to give students a working knowledge of the fundamental concepts and modern applications of nonlinear optics in optical communications, lasers, optical metrology, and quantum computing. Through this course, students will gain in-depth understanding and master mathematical tools for modeling nonlinear optical susceptibilities, wave propagation and coupling in nonlinear media, harmonic, sum, and difference frequency generation, parametric amplification and oscillation, phase-conjugation via four-wave mixing, self-phase modulation, and solitons. Prerequisites: PEP 542, PEP 553

PEP 580   Electronic Materials and Devices   (3 - 3 - 0)

Electronic, magnetic, optical, and thermal properties of materials, the description of these properties based on solid state physics. Description and principles of operation of devices. Cross-listed with: MT 570

PEP 585   Physical Design of Wireless Systems   (3 - 3 - 0)

Physical design of wireless communication systems, emphasizing present and next-generation architectures; impact of non-linear components on performance; noise sources and effects; interference; optimization of receiver and transmitter architectures; individual components(LNAs, power amplifiers, mixers, filters, VCOs, phase-locked loops, frequency synthesizers, etc.); digital signal processing for adaptable architectures; analog-digital converters; new component technologies (SiGe, MEMS, etc.); specifications of component performance; reconfigurability and the role of digital signal processing in future generation architectures; direct conversion; RF packaging; and minimization of power dissipation in receivers. Cross-listed with: EE 585, MT 585

PEP 595   Reliability and Failure of Solid State Devices   (3 - 3 - 0)

Treatment of the electrical, chemical, environmental, and mechanical driving forces that compromise the integrity and lead to the failure of devices. Both chip and packaging level failures will be modeled and quantified statistically. On the packaging level, thermal stresses, solder creep, fatigue and fracture, contact relaxation, corrosion and environmental degradation will be treated. Cross-listed with: MT 595, EE 595 Prerequisites: PEP 507, EE 507 MT 507

PEP 596   Micro-Fabrication Techniques   (3 - 3 - 0)

Discussions of aspects of the technology of processing procedures involved in the fabrication of microelectronic devices and microelectromechanical systems (MEMS). Topics with respect to IC fabrication include crystal growth, epitaxy, silicon oxide growth, impurity doping, ion implantation, photo and electron beam lithography, etching, sputtering, thin film metallization, passivation and packaging. Students will also learn that MEMS are sensors and actuators that are designed using different areas of engineering disciplines and they are constructed using a microlithographically-based manufacturing process in conjunction with both semiconductor and micromachining microfabrication technologies. Cross-listed with: MT 596, EE 596, NANO 596 Prerequisites: PEP 507, PEP 501, MT 501, EE 507

PEP 601   Fundamentals of Data Transmitting   (3 - 0 - 3)

The course is the first part of the graduate certificate program "Wireless Secure Network Design" which includes also three other courses - PEP 602, 603 and 604. Program focuses on heterogeneous wireless systems used by first-responders - police, fire fighters, National Guard and other emergency forces - to protect the public during large scale crises, such as natural disasters and acts of terrorism. The program also includes analysis of homeland defense, financial and military operations using secure wireless systems. At the end of the program students will learn how protect existing wireless systems and how design highly secure systems for a future use. The course presents a comprehensive analysis of different parts of the electromagnetic spectrum, transmission and modulation technologies, hardware new artificially engineered materials, and MEMS with accent on security and robustness of communications. Fall Semester

PEP 602   Secure and Robust Communications   (3 - 0 - 3)

The course presents an overview of areas of first responders and military activities and using of different heterogeneous wireless systems during large scale crises, such as natural disasters, acts of terrorism, and also during homeland defense, financial and military operations. The course includes an analysis of different wireless network architectures from security point of view. The course is the second part of the graduate certificate program "Wireless Secure Network Design" which includes also three other courses - PEP 601, 603 and 604. Fall semester.

PEP 603   Physical and Logical Security   (3 - 0 - 3)

The course presents an overview of different methods of authentication and authorization in secure wireless networks. The course focused on different methods of physical data and link protection, probability of detection and interception, anti-jam and covert capabilities, active and passive protection methods and equipment. The course is the third part of the graduate certificate program "Wireless Secure Network Design" which includes also three other courses - PEP 601, 602 and 604. Spring Semester

PEP 604   Secure Telecomm Wireless System Design   (3 - 0 - 3)

The course presents an overview of different methods used in secure heterogeneous wireless systems design. Large scale infrastructure and ad hoc networks test and simulation are one of the major parts of the course. The course also includes practical exercises and lab experiments. The course is the last part of the graduate certificate program "Wireless Secure Network Design" which includes also three other courses - PEP 601, 602 and 603. Students successfully finished all four courses will receive a graduate certificate in wireless secure network design. Spring Semester.

PEP 607   Plasma Physics I   (3 - 0 - 3)

Motion of charged particles in electromagnetic field; Boltzmann equation for plasma; properties of magnetoplasmas; and fundamentals of magnetohydrodynamics. Applications to include: mirror geometry, high frequency confinement, plasma confinement, and heating by means of magnetic fields; motion of plasmas along and across magnetic field lines; magnetohydrodynamic stability theory; plasma oscillations; microinstabilities waves in magnetoplasma; dispersion relations; Fokker-Planck equation for plasmas; plasma conductivity; runaway electrons; relaxation times; radiation phenomena in magnetoplasmas; stability theories; finite Larmor radius stabilization; minimum-B stability; and universal instabilities. Typical text: Schmidt, Physics of High Temperature Plasmas. Fall semester. Prerequisite: PEP 555, PEP 642, PEP 643

PEP 608   Plasma Physics II   (3 - 0 - 3)

Motion of charged particles in electromagnetic field; Boltzmann equation for plasma; properties of magnetoplasmas; and fundamentals of magnetohydrodynamics. Applications to include: mirror geometry, high frequency confinement, plasma confinement, and heating by means of magnetic fields; motion of plasmas along and across magnetic field lines; magnetohydrodynamic stability theory; plasma oscillations; microinstabilities waves in magnetoplasma; dispersion relations; Fokker-Planck equation for plasmas; plasma conductivity; runaway electrons; relaxation times; radiation phenomena in magnetoplasmas; stability theories; finite Larmor radius stabilization; minimum-B stability; and universal instabilities. Typical text: Schmidt, Physics of High Temperature Plasmas. Spring semester. Prerequisite: PEP 607

PEP 610   Advanced Modern Optics Laboratory   (3 - 0 - 3)

A continuation of PEP 510 for those students desiring a more thorough knowledge of optical systems. Included would be the use of an OTDR, ellipsometry, vacuum deposition of thin films, and other instrumentation. Students are encouraged to pursue their individual interests using the available equipment.Spring or fall term by arrangement. Prerequisite: PEP 510

PEP 619   Solid State Devices   (3 - 0 - 3)

Operating principle, modeling, and fabrication of solid state devices for modern optical and electronic system implementation; recent developments in solid state devices and integrated circuits; devices covered include bipolar and MOS diodes and transistors, MESFET, MOSFET transistors, tunnel, IMPATT and BARITT diodes, transferred electron devices, light emitting diodes, semiconductor injection and quantum-well lasers, PIN, and avalanche photodetectors. Prerequisite: EE 503

PEP 621   Quantum Chemistry   (3 - 0 - 3)

Theorems and postulates of quantum mechanics; operator relationships; solutions of the Schrödinger equation for model systems; variational and perturbation methods; pure spin states; Hartree-Fock self-consistent field theory; and applications to many-electron atoms and molecules. CH 520 is an alternative prerequisite. Prerequisite: PEP 554

PEP 626   Optical Communication Systems   (3 - 0 - 3)

Topics covered include components for and design of optical communication systems; propagation of optical signals in single mode and multimode optical fibers; optical sources and photodetectors; optical modulators and multiplexers; optical communication systems: coherent modulators, optical fiber amplifiers and repeaters, transcontinental and transoceanic optical telecommunication system design; optical fiber local area networks.

PEP 630   Nonlinear Dynamics   (3 - 0 - 3)

Definition of dynamical systems; phase space and equilibrium states and their classification; nonlinear oscillator with and without dissipation; Van der Pol generator; Poincare map; slow and fast motion; forced nonlinear oscillator: linear and nonlinear resonances; forced generators: synchronization; Poincaré indices and bifurcations; solitons; shock waves; weak turbulence; regular patterns in dissipative media; and chaos: fractal dimension, and Lyapunov exponents. Typical textbooks: H.D.I. Abarbanel, M.I. Rabinovich, and M.M. Sushchik, Introduction to Nonlinear Dynamics for Physicists; R.H. Abraham and C.D. Shaw, Dynamics: The Geometry of Behavior. Prerequisite: PEP 528

PEP 642   Mechanics   (3 - 0 - 3)

Lagrangian and Hamiltonian formulations of mechanics, rigid body motion, elasticity, mechanics of continuous media, small vibration theory, special relativity, canonical transformations, and perturbation theory. Typical text: Goldstein, Classical Mechanics. Prerequisite: PEP 538

PEP 643   Electricity and Magnetism I   (3 - 0 - 3)

Electrostatics, boundary value problems, Green's function techniques, methods of image, inversion, and conformal mapping; multipole expansion. Magnetostatics, vector potential. Maxwell's equations and conservation laws. Electromagnetic wave propagation in media. Crystal optics. Fall semester. Typical texts: Jackson, Classical Electrodynamics; Landau and Lifshitz, Electrodynamics in Continuous Media. Prerequisite: PEP 542

PEP 644   Electricity and Magnetism II   (3 - 0 - 3)

Interaction of electromagnetic waves with matter, dispersion, waveguides and resonant cavities, radiating systems, scattering and diffraction, covariant electromagnetic theory, motion of relativistic particles in electromagnetic fields, relativistic radiation theory, radiation damping, and self-fields. Spring semester. Typical texts: Jackson, Classical Electrodynamics and Landau and Lifshitz, The Classical Theory of Fields, Electrodynamics in Continuous Media. Prerequisite: PEP 643

PEP 651   Advanced Physics Lab II   (3 - 3 - 0)

Advanced laboratory work in modern physics arranged to suit your requirement. Fall and spring semesters.Typical text: see PEP 551.

PEP 653   Quantum Mechanics II   (3 - 0 - 3)

This course is a continuation of PEP 554. Topics include: principles of quantum dynamics, time-dependent perturbation theory, scattering theory, the density matrix, quantization of the electromagnetic field, interaction of photons with atoms and non-relativistic particles, identical particles, and second quantization for many-body systems. Typical text: Quantum Mechanics by E. Merzbacher. Prerequisites: PEP 542, PEP 554

PEP 657   Quantum Field Theory Methods in Statistical and Many-Body Physics   (3 - 0 - 3)

Dirac notation; Transformation theory; Second quantization; Particle creation and annihilation operators; Schrodinger, Heisenberg and Interaction Pictures; Linear response; S-matrix; Density matrix; Superoperators and non-Markovian kinetic equations; Schwinger Action Principle and variational calculus; Quantum Hamilton equations; Field equations with particle sources, potential and phonon sources; Retarded Green's functions; Localized state in continuumand chemisorption; Dyson equation; T-matrix; Impurity scattering; Self-consistent Born approximation;Density-of-states;Greens function matching; Ensemble averages and statistical thermodynamics, Bose and Fermi distributions, Bose condensation; Thermodynamic Green's functions; Lehmann spectral representation; periodicity/antipeiodicity in imaginary time and Matsubara Fourier series/frequencies; Anallytic continuation to real time; Multiparticle Green's functions; Electromagnetic current-current correlation response; Exact variational relations for multiparticle Green's functions; Cumulants; Linked cluster theorem; Random phase approximation; Perturbation theory for green's functions, self-energy and vertex functions by variational differential formulation; Shielded potential perturbation theory;Imaginary time contour ordering Langreth algebra and the GKB Ansatz. Typical texts: Kadanoff and Baym, Quantum Statistical Mechanics, and Inkson, Many-Body Theory of Solids. Corequisite: PEP 554 Prerequisite: PEP 242

PEP 658   Quantum Statistical Mechanics   (3 - 0 - 3)

The course features the application of modern field theory methods and especially Feynman diagrams to fermion and boson system and critical phenomena. The initial text will be Quantum field theory and statistical physic by Abrikosov, Gorkov and Dzyalizhinski. Also discussed will be an introduction to scaling and the renormalization group (Wilson papers, texts of Pfeuty and Toulose, Ma and Reichl). Other topics will include broken symmetry non-phonon mechanisms in fermion superconductivity, field theory generalizations of the independent particle or Hartree-Fock model for non-homogeneous Fermion systems, Feynman path integrals and Wiener measure in statistical physics, exact properties of the Ising model, Feynman path integrals and Wiener measure in statistical physics, onset of ferromagnetism and spin-fluctuations. Prerequisite: PEP 242

PEP 661   Solid State Physics I (3 - 0 - 3)

Crystal symmetry. Space-group-theory analysis of normal modes of lattice vibration, phonon dispersion relations, and Raman and infrared activity. Crystal field splitting of ion energy level and transition selection rules. Bloch theorem and calculation of electronic energy bands through tight binding and pseudopotential methods for metals and semiconductors and Fermi surfaces. Transport theory, electrical conduction, thermal properties, cyclotron resonance, de Haas van Alfen, and Hall effects. Dia-, para-, and ferro-magnetism and magnon spinwaves. Fall semester. Typical texts: Callaway, Quantum Theory of Solid State; Ashcroft and Mermin, Solid State Physics; and Kittel, Quantum Theory of Solids. Prerequisite: PEP 544

PEP 662   Solid State Physics II (3 - 0 - 3)

Crystal symmetry. Space-group-theory analysis of normal modes of lattice vibration, phonon dispersion relations, and Raman and infrared activity. Crystal field splitting of ion energy level and transition selection rules. Bloch theorem and calculation of electronic energy bands through tight binding and pseudopotential methods for metals and semiconductors and Fermi surfaces. Transport theory, electrical conduction, thermal properties, cyclotron resonance, de Haas van Alfen, and Hall effects. Dia-, para-, and ferro-magnetism and magnon spinwaves. Spring semester. Typical texts: Callaway, Quantum Theory of Solid State; Ashcroft and Mermin, Solid State Physics; and Kittel, Quantum Theory of Solids. Prerequisite: PEP 661

PEP 667   Statistical Mechanics (3 - 0 - 3)

Advanced transport theory, classical statistical mechanics, fluctuation theory, quantum statistical mechanics, ideal Bose and Fermi gases, imperfect gases, phase transitions, superfluids, Ising model critical phenomena, and renormalization group. Typical text: Huang, Statistical Mechanics. Prerequisite: PEP 555

PEP 678   Physics of Optical Communication Systems (3 - 0 - 3)

This course explains the physics behind modern optical communication systems at high data rates. The first half of this course covers information theory and light propagation over fiber optic waveguide channels; semiconductor laser sources and detectors; high speed digital optic links; and dense wavelength division multiplexing methods and devices. The second half of this course covers quantum optical information theory; coherent systems and quantum correlations; optical solition-based communication; squeezed light and noise limitations; de-phasing and de-coherence; teleportation and secure communication system protocols; and cryptography and chaotic optics. Prerequisite: PEP 553

PEP 679   Fourier Optics (3 - 0 - 3)

Abbe diffraction theory of image formation, spatial filtering, coherence lengths, and areas. Holograms; speckle photography; impulse response function; CTF, OTF, and MTF of lens system; and coherent and incoherent optical signal processing. Spring semester. Typical text: Goodman, Introduction to Fourier Optics.

PEP 680   Quantum Optics (3 - 0 - 3)

This course explores the quantum mechanical aspects of the theory of electromagnetic radiation and its interaction with matter. Topics covered include Einstein's theory of emission and absorption, Planck's law, quantum theory of light-matter interaction, classical fluctuation theory, quantized radiation field, photon quantum statistics, squeezing, and nonlinear interactions. Offered in alternate years. Typical text: Loudon, Quantum Theory of Light. Prerequisites: PEP 509, PEP 542, PEP 554

PEP 685   Physical Design of Wireless Systems (3 - 0 - 3)

Physical design of wireless communication systems, emphasizing present and next generation architectures. Impact of non-linear components on performance; noise sources and effects; interference; optimization of receiver and transmitter architectures; individual components (LNAs, power amplifiers, mixers, filters, VCOs, phase-locked loops, frequency synthesizers, etc.); digital signal processing for adaptable architectures; analog-digital converters; new component technologies (SiGe, MEMS, etc.); specifications of component performance; reconfigurability and the role of digital signal processing in future generation architectures; direct conversion; RF packaging; minimization of power dissipation in receivers.

PEP 690   Introduction to VLSI Design (3 - 0 - 3)

Introduction to the principles and design techniques of very large scale integrated circuits (VLSI). Topics include: MOS transistor characteristics, DC analysis, resistance, capacitance models, transient analysis, propagation delay, power dissipation, CMOS logic design, transistor sizing, layout methodologies, clocking schemes, case studies. Students will use VLSI CAD tools for layout, and simulation.

PEP 691   Physics and Applications of Semiconductor Nanostructures   (3 - 0 - 3)

This course is intended to introduce the concept of electronic energy band engineering for device applications. Topics to be covered are electronic energy bands, optical properties, electrical transport properties of multiple quantum wells, superlattices, quantum wires, and quantum dots; mesoscopic systems, applications of such structures in various solid state devices, such as high electron mobility, resonant tunneling diodes, and other negative differential conductance devices, double-heterojunction injection lasers, superlattice-based infrared detectors, electron-wave devices (wave guides, couplers, switching devices), and other novel concepts and ideas made possible by nano-fabrication technology. Fall semester. Typical text: M. Jaros, Physics and Applications of Semiconductor Microstructures; G. Bastard, Wave Mechanics Applied to Semiconductor Heterostructures. Prerequisites: PEP 503, PEP 553

PEP 700   Quantum Electron Physics and Technology Seminar   (1 - 0 - 1)

This seminar is focused on nanostructure-scale electron systems that are so small that their dynamic and statistical properties can only be properly described by quantum mechanics. This includes many submicron semiconductor devices based on heterostructures, quantum wells, superlattices, etc., and it interfaces solid state physics with surface physics and optics. Outstanding visiting scientists make presentations, as well as some faculty members and doctoral research students discussing their thesis work and related journal articles. Participation in these seminars is regarded as an important part of the research education of a physicist working in condensed matter physics and/or surface physics and optics.

PEP 701   Seminar on Current Topics in Physics and Applications   (1 - 0 - 1)

This seminar is focused on current topics in physics and their applications in various areas. The format of the seminar is similar to PEP 700, but the scope of the seminar covers a broader range of topics, including interdisciplinary areas and applications such as low-temperature plasma science and technology, atmospheric and environmental science and technology, and other topics. One credit per semester. PEP 700 and PEP 701 may be taken for up to three credits.

PEP 704   Group Theory for Physics in Solid State and Molecular Physics   (3 - 0 - 3)

Group theory for physicists with applications to solid state and molecular physics. Relation between group theory and quantum (or classical) mechanics, between classes and observables, and between representations and states. Point groups: full rotation group, crystallographic point groups, and spin-associated double groups. Crystal field theory with and without spin, selection rules and character tables, and use of product representation. Form of macroscopic crystal tensors molecular vibrational states and spectra. Translational properties of crystals. Energy band structure. Formal classification of space groups with examples. Time reversal and Onsager relations with examples. Lattice vibrations and phonons. Localized valence orbitals in chemistry. Hartree-Fock many-electron wave-functions. Phase transitions. Representative texts: M. Lax Symmetry, Principles in Solid State and Molecular Physics; Heine Group, Theory in Quantum Mechanics. Prerequisite: PEP 554

PEP 722   Molecular Spectroscopy   (3 - 0 - 3)

Theoretical foundations of spectroscopic methods and their application to the study of atomic and molecular structure and properties; theory of absorption and emission of radiation; line spectra of complex atoms; group theory; rotational, vibrational, and electronic spectroscopy of diatomic and polyatomic molecules; infrared, Raman, and uv-vis spectroscopy; laser spectroscopy and applications; photoelectron spectroscopy; and multi-photon processes. Prerequisites: PEP 509, PEP 554

PEP 740   The Physics of Nanostructures   (3 - 0 - 3)

Progress in the technology of nanostructure growth; space and time scales; quantum confined systems; quantum wells, coupled wells, and superlattices; quantum wires and quantum dots; electronic states; magnetic field effects; electron-phonon interaction; and quantum transport in nanostructures: Kubo formalism and Butikker-Landau formalism; spectroscopy of quantum dots; Coulomb blockade, coupled dots, and artificial molecules; weal localization; universal conductance fluctuations; phase-breaking time; theory of open quantum systems: fluctuation-dissipation theorem; and applications to quantum transport in nanostructures. Prerequisites: PEP 554, PEP 661

PEP 750   Quantum Field Theory   (3 - 0 - 3)

This course is open to students who have taken PEP 754 or its equivalent. It concerns itself with modern field theory; such topics as Yang-Mills fields, the renormalization group, and functional integration. It will concern itself with applications to both elementary particles and condensed matter physics; i.e. the theory of critical exponents. Typical text: C. Quigg, Gauge Theories of Strong, Weak, and Electromagnetic Interactions. Prerequisite: PEP 754

PEP 751   Elementary Particles   (3 - 0 - 3)

This course is open to students who have taken PEP 754 or its equivalent. It is an introduction to the theory of elementary particles. It stresses symmetries of both the strong and weak interactions. It presents a detailed study of SU(3) and the quark model, as well as the Cabbibo theory of the weak interactions. Typical text: F. Close, An Introduction to Quarks and Partons. Prerequisite: PEP 754

PEP 754   Advanced Quantum Mechanics   (3 - 0 - 3)

This course is an introduction to relativistic quantum mechanics and quantum field theory. Relativistic wave equations, including the Klein-Gordon equation and the Dirac equation. Commutation relation and canonical quantization of free fields. Spin and statistics of Bose and Fermi fields. Interacting quantum fields: interaction representation and S-matrix perturbation theory, Feynman diagrams, and renormalization theory with applications to quantum electrodynamics. Typical texts: Advanced Quantum Mechanics by J. J. Sakurai and Quantum Field Theory by F. Mandl and G. Shaw. Prerequisite: PEP 653

PEP 764   Advanced Quantum Mechanics IIs   (3 - 0 - 3)

Second quantization of Bose and Fermi fields; interaction and Heisenberg pictures; S-matrix theory; quantum electrodynamics; diagrammatic techniques. Fall semester, by reqeust. Typical texts: Mandl, Introduction to Quantum Field Theory; Sakurai, Advanced Quantum Mechanics.

PEP 777   Methods of Quantum Control   (3 - 0 - 3)

Since its emergence over 75 years ago, quantum mechanics brings each generation new challenging investigations and discoveries of quantum phenomena. In this course we introduce the results of research on quantum properties of light and matter that afford the possibility of unprecedented control over dynamics of atoms and molecules. The course Methods of Quantum Control is developed for students interested in understanding of the light-matter interactions and learning about advanced methods of control of ultrafast dynamics in atomic and molecular systems using femtosecond laser pulses that allow one to achieve a desired quantum yield. Topics include: Photoexcitation of a molecule with a pulse of light. Photodissociation. Energy-resolved quantities. Weak-field coherent control. Photodissociation from a Superposition State. One- vs. Three-Photon Interference. Pump-dump control, Tannor-Rice scheme. Wave packet motion on a potential energy surface. Pump-dump excitation with many levels. Silberg's model using the phase step. Applications for selective excitation. Strong-field control. Femtosecond pulses. Time-dependent problems. Two-level systems. Rotating-wave approximation. State-interaction representation. Field-interaction representation. Dressed-state analysis. Rabi Oscillations. Strong-field control by pulse area, pi-pulses. Stimulated Raman Spectroscopy. Maxwell-Bloch equations. Control by femtosecond pulse amplitude modulation. Strong-field control using chirped pulses. Characteristics of chirped laser pulses. Adiabatic dressed states. Adiabatic passage. Dark states, Stimulated Raman adiabatic passage. Non-impulsive Raman scattering. Chirped pulse adiabatic passage control. Optimal Control theory. Adaptive learning technique. Applications: selective excitation of vibrational modes in molecular gas $CO2$ and liquid methanol. Coherent control in equilibrated condensed phases. Density matrix representation. Liouville von Neumann equations with relaxation terms in the field-interaction representation. Dressed states in the density matrix representation in the presence of dephasing. Prerequisites: PEP 527, PEP 554

PEP 800   Special Topics in Physics (MS)   (3 - 0 - 0)

Topics include any one of the following: magnetohydrodynamics, quantum mechanics, general relativity, many-body problem, nuclear physics, quantum field theory, low temperature physics, diffraction theory,and particle physics. Limit of six credits for the master's degree.

PEP 801   Special Topics in Physics (PhD)   (1 - 0 - 1)

One to six credits. Limit of six credits for the degree of Doctor of Philosophy.

PEP 810   Special Topics in Physics and Engineering Physics   (3 - 0 - 3)

A participating seminar on topics of current interest and importance in Physics and Engineering Physics.

PEP 900   Thesis in Physics (MS)   (0 - 0 - 0)

For the degree of Master of Science. Five to ten credits with departmental approval.

PEP 901   Thesis in Engineering Physics   (0 - 0 - 0)

For the degree of Master of Engineering. Five to ten credits with departmental approval.

PEP 960   Research in Physics (PhD)   (1 - 0 - 1)

Original experimental or theoretical research undertaken under the guidance of the faculty of the department which may serve as the basis for the dissertation required for the degree of Doctor of Philosophy. Hours and credits to be arranged. This course is open to students who have passed the doctoral qualifying examination; a student who has already taken the required doctoral courses may register for this in the term in which s/he intends to take the qualifying examination.

SCHOOL OF SYSTEMS AND ENTERPRISES (SSE)

SCHOOL OF SYSTEMS AND ENTERPRISES (SSE)

The mission of the School of Systems and Enterprises is to provide students with a research-centered interdisciplinary and transdisciplinary education embedded in systems thinking and design. SSE focuses on applying a systems approach that teaches technical leaders to view challenges from all angles, to understand the nature and complexity of enterprise-wide problems and to conceive creative solutions that achieve breakthrough results across a range of domains.

The School of Systems and Enterprises will build on its strengths as a world leader in systems science and engineering to play an evolutionary role in facilitating efficient solutions to some of the most pressing challenges facing our society. The school will effectively educate thought and technical leaders who will impact global challenges in research and development, policy and strategy, and entrepreneurial innovation in academia, business and government.

FACULTY & AFFILIATES

Kathryn Abel, Ph.D.
Teaching Associate Professor; Undergraduate Engineering Management Program Lead and Undergraduate Industrial and Systems Engineering Program Lead

Onur Asan, Ph.D.
Associate Professor

Anthony Barrese, Ph.D.
Teaching Professor and Interim Vice Provost for Academics

Alparsian Emrah Bayrak, Ph.D.
Assistant Professor

Mark Blackburn, Ph.D.
Senior Research Scientist

Robbie Cohen, Ph.D.
Teaching Professor

Mo Dehghani, Ph.D.
Professor and Vice Provost for Research, Innovation and Entrepreneurship

Ralph Giffin
Distinguished Service Professor

Paul Grogan, Ph.D.
Assistant Professor

Yeganeh M. Hayeri, Ph.D.
Assistant Professor

Steven Hoffenson, Ph.D.
Assistant Professor

Eirik Hole
Senior Lecturer

Benjamin Kruse, Ph.D.
Research Assistant Professor

Carlo Lipizzi, Ph.D.
Teaching Assistant Professor, Graduate Engineering Management Program Lead

Mo Mansouri, Ph.D.
Research Associate Professor and Systems Engineering and Socio-Technical Program Lead

Yehia Massoud, Ph.D.
Professor and Dean

Roshanak Nilchiani, Ph.D.
Associate Professor

Michael Pennock, Ph.D.
Assistant Professor and Associate Director, CCSE

Jose Emmanuel Ramirez Marquez, Ph.D.
Associate Professor and Director, Enterprise Science and Engineering Division

Bill Robinson
Teaching Professor

William Rouse, Ph.D.
Alexander Crombie Humphreys Professor and Director, CCSE

James Rowland
Lecturer

Earl Sprague
Lecturer

Dinesh Verma, Ph.D.
Professor and Executive Director, Systems Engineering
Research Center (SERC)

Gregg Vesonder, Ph.D.
Teaching Professor and Software Engineering
Program Lead

Jon Wade, Ph.D.
Research Professor, Chief Technology Officer of the
Systems Engineering Research Center (SERC);
Director, Systems and Software Division

Lu Xiao, Ph.D.
Assistant Professor

Ye Yang, Ph.D.
Associate Professor

Zhongyuan Yu, Ph.D.
Research Assistant Professor

Teresa Zigh, Ph.D.
Teaching Associate Professor

Rajarathnam Chandramouli, Ph.D.
Joint SSE and SES Chaired Professor

Undergraduate Programs

ENGINEERING MANAGEMENT

Stevens has a 140-year history of leading innovation in engineering, science and technology. One of the first universities in the world to offer an engineering management program, today, Stevens continues to advance the discipline of Engineering Management for the 21st century.

The Stevens Engineering Management program prepares students to become decision makers that are able to engineer solutions for complex management problems. Upon graduation, students are able to assume professional positions of increasing responsibility across a broad range of industries, such as: healthcare, technology, business, finance, manufacturing, and information systems.

Bachelor of Engineering in Engineering Management

Engineering Management (EM) is a rapidly expanding field that integrates engineering, technology, management, systems, and business. High-technology companies in the telecommunications, financial services, manufacturing, pharmaceutical, consulting, information technology and other industries utilize the concepts and tools of EM such as project management, quality management, engineering economics, modeling and simulation, systems engineering and integration, and statistical tools. These technology-based companies recruit EM graduates for their expertise in these tools and techniques and to fill a critical need of integrating engineering and business operations.

The EM program combines a strong engineering core with training in accounting, cost analysis, managerial economics, quality management, project management, production and technology management, systems engineering, and engineering design. The course selection offered by this major exemplifies the Stevens interdisciplinary approach to developing strong problem-solving skills. The program prepares students for careers that involve the complex interplay of technology, people, economics, information, and organizations. The program also provides the skills and knowledge needed to enable students to work effectively at the interface between engineering and management and to assume professional positions of increasing responsibility in management or as key systems integrators. Concentrations are available in two areas:

▸ Systems Engineering

▸ Financial Engineering

Bachelor of Engineering in Engineering Management Mission & Objectives

The mission of the Bachelor of Engineering in Engineering Management (BEEM) Program is to provide an education based on a strong engineering core, complemented by studies in business, technology, systems, and management, to prepare the graduate to work at the interface between technology/engineering and management, and to be able to assume positions of increasing technical and managerial responsibility. The objectives of the EM program can be summarized as follows:

▸ EM graduates define, design, develop and assess solutions, as well as manage resources and processes to address complex multidisciplinary problems through their strong broad-based foundation and engineering management education and knowledge of modern technological tools.

▸ EM graduates effectively lead and work on multidisciplinary project teams and are able to communicate and solve real world problems using knowledge and tools gained from their engineering management education.

▸ EM graduates continue sustained intellectual growth in the corporate or academic world.

427

▸ EM graduates successfully adapt to diverse technological and societal conditions to bring innovative, flexible and ethical solutions to their work.

Minor in Engineering Management

▸ EM 275 Project Management

▸ EM 301 Accounting & Business Analysis

▸ EM 360 Operations Management and Process Engineering

▸ EM 480 Managing the Development Enterprise

EM Minors take the following courses as part of the Engineering Curriculum:

Required Engineering Core

▸ E 355 Engineering Economics

▸ E 243 Probability and Statistics for Engineers

▸ IDE 400/401 Senior Innovation

▸ IDE 402 Senior Innovation III

Required Humanities Core

▸ BT 243 Macroeconomics

▸ BT 244 Microeconomics

An EM minor requires a two-course overload.

Approved Courses from the Major Department for the SE Minor

These courses may also satisfy requirements within the major department. Some may have prerequisites, which must be taken within the requirements for the major or as additional overload and do not satisfy any SE Minor requirements.

Electrical Engineering

▸ EE 441 Introduction to Wireless Systems, or

▸ EE 478 Control Systems

Computer Engineering

▸ CPE 441 Introduction to Wireless Systems

Mechanical Engineering

▸ ME 421 Energy Conversion Systems, or

▸ ME 483 Control Systems

Environmental Engineering

▸ EN 377 Environmental Systems

Biomedical Engineering

▸ BME 504 Medical Instrumentation and Imaging

Chemical Engineering

▸ CHE 462 Chemical Process Control

Civil Engineering

▸ CE 410 Transportation Engineering Design

Naval Engineering

▸ OE 524 Introduction to Ship Design and Ship Building

Engineering Management Curriculum

Term I

Course #	Course Name	Lecture	Lab	Study	Credit
CH 115	General Chemistry I	3	0	6	3
CH 117	General Chemistry Laboratory I	0	3	1	1
E 101	Engineering Experiences I	1	0	0	1
E 120	Engineering Graphics	0	2	1	1
E 121	Engineering Design I: Introduction to Systems Thinking	0	3	2	2
E 115	Introduction to Programming	1	2	3	2
CAL 103	Writing And Communications Colloquium	3	0	6	3
MA 121; MA 122	Differential Calculus; Integral Calculus	4	0	8	4
	Total	**12**	**10**	**27**	**17**

Term II

Course #	Course Name	Lecture	Lab	Study	Credit
S.E.	Science Elective I[3]	3	0	6	3
PEP 111	Mechanics	3	0	6	3
E 122	Engineering Design II: Field Sustainable Systems with Sensors	0	3	3	2
CAL 105	CAL Colloquium: Knowledge, Nature, Culture	3	0	6	3
MA 123; MA 124	Series, Vectors, Functions, and Surfaces; Calculus of Two Variables	4	0	8	4
MGT 103	Introduction to Entrepreneurial Thinking	1	2	0	2
	Total	**14**	**5**	**29**	**17**

Term III

Course #	Course Name	Lecture	Lab	Study	Credit
MA 221	Differential Equations	4	0	8	4
PEP 112	Electricity and Magnetism	3	0	6	3
E 126	Mechanics of Solids	4	0	8	4
E 231	Engineering Design III: Structural Performance and Failure	0	3	2	2
E 245	Circuits and Systems	2	3	7	3
HUM	Humanities	3	0	6	3
	Total	**16**	**6**	**37**	**19**

Term IV

Course #	Course Name	Lecture	Lab	Study	Credit
MA 227	Multivariable Calculus	3	0	6	3
E 232	Engineering Design IV: Systems with Analog Circuits	2	3	7	3
E 234	Thermodynamics	3	0	6	3
S.E.	Science Elective II[3]	3	0	6	3
EM 275	Project Management	3	0	6	3
EM 224	Informatics and Software Development	3	0	3	3
	Total	**17**	**3**	**34**	**18**

Term V

Course #	Course Name	Lecture	Lab	Study	Credit
ISE 350	Logistics and Supply Chain Management	3	0	6	3
E 321	Engineering Design V: Materials Selection and Process Optimization	0	3	2	2
E 344	Materials Processing	3	0	6	3
EM 301	Accounting & Business Analysis	3	3	4	4
EM 360	Operations Management and Process Engineering	3	0	3	3
EM 365	Statistics for Engineering Managers	3	2	4	4
	Total	**15**	**8**	**25**	**19**

Term VI

Course #	Course Name	Lecture	Lab	Study	Credit
E 355	Engineering Economics[1]	3	3	6	4
EM 322	Engineering Design VI	1	2	0	2
EM 345	Modeling and Simulation	3	0	3	3
EM 385	Innovative System Design	3	0	3	3
G.E.	General Elective[4]	3	0	6	3
EM 357	Elements Of Operations Research	3	0	3	3
IDE 400	Senior Innovation I[5]	1	0	2	1
	Total	**17**	**5**	**23**	**19**

Term VII

Course #	Course Name	Lecture	Lab	Study	Credit
T.E.	Technical Elective[6]	3	0	6	3
G.E.	General Elective[4]	3	0	6	3
IDE 401	Senior Innovation II	1	0	2	1
EM 423	Engineering Design VII	0	8	3	3
EM 489	Data-Mining and Risk Assessment or FE Concentration Elective	3	0	6	3
BT 244	Microeconomics[2]	3	0	6	3
	Total	**13**	**8**	**29**	**16**

Term VIII

Course #	Course Name	Lecture	Lab	Study	Credit
G.E.	General Elective[4]	3	0	6	3
EM 424	Engineering Design VIII	0	8	3	3
HUM	Humanities	3	0	6	3
BT 243	Macroeconomics[2]	3	0	6	3
IDE 402	Senior Innovation III	1	0	2	1
EM 480	Managing the Development Enterprise	3	0	0	3
	Total	**13**	**8**	**23**	**16**

(1) E 355 is a core course for all engineers that is taught by SSE faculty
(2) Students can take BT 243 and 244 in any semester; these courses are part of the humanities requirements.
(3) Science Electives: See pages 79-80 for details.
(4) General Electives: chosen by the student- can be used towards a minor or option- can be applied to research or approved international studies
(5) IDE 400 can be taken concurrently with IDE 401 in Term VII as determined by the engineering program
(6) This Technical elective must be a 500 level EM, ES, ISE, SES, SSW or SYS course

Concentrations in Engineering Management

EM students can select their concentration elective courses among two technical electives and three general electives in various ways. Some of the students may wish to cluster those electives in ways that would help them gain expertise in an area of specialization within Engineering Management. The following groupings are possible concentration areas that students can select from within the EM program:

Systems Engineering

‣ EM 357 Elements of Operations Research

‣ EM 385 Innovative Systems Design

‣ EM 585 Intro to Systems Architecture & Design

Financial Engineering

‣ EM 357 Elements of Operations Research

‣ FE 530 Intro to Financial Engineering

‣ FE 535 Financial Risk Management or QF 435 Risk Management

INDUSTRIAL AND SYSTEMS ENGINEERING

Today, engineers with strong roots in engineering and science, and with capability in data analysis, are needed to improve technology and processes in enterprises. The Industrial and Systems Engineering (ISE) program at Stevens prepares students with cross-disciplinary, 'big picture' systems perspectives and knowledge to engineer, develop and maintain complex systems.

Bachelor of Engineering in Industrial and Systems Engineering

The Industrial and Systems Engineering (ISE) program at Stevens is a rich educational experience that provides students with a broad-based engineering education and with a specialization in data analysis aspects of the industrial and systems engineering fields.

Industrial and Systems Engineers (ISEs) take a cross-disciplinary 'big picture' systems perspective of engineering problems. ISEs are concerned with designing, managing and implementing solutions to improve quality, performance and efficiency.

They reduce waste in all forms that do not generate value. In essence, ISEs figure out how to do things better; increasing customer satisfaction and internal efficiencies and decreasing costs.

ISE is systems oriented: it analyzes the interaction and interplay between components in complex system networks (of humans, machines and processes). Complex systems require modeling to understand variability. These models are used in the overall system development process and incorporated into system designs to enable optimized and robust operations.

ISEs are engineering professionals trained specifically to be productivity and quality improvement specialists, where they examine the entire system to make sure that people and things move together as efficiently and effectively as possible.

The Stevens ISE program is data driven; teaching the extraction of useful data from the plethora of information businesses collect and using this data in mathematical models and analytical tools to gain insight for problem solving and decision support.

ISE's have the ability to impact people's lives through their improvement of existing systems or creation of new systems in commercial and government segments. ISE's have a broad reach and can apply their skills to address problems and opportunities in many sectors (including manufacturing, service, aerospace, healthcare, transportation, energy, finance and entertainment) and settings (including sales, marketing, information systems, personnel and manufacturing).

ISEs fill positions as Industrial Engineers, System Engineers, System Integration Engineers, Quality Engineers, Project Engineers, Sales Engineers, Field Engineers and Application Engineers, as well as Analysts, Consultants and Planners.

Bachelor of Engineering in Industrial and Systems Engineering Mission & Objectives

The mission of the Bachelor of Engineering in Industrial and Systems Engineering Program is to provide an education based on a strong engineering core, complemented by studies in systems and data science, to prepare the graduate to work on cross-disciplinary systems and be able to assume positions of increasing technical responsibility. The objectives of the ISE program can be summarized as follows:

- Develop, implement and improve systems or subsystems comprised of people, processes, hardware or software elements that are innovative, reliable and cost-efficient.
- Use ISE tools to address real world problems and create solutions consistent with societal needs including economic, ethical and environmental considerations.
- Provide leadership for, and communicate effectively within, data-intensive, multidisciplinary team-based environments in diverse and dynamically changing organizations.
- Continue to develop skills in engineering, technology management, business and other Industrial and Systems Engineering related fields.

Minor in Industrial and Systems Engineering

The Minor in Industrial and Systems Engineering is open to engineering students enrolled in an engineering major. (Non-engineering majors are not eligible for this Minor.) An ISE minor requires a two-course overload. Students must possess a cumulative GPA of at least 3.0 at graduation.

Required courses for the minor are as follows:

- SYS 501 Probability & Statistics for Systems Engineers
- SYS 581 Introduction to Systems Engineering
- ISE 357 Elements of Operations Research I

Plus two of the following courses:

- ISE 345 Modeling and Simulation

‣ ISE 350 Logistics and Supply Chain Management

‣ ISE 457 Elements of Operations Research II

‣ EM 585 Introduction to System Architecture and Design

Plus the following required Engineering Core Courses – Interdisciplinary Senior Design:

‣ Ex 423 X1,X2, or X3 Section (ISE Minor Advisor serves as co-advisor)

‣ Ex 424 X1,X2, or X3 Section (ISE Minor Advisor serves as co-advisor)

Industrial and Systems Engineering Curriculum

Term I

Course #	Course Name	Lecture	Lab	Study	Credit
CH 115	General Chemistry I	3	0	6	3
CH 117	General Chemistry Laboratory I	0	3	1	1
E 101	Engineering Experiences I	1	0	0	1
E 120	Engineering Graphics	0	2	1	1
E 121	Engineering Design I: Introduction to Systems Thinking	0	3	2	2
E 115	Introduction to Programming	1	2	3	2
CAL 103	Writing And Communications Colloquium	3	0	6	3
MA 121; MA 122	Differential Calculus; Integral Calculus	4	0	8	4
	Total	**12**	**10**	**27**	**17**

Term II

Course #	Course Name	Lecture	Lab	Study	Credit
S.E.	Science Elective I[3]	3	0	6	3
PEP 111	Mechanics	3	0	6	3
E 122	Engineering Design II: Field Sustainable Systems with Sensors	0	3	3	2
CAL 105	CAL Colloquium: Knowledge, Nature, Culture	3	0	6	3
MA 123; MA 124	Series, Vectors, Functions, and Surfaces; Calculus of Two Variables	4	0	8	4
MGT 103	Introduction to Entrepreneurial Thinking	1	2	0	2
	Total	**14**	**5**	**29**	**17**

Term III

Course #	Course Name	Lecture	Lab	Study	Credit
MA 221	Differential Equations	4	0	8	4
PEP 112	Electricity and Magnetism	3	0	6	3
E 126	Mechanics of Solids	4	0	8	4
E 231	Engineering Design III: Structural Performance and Failure	0	3	2	2
E 245	Circuits and Systems	2	3	7	3
HUM	Humanities	3	0	6	3
	Total	**16**	**6**	**37**	**19**

Term IV

Course #	Course Name	Lecture	Lab	Study	Credit
MA 227	Multivariable Calculus	3	0	6	3
E 232	Engineering Design IV: Systems with Analog Circuits	2	3	7	3
E 234	Thermodynamics	3	0	6	3
S.E.	Science Elective II[3]	3	0	6	3
ISE 224	Informatics and Software Development	3	0	6	3
ISE 225	Data Infrastructures	3	0	6	3
	Total	**17**	**3**	**37**	**18**

Term V

Course #	Course Name	Lecture	Lab	Study	Credit
ISE 350	Logistics and Supply Chain Management	3	0	6	3
E 321	Engineering Design V: Materials Selection and Process Optimization	0	3	2	2
E 344	Materials Processing	3	0	6	3
Hum	Humanities	3	0	3	3
SYS 501	Probability & Statistics for Systems Engineers	3	0	3	3
EM 365	Statistics for Engineering Managers	3	2	4	4
	Total	**15**	**5**	**24**	**18**

Term VI

Course #	Course Name	Lecture	Lab	Study	Credit
E 355	Engineering Economics[1]	3	3	6	4
ISE 322	Engineering Design VI	1	2	0	2
ISE 345	Modeling and Simulation	3	0	3	3
ISE 357	Elements Of Operations Research I	3	0	3	3
G.E.	General Elective[4]	3	0	3	3
SYS 581	Introduction to Systems Engineering	3	0	3	3
IDE 400	Senior Innovation I[5]	1	0	2	1
	Total	**17**	**5**	**20**	**19**

Term VII

Course #	Course Name	Lecture	Lab	Study	Credit
G.E.	General Elective[4]	3	0	6	3
IDE 401	Senior Innovation II	1	0	2	1
ISE 423	Engineering Design VII	0	8	3	3
ISE 457	Elements of Operations Research II	3	0	6	3
BT 244	Microeconomics[2]	3	0	6	3
TE	Technical Elective[6]	3	0	6	3
	Total	**13**	**8**	**29**	**16**

Term VIII

Course #	Course Name	Lecture	Lab	Study	Credit
ISE 490	Data-Mining & Applied Machine Learning	3	0	6	3
G.E.	General Elective[4]	3	0	6	3
ISE 424	Engineering Design VIII	0	8	3	3
HUM	Humanities	3	0	6	3
ISE 451	Analysis of Networks and Strategies	3	0	6	3
IDE 402	Senior Innovation III	1	0	2	1
	Total	**13**	**8**	**29**	**16**

(1) E 355 is a core course for all engineers that is taught by SSE faculty

(2) Students can take BT 244 in any semester; the course is part of the humanities requirements.

(3) Science Electives: See pages 79-80 for details.

(4) General Electives: chosen by the student- can be used towards a minor or option- can be applied to research or approved international studies

(5) IDE 400 can be taken concurrently with IDE 401 in Term VII as determined by the engineering program

(6) This Technical elective must be a 500 level EM, ES, ISE, SES, SSW or SYS course.

Software Engineering

Bachelor of Engineering in Software Engineering

Software Engineering is the discipline dedicated to the engineering principles and techniques required for the sound construction of the computer systems of today and tomorrow. As businesses and institutions integrate new technologies to compete in the global environment they require individuals who are cognizant of the latest techniques in computational intelligence and are armed with the skills required to construct new dynamically interacting components.

Software engineers are trained in all aspects of software creation- from specification through analysis and design, to testing, maintenance and evaluation of the product. They are equipped with advanced knowledge in software architecture, project management, technical planning, risk management and software assurance – areas that are essential in implementing and overseeing software-intensive projects of high technical complexity.

Bachelor of Engineering in Software Engineering Mission and Objectives

The mission of the Bachelor of Engineering in Software Engineering (BESWE) Program is to provide an education based on a strong engineering core, complemented by a strong thread of systems thinking and critical thinking. Students will have an opportunity to explore a domain of interest where they may apply their software engineering skills. Graduates from this program will be able to:

▸ Design and develop software components for complex systems.

▸ Communicate with engineers of all disciplines in the languages and methods of those engineers.

▸ Understand the overall systems context for their projects and apply systems thinking in designing solutions that integrate components of different types, such as hardware, software, and people.

Software Engineering Curriculum

Term I

Course #	Course Name	Lecture	Lab	Study	Credit
CH 115	General Chemistry I	3	0	6	3
CH 117	General Chemistry Laboratory I	0	3	1	1
E 101	Engineering Experience I	1	0	0	1
E 120	Engineering Graphics	0	2	1	1
E 121	Engineering Design I: Introduction to Systems Thinking	0	3	2	2
E 115	Introduction to Programming	1	2	3	2
CAL 103	Writing And Communications Colloquium	3	0	6	3
MA 121; MA 122	Differential Calculus; Integral Calculus	4	0	8	4
	Total	**12**	**10**	**27**	**17**

Term II

Course #	Course Name	Lecture	Lab	Study	Credit
S.E.	Science Elective I[2]	3	0	6	3
PEP 111	Mechanics	3	0	6	3
E 122	Engineering Design II: Field Sustainable Systems with Sensors	0	3	3	2
CAL 105	CAL Colloquium: Knowledge, Nature, Culture	3	0	6	3
MA 123; MA 124	Series, Vectors, Functions, and Surfaces; Calculus of Two Variables	4	0	8	4
MGT 103	Introduction to Entrepreneurial Thinking	1	2	0	2
	Total	**14**	**5**	**29**	**17**

Term III

Course #	Course Name	Lecture	Lab	Study	Credit
MA 221	Differential Equations	4	0	8	4
PEP 112	Electricity and Magnetism	3	0	6	3
E 126	Mechanics of Solids	4	0	8	4
E 231	Engineering Design III: Structural Performance and Failure	0	3	2	2
E 245	Circuits and Systems	2	3	7	3
HUM	Humanities[2]	3	0	6	3
	Total	**16**	**6**	**37**	**19**

Term IV

Course #	Course Name	Lecture	Lab	Study	Credit
E 232	Engineering Design IV: Systems with Analog Circuits	2	3	7	3
E 234	Thermodynamics[5]	3	0	6	3
S.E.	Science Elective II[2]	3	0	6	3
MA 134	Discrete Math	3	0	6	3
SSW 215	Individual Software Engineering[5]	3	0	6	3
HUM	Humanities[1]	3	0	6	3
	Total	**17**	**3**	**37**	**18**

Term V

Course #	Course Name	Lecture	Lab	Study	Credit
ISE 350	Logistics and Supply Chain Management[5]	3	0	6	3
E 321	Engineering Design V: Materials Selection and Process Optimization	0	3	2	2
E 344	Materials Processing	3	0	6	3
E 243	Probability & Statistics	3	0	6	3
SSW 315	Object Based Software Development[5]	3	0	6	3
HUM	Humanities[1]	3	0	6	3
	Total	**15**	**3**	**32**	**17**

Term VI

Course #	Course Name	Lecture	Lab	Study	Credit
E 355	Engineering Economics[1]	3	3	6	4
SSW 345	Model-Based Software Engineering[5]	3	0	6	3
SSW 322	Software Design Evolution[5]	3	0	6	3
SSW 564	Software Requirements Engineering[5]	3	0	6	3
G.E.	General Elective[3]	3	0	6	3
D.E.	Domain Elective[3]	3	0	6	3
IDE 400	Senior Innovation I[6]	1	0	2	1
	Total	**19**	**3**	**38**	**20**

Term VII

Course #	Course Name	Lecture	Lab	Study	Credit
G.E.	General Elective[3]	3	0	6	3
SSW 555	Agile Methods for Software Development[5]	3	0	6	3
SSW 533	Software Estimation and Metrics[5]	3	0	6	3
D.E.	Domain Elective[4]	3	0	6	3
SSW 423	Engineering Design VII[5]	0	8	6	3
IDE 401	Senior Innovation II	1	0	2	1
	Total	**13**	**8**	**32**	**16**

Term VIII

Course #	Course Name	Lecture	Lab	Study	Credit
SSW 567	Software Testing and Quality Assurance[5]	3	0	6	3
SYS 581	Introduction to Systems Engineering[5]	3	0	6	3
G.E.	General Elective[3]	3	0	6	3
SSW 424	Engineering Design VIII[5]	0	8	3	3
HUM	Humanities[1]	3	0	6	3
IDE 402	Senior Innovation III	1	0	2	1
	Total	**13**	**8**	**29**	**16**

(1) Humanities Requirement: see pages 599-600 for details.
(2) Science Electives: See pages 79-80 for details.
(3) General Elective: Chosen by student; Can be used towards a minor or option; Can be applied to research or approved international studies.

(4) Domain Elective: Chosen by student; Can be used towards a minor or option.
(5) Core Option - Specific course determined by engineering program.
(6) IDE 400 can be taken concurrently with IDE 401 in Term VII as determined by the engineering program

Minor in Software Engineering

Students must possess a cumulative GPA of at least 2.7 at graduation. A Software Engineering Minor requires a two course overload. The following are the required courses:

- ▸ MA 134 Discrete Math or CS 135

- ▸ SSW 215 Individual Software Engineering

- ▸ SSW 315 Object Based Software Engineering

- ▸ SSW 345 Model Based Software Engineering

- ▸ SSW 555 Agile Methods

- ▸ SSW581 System Engineering Architecture

The following prerequisite is needed to undertake the minor program:

- ▸ E115 Introduction to Programming or CS115 Introduction to Computer Science

Graduate Programs

Today's engineered systems are more complex than their predecessors, not only in the sophistication of elements from which they are constructed, but in the number and nature of the interconnections between those elements. System failures today, whether an automobile malfunction on a busy highway or the loss of a spacecraft on a distant planet, are much more likely to result from an unanticipated interaction between elements than from the failure of a single part.

Enterprises represent a special case of systems, one with enormous economic importance. While not traditionally considered within the same domain as technical systems, enterprises are increasingly viewed as representatives of a broader class of human designed systems, of which technical systems are only one example.

Stevens created the School of Systems and Enterprises (SSE) with the mission to provide interdisciplinary and trans-disciplinary education and research rooted in systems thinking. We focus on applying a "systems approach" to better understand the nature of problems and opportunities, and to conceive novel concepts and solutions that achieve breakthrough results.

The following graduate programs are offered by SSE.

Master of Science

Software Engineering

The Software Engineering master's program combines a deep core in software engineering principles and practices with application to a series of increasingly complex systems challenges drawn from the real world. Our students are trained in all aspects of software creation- from specification through analysis and design, to testing, maintenance and evaluation of the product. They are equipped with advanced knowledge in software architecture, project management, technical planning, risk management and software assurance – areas that are essential in implementing and overseeing software-intensive projects of high technical complexity.

The master's degree requires 10 courses (30 credits): seven core required courses and three elective courses.

- ▸ SSW 540 Fundamentals of Software Engineering
- ▸ SSW 555 Agile Methods for Software Development Method
- ▸ SSW 564 Software Requirements Analysis and Engineering
- ▸ SSW 565 Software Architecture and Component-Based Design
- ▸ SSW 567 Software Testing, Quality Assurance and Maintenance
- ▸ SSW 533 Cost Estimation and Measurement
- ▸ SSW 695 Software Engineering Studio (Capstone)

Elective Courses

Electives must be approved by advisor and can be chosen from software engineering, engineering management or computer science. Students with extensive experience in software engineering may be able to substitute additional elective courses for some required courses, with the approval of their graduate studies advisor. Most students in the master's program come with a solid foundation in software programming and discrete mathematics, but students may also use their electives to take ramp courses in these areas.

Master of Engineering

Engineering Management

Many engineers find themselves at a decision point about five years after graduation, when they must choose either to continue with their technical specialty or to enter the ranks of technical management. Those who choose the latter often find themselves inadequately prepared for their new responsibilities, having little experience or training in management, accounting, business strategy, team development and other vital management skills. Engineering Management fills these gaps in engineering and science education with studies in business, management and systems engineering by affording the traditional engineer with formal education in the human, financial, and management skills necessary to develop high quality, cost efficient, technically complex systems and products.

The master's degree requires 10 courses (30 credits): six core required courses and four elective courses.

Required Core Courses

- ▸ EM 600 Engineering Economics and Cost Analysis
- ▸ EM 605 Elements of Operations Research
- ▸ EM 612 Project Management of Complex Systems
  - • *Or* EM 680 Designing and Managing the Development Enterprise
- ▸ EM 624 Informatics for Engineering Management
- ▸ SYS 660 Decision and Risk Analysis
- ▸ SYS 611 Systems Modeling and Simulation
  - • *Or* SYS 681 Dynamic Modeling of Systems and Enterprise

Elective Courses

Students are encouraged to take an integrated four-course sequence leading to a graduate certificate for the four electives; or choose the electives from our course catalog. All elective courses must be approved by an advisor. A list of available graduate certificates is included in this catalog and on the School of Systems and Enterprises website.

Systems Analytics

Data-driven insights and analytics are facilitating and optimizing intelligent decision-making across industries today. Intended to meet the need for professionals who can harness complex data and convert it into meaningful information, the master's in systems analytics at the School of Systems and Enterprises is providing students with expertise in visualizing, manipulating and extracting important concepts from systems data, and complementing it with traditional systems decision-making. The master's degree equips students with state-of-the art data visualization and knowledge extraction techniques for the purpose of analyzing trends, assessing risk, discovering patterns, and building decision models that can better develop, maintain and improve complex engineering systems and enterprises.

This master's degree consists of 10 courses* (30 credits): seven required core courses and four electives as described below.

*Please note: course total could equal 11 if the student elects to take the combination of the two FE courses that equals a total of three credits. See the listing below.

Required Core Courses

▸ EM 622 Data Analysis and Visualization Techniques for Decision-making

- *Or* ES 630 Modeling and Visualization of Complex Systems and Enterprises

▸ SYS 660 Decision and Risk Analysis

▸ SYS 670 Forecasting and Demand Modeling Systems

▸ ES 660 Multi-Agent Socio-Technical Systems

▸ SYS 611 Systems Modeling and Simulation

- *Or* SYS 681 Dynamic Modeling of Systems and Enterprises

▸ EM 623 Data Science and Knowledge Discovery in Engineering Management

- *Or* FE 582 Foundations of Financial Data Science (2 credits) *and*
- FE 513 Practical Aspects of Database Design Lab (1 credit)

Elective Courses

Students are encouraged to take and integrated four-course sequence leading to a graduate certificate for the four electives, or choose the electives from the course catalog. All elective courses must be approved by an advisor. A list of available graduate certificates is included in this catalog and on the School of Systems and Enterprises website.

Space Systems Engineering

The Master of Engineering in Space Systems Engineering at Stevens, delivered by the primary authors in the field of space systems today, provides experienced professionals with the edge needed to excel in this increasingly complex and competitive industry. Stevens is a recognized provider of space systems engineering education to NASA employees and space industry professionals worldwide, taught in partnership with Teaching Science and Technology, Inc. (TSTI). The degree allows professionals working in government and industry to combine a robust technical education in space systems design and development, as well as key space system engineering processes and tools, with a holistic understanding of systems engineering principles.

The program consists of 10 courses (30 credits): six required core courses, three (3) electives and a project or thesis.

Students without professional experience beyond the Bachelor's Degree taking a Master in Space Systems Engineering must take SYS 581 Introduction to Systems Engineering, preferably in the later stages of the senior design project. SYS 581 should be taken before the *Concept, Architecture & Design, Implementation* and *Sustainment* courses, if possible. All exceptions require approval of the advisor and systems engineering program director.

Required Core Courses

▸ Modeling, Simulation & Analysis:

One of:

- SYS 611 Systems Modeling & Simulation
- SYS 660 Decision and Risk Analysis

▸ Management:

- EM 612 Project Management of Complex Systems

▸ Concept:

One of:

- SYS 625 Fundamentals of Systems Engineering
- SYS 671 Conception of CPS: Deciding What to Build and Why

▸ Architecture & Design:

One of:

- SYS 632 Designing Space Missions and Systems
- SYS 635 Human Spaceflight

▸ Implementation:

One of:

- SYS 633 Mission and System Design, Verification and Validation
- SYS 605 Systems Integration

▸ Sustainment:

- SYS 637 Cost-Effective Space Mission Operations

Electives

Three (3) advisor approved electives (9 credits) can be chosen from SSE course offerings in (SYS) Systems Engineering, (SSW) Software Engineering, (EM) Engineering Management, (ES) Socio-Technical Systems, (SES) Systems Engineering Security or advisor approved courses. SYS 611, SYS 660 and SYS 645, if not already taken, are strongly recommended as electives.

Project or Thesis

At least three (3) credits and up to six (6) credits, must be applied towards a project (SYS 800 Special Problems in Systems Engineering), or a thesis (SYS 900 Thesis in Systems Engineering). If a thesis is chosen instead of a project, the completion of six (6) credits of SYS 900 is required, replacing SYS 800 and one elective course. The project or thesis should be in the concentration area.

Systems Engineering

The SSE Systems Engineering graduate program offers a multidisciplinary approach to engineering education by providing a blend of engineering, systems, and management subjects. Our graduates manage engineering and technology, are able to address systems integration, life cycle issues, and systems thinking at the system and enterprise levels, in a market where globalization, technology, quality, complexity, and productivity are the key business drivers. Concentrations are offered in: Large-Scale Cyber-Physical Systems, Embedded Cyber-Physical Systems, Space Systems, and Software Systems.

Completion of this program will result in the following Masters of Engineering degree in Systems Engineering with a concentration in:

- Large-Scale Cyber-Physical Systems

- Embedded Cyber-Physical Systems

- Space Systems

- Software Systems

- unspecified (if courses not taken in one concentration, as noted below)

Students satisfying the requirement for the Space Systems concentration, may alternatively receive a degree in Masters of Engineering in Space Systems Engineering. Students who, with their advisor's approval, choose not to complete all of the courses in a single concentration will receive a Masters of Engineering in Systems Engineering degree without a specified concentration.

The program consists of 10 courses (30 credits): six (6) required core courses, three (3) electives and a project or thesis. Three of these six required core courses are selected from one of four concentration areas.

Students without professional experience beyond the Bachelor's Degree taking a Master in Systems Engineering in a non-Software Systems concentration must take SYS 581 Introduction to Systems Engineering, preferably in the later stages of the senior design project. SYS 581 should be taken before the *Concept, Architecture & Design, Implementation* and *Sustainment* courses, if possible. Students without professional experience taking a concentration in Software Systems must take SSW 540 Fundamentals of Software Engineering. In addition, they must have competency in software programming. All exceptions require approval of the advisor and systems engineering program director.

Required Core Courses

- Modeling, Simulation & Analysis:

    One of:

    - SYS 611 Systems Modeling & Simulation

    - SYS 660 Decision and Risk Analysis

- Management:

    - EM 612 Project Management of Complex Systems

- Concept:

    One of:

    - SYS 625 Fundamentals of Systems Engineering

    - SYS 671 Conception of CPS: Deciding What to Build and Why

- Architecture & Design – Concentration (noted below)

- Implementation – Concentration (noted below)

- Sustainment – Concentration (noted below)

Concentrations

One course must be taken from each of the three (3) areas: Architecture & Design, Implementation, and Sustainment. To receive a concentration, these courses must be taken from a single concentration area. The following are the courses for Large-Scale Systems, Cyber-Physical Systems, Space Systems, and Software Systems concentrations.

Large-Scale Cyber-Physical Systems

▶ Architecture & Design:

- SYS 650 System Architecture and Design

▶ Implementation:

- SYS 605 Systems Integration

▶ Sustainment:

One of the following:

- SYS 640 System Supportability and Logistics and Supportability

- SYS 645 Design for System Reliability, Maintainability, and Supportability

Embedded Cyber-Physical Systems

▶ Architecture & Design:

- SYS 672 Design of CPS: Ensuring Systems Work and are Robust

▶ Implementation:

- SYS 673 Implementation of CPS: Bringing Solutions to Life

▶ Sustainment:

- SYS 674 Sustainment of CPS: Managing Evolution

Space Systems

▶ Architecture & Design:

One of the following:

- SYS 632 Designing Space Missions and Systems

- SYS 635 Human Spaceflight

▶ Implementation:

One of the following:

- SYS 633 Mission and System Design, Verification and Validation

- SYS 605 Systems Integration

▶ Sustainment:

- SYS 637 Cost-Effective Space Mission Operations

Software Systems

▶ Architecture & Design:

- SSW 565 Software Architecture and Component-Based Design

▶ Implementation:

- SSW 567 Software Testing, Quality Assurance, and Maintenance

▶ Sustainment:

- SSW 590 Devops Principles and Practice

Electives

Three (3) advisor approved electives (9 credits) can be chosen from SSE course offerings in (SYS) Systems Engineering, (SSW) Software Engineering, (EM) Engineering Management, (ES) Socio-Technical Systems, (SES) Systems Engineering Security or advisor approved courses. SYS 611, SYS 660 and SYS645, if not already taken, are strongly recommended as electives.

Project or Thesis:

At least three (3) credits and up to six (6) credits, must be applied towards a project (SYS 800 Special Problems in Systems Engineering), or a thesis (SYS 900 Thesis in Systems Engineering). If a thesis is chosen instead of a project, the completion of six (6) credits of SYS 900 is required, replacing SYS 800 and one elective course. The project or theses should be in the concentration area.

Master of Philosophy

The Master of Philosophy (M.Phil.) is a postgraduate research degree. It is offered to enrolled Ph.D. students who achieve a record of distinction during the pre-dissertation phase. Because the Master of Philosophy is not designed as a terminal degree, its requirements are integrated with the requirements for the Doctor of Philosophy degree: potential candidates for the Master of Philosophy degree must be qualified to pursue the doctorate and have been advised to apply for admission to a doctoral program.

This degree requires a minimum of two years of advanced study beyond the master's degree. Placed between the Master's degree and the Doctor of Philosophy, the Master of Philosophy marks a student's successful completion of all requirements for the doctorate, except the final phase of research and the dissertation. The degree is intended to provide recognition that a prospective doctoral candidate has successfully and expeditiously completed a major phase of graduate study and has achieved a comprehensive mastery of the general field of concentration.

Requirements

- Completion of doctoral course requirements: a minimum of 15 credits
- Completion of minimum doctoral research credits: a minimum of 15 credits
- Successful completion of qualifying exam
- Successful completion of proposal defense
- Be a doctoral student in good standing

DOCTORAL PROGRAMS

Requirements

- Completion of doctoral course requirements: a minimum of 15 credits
- Completion of minimum doctoral research credits: a minimum of 15 credits
- Successful completion of qualifying exam
- Successful completion of proposal defense
- Be a doctoral student in good standing

The programs leading to the Doctor of Philosophy (Ph.D.) degree are designed to develop the student's ability to perform research or high-level design in Systems Engineering, Engineering Management and/or Socio-Technical Systems. Admission to the doctoral program is made through the school's Doctoral Studies Committee and is based on a review of the candidate's scholastic record, professional accomplishments and the fit between his/her research objectives and those of the available SSE faculty. All admitted students must have the potential to advance the state of the art in their field of research.

For domestic students, admission to the doctoral programs in SSE requires that the candidate has graduated from an ABET accredited undergraduate program, preferably in engineering or science. A master's degree is usually required before a student is admitted to the doctoral program. A student's master's level academic performance and/or career must reflect his/her ability to pursue advanced studies and perform independent research. Typically a GPA of 3.5 or better at master's level and 3.0 or better at the undergraduate level is required for admission to the doctoral program. International students must also demonstrate proficiency in the English language prior to admission by scoring at least 550 (210 for computer-based) on the TOEFL examination.

All doctoral applicants are required to submit Graduate Record Exam (GRE) results. Applicants may submit GMAT scores in lieu of GREs for the Doctorate in Engineering Management.

In addition, each applicant must submit a current resume or curriculum vitae, three recommendations, evidence of written work and a statement of purpose. The Statement of Purpose should be limited to three pages and describe the applicant's academic interests, proposed course work, research interests and rationale, general career objectives and desired full/part-time student status. Applicants are strongly encouraged to review the available doctoral advisors on the SSE website http://www.stevens.edu/school-systems-enterprises/faculty and identify those who they believe are most closely aligned with their desired areas of research in their Statement of Purpose. The Statement of Purpose not only represents the student's interests, motivations and goals, but also is a reflection of his/her ability to communicate effectively and reflects the maturity of his/her research aspirations. Each applicant must submit an example of his/her written technical work. This work should be written solely by the applicant; published work, if available, is most desirable. All applications for part-time studies must include a letter of commitment from the applicant's employer.

Application Deadlines

- Fall applications: March 15th
    - If seeking financial support: February 1st
- Spring applications: October 15th
    - Applicants seeking financial support are encouraged to apply as early as possible

Coursework & Requirements

The following is a summary of coursework and the requirements for a doctoral degree in the School of Systems and Enterprises.

Course & Research Work

84 credits of graduate work in an approved program of study beyond the bachelor's degree consisting of:

- A maximum of 30 credit hours obtained in a master's program
- A minimum of 15 credits of additional graduate course work
- A minimum of 15 credit hours of dissertation work
- Completion of SSE core course requirements
- Completion of Stevens Doctoral Signature Course

Examinations

- Written and Oral Qualifying Examination – due by the end of the 4th semester
- Dissertation Proposal Defense (also called Preliminary Examination)
- Dissertation Defense (also called Final Examination)

Dissertation

The dissertation is the capstone of the doctoral program and should result in research that advances the state of the art in the chosen field. Dissertations may be written in a traditional format or composed of a portfolio where the main body of the dissertation integrates a set of refereed journals and peer reviewed conference papers, which are included as appendices for the details. Regardless of the format, the results of the research must be deemed publishable in major scholarly journals. The following are the guidelines for publication prior to dissertation defense, but should be considered the norm:

- One (1) accepted peer reviewed journal article
- One (1) submitted peer reviewed journal article
- Two (2) presented refereed conference papers

The intent of this requirement is the belief that peer reviewed research produces a superior dissertation, providing a broad review of quality and dissemination of the results to a wider community. (See http://library.stevens.edu/submit for specific formatting and submission information.)

All research that involves human subjects requires Institutional Review Board (IRB) approval.

Core Course Requirements

To ensure that every student has the skills to be successful in his/her chosen field, ensure consistency in skill set standards and provide a common experience between students, there are a number of core courses requirements.

Core courses required for all SSE doctorate degrees:*

- Systems Thinking - ES684
- Research Methods - SYS710
- Doctoral Signature Course - PRV961

Area Specific

Selection of one (1) course from each of the following two areas (other courses may be accepted based on the approval of the advisor and the Associate Dean of Research):

Quantitative Methods

- EM605 Elements of Operations Research
- FE610 Stochastic Calculus for Financial Engineers
- FE621 Computational Methods in Finance
- SYS611 Modeling and Simulation
- SYS645 Design for Reliability, Maintainability, and Supportability
- SYS660 Decision and Risk Analysis
- SYS670 Forecasting and Demand Modeling Systems
- SYS681 Dynamic Modeling of Systems and Enterprise

Economics, Financial Systems & Policy

- EM600 Engineering Economics and Cost Analysis
- FE620 Pricing and Hedging
- FE630 Portfolio Theory and Applications

‣ FE635 Financial Enterprise Risk Engineering

‣ FE655 Systemic Risk and Financial Regulation

‣ FE680 Advanced Derivatives

Domain Specific - Selection of three (3) courses from degree domain

Domain Non-Specific - Selection of one (1) course from any domain

Note that each doctoral program might have additional core course requirements. Students should contact their advisor to ensure that they have complied with their specific program requirements. In general, these are courses that are required for the master's degree in the area. It is recommended that the core course requirements are completed before the student enrolls in any elective courses.

Graduate Certificates

Certificates are offered on-campus, online and at sponsor locations. They can be completed as an individual credential or incorporated into a related master's degree for those meeting the program admission requirements. Certificates are four courses (12 credits) unless otherwise noted.

Advanced Systems Engineering

This Graduate Certificate will provide students with a solid foundation in the fundamentals and practical use of methods, processes and tools for the conception, architecture, modeling and simulation, and analysis of complex systems. The skills obtained will be applicable to the systems engineering of systems in other domains, but are focused on systems with the attributes of distributed control, complexity and evolution. Systems thinking, Model-based Systems Engineering and simulation approaches are emphasized.

Choose four from the following six courses:

‣ SYS 678 Agile Systems & Enterprises

‣ SYS 725 Advances in Systems of Systems Engineering

‣ ES 684 Systems Thinking

‣ SYS 750 Advanced System and Software Modeling and Assessment

‣ SYS 611 Systems Modeling and Simulation

‣ SYS 681 Dynamic Modeling of Systems and Enterprises

Data Exploration and Visualization for Risk and Decision Making

This graduate certificate will improve students' career toolkit to include decision making by visualizing, manipulating and extracting important concepts from data. The emphasis of this certificate is for the student to be able to understand the latest techniques in data visualization and knowledge extraction, and to leverage such understanding with the latest techniques for decision-making and risk analysis.

The required courses are:

‣ EM 622 Data Analysis and Visualization Techniques for Decision-making

‣ EM 623 Data Science and Knowledge Discovery in Engineering Management

‣ EM 624 Informatics for EM

‣ SYS 660 Decision and Risk Analysis

Engineering Management

Engineering Management (EM) is a rapidly expanding field that combines engineering, technology, management, systems and business. High-technology companies in the telecommunications, financial services, manufacturing, pharmaceutical, consulting, information technology and other industries utilize EM concepts and tools such as project management, quality management, engineering economics, modeling and simulation, systems engineering and integration, and statistical tools. Given that most students will spend most of their professional careers in a management or supervisory capacity, this certificate provides many of the skills necessary to be successful in the 21st century global economy.

The required courses are:

- EM 600 Engineering Economics and Cost Analysis
- EM 605 Elements of Operations Research
- EM 612 Project Management of Complex Systems
- EM 680 Designing and Managing the Development Enterprise

Integrated Ship Systems Engineering

This certificate provides professionals in government and industry with robust technical education in ship design and development, key ship systems engineering processes and tools, and a holistic understanding of systems engineering principles. With faculty advisor's approval, OE 524 can be waived for students with naval architecture background through undergraduate academics or work experience.

The required courses are:

- SYS 625 Fundamentals of Systems Engineering
- SYS 650 Systems Architecture and Design
- OE 661 Principles of Naval Ship Systems
- OE 660 Naval Ship Acquisition Process
- OE 524 Introduction to Ship Design and Ship Building

Logistics and Supply Chain Analysis

The logistics and supply chain analysis certificate focuses on the theory and practice of designing and analyzing supply chains. It will provide quantitative tools to identify key drivers of supply chain performance such as inventory, transportation, information and facilities from a holistic perspective. This graduate certificate program has a "how-to" orientation and the understanding gained in the courses can be immediately applied to the solution of on-the-job problems.

The required courses are:

- SYS 640 System Supportability and Logistics
- EM 665 Integrated Supply Chain Management
- SYS 670 Forecasting and Demand Modeling Systems
- EM 605 Elements of Operations Research
  - *Or* SYS 611 Systems Simulation and Modeling

Software Design and Development

This graduate program certifies that the student has a sound mastery of software development methods, processes and techniques. Students who complete the program should be well positioned to take technical leadership positions in software design and development.

The required courses are:

▸ SSW 555 Agile Methods for Software Development

▸ SSW 565 Software Architecture and Component-Based Design

▸ CS 574 Object-oriented Design and Analysis

▸ CS 546 Web Programming

- *Or* CS 548 Engineering of Enterprise Software Systems

Software Engineering

Creating successful systems is more than just writing software. This introductory certificate gives you a strong foundation in the fundamentals of software engineering - the engineering that is required to create software systems that work.

Core requirements are:

▸ SSW 540 Fundamentals of Quantitative Software Engineering

▸ SSW 533 Software Estimation and Measurement

Electives:

Choose two additional Software Engineering courses (SSW Prefix)

Or

Select two courses from the following list:

▸ SSW 555 Agile Methods for Software Development

▸ CS 501 Introduction to Java Programming

▸ CS 546 Web Programming

▸ EM 612 Project Management of Complex Systems

Software Systems Architecture

Software systems architecture is one of the most important activities in any system development project. Systems succeed or fail because of their architecture. This graduate certificate is an intensive, in-depth study of the best practices of software systems architecture and design.

The required courses are:

▸ SSW 540 Fundamentals of Software Engineering

▸ SYS 650 System Architecture and Design

▸ SSW 565 Software Architecture and Component-Based Design

▸ SYS 750 Advanced System & Software Architecture

Space Systems Engineering

The certificate integrates crucial activities spanning the entire life cycle. Information and capabilities are learned by participants in hands-on space system and mission design assignments focusing on: operations, concept development, space system architecture, verification and validation, as well as key system engineering processes and tools. These four courses provide the backbone for the development of space systems engineers. This certificate is relevant for professionals who wish to complement their existing knowledge and skills base to include state of the art spacecraft and mission analysis design combined with a holistic systems engineering and architecture perspective.

The required courses are:

- SYS 625 Fundamentals of Systems Engineering
- SYS 650 System Architecture and Design
- SYS 632 Designing Space Missions and Systems
    - *Or* SYS 635 Human Spaceflight
- SYS 633 Mission and Systems Design Verification and Validation
    - *Or* SYS 605 Systems Integration

Systems Supportability Engineering

This four-course cluster presents innovative methods and practices to integrate system reliability, maintainability, and supportability considerations into the systems engineering process. On the other hand, methods to optimize necessary logistics resources and processes are critical and are also studied in this sequence of courses. Current business trends are discussed and assessed.

Core Requirements:

- SYS 640 System Supportability and Logistics
- SYS 645 Design for System Reliability, Maintainability, and Supportability

Electives:

Select two courses from the following list:

- SYS 625 Fundamentals of Systems Engineering
- SYS 650 System Architecture and Design
- ES 684 Systems Thinking
- EM 680 Designing and Managing the Development Enterprise

Systems Engineering

The topics covered and material presented in this certificate provides an interdisciplinary approach based on an "entire view" of missions and operational environments, and combines the capabilities of platforms, systems, operators and support to fashion solutions that meet customer needs.

Core Requirements:

- SYS 625 Fundamentals of Systems Engineering
- SYS 650 System Architecture and Design

Electives:

Select two courses from the following list:

▸ SYS 605 Systems Integration

▸ EM 612 Project Management of Complex Systems

▸ SYS 750 Advanced System and Software Architecture Modeling and Assessment

A maximum of one from the following:

- SYS 645 Design for System Reliability, Maintainability and Supportability,

- SYS 660 Decision and Risk Analysis

- SYS 611 Systems Modeling and Simulation

Systems Engineering of Embedded/Cyber-Physical Systems

The Systems Engineering of Embedded/Cyber-Physical Systems (CPS) four-course certificate program has been designed to provide engineers with systems engineering skills such that they can be effective in small, agile teams in the development of such systems. This certificate will provide students with a solid foundation in the fundamentals and practical use of tools for the conception, design, implementation and sustainment of embedded and CPS from a systems perspective using an integrated, intensive team-based project experience throughout the life cycle. The skills obtained will be applicable to the systems engineering of systems in other domains, but are focused on systems with the attributes of embedded and cyber-physical systems.

The required courses are:

▸ SYS 671 Conception of Cyber-Physical Systems

▸ SYS 672 Design of Cyber-Physical Systems

▸ SYS 673 Implementation of Cyber-Physical Systems

▸ SYS 674 Sustainment of Cyber-Physical Systems

Systems Engineering Management

This certificate is designed for program managers, project managers and lead systems engineers involved with conceiving, defining, architecting, integrating and testing complex and multi-functional systems. Students are introduced to the concept of the "extended" enterprise and the delivery of a value chain solution. Additionally, the human, financial, organizational and systems integration skills necessary to make project teams more productive are addressed in this graduate certificate offering.

Core Requirements:

▸ EM 612 Project Management of Complex Systems

▸ SYS 625 Fundamentals of Systems Engineering

▸ SYS 660 Decision and Risk Analysis

Electives:

Select one course from the following list:

▸ EM 680 Managing the Development Enterprise

▸ ES 621 Fundamentals of Enterprise Systems

Systems Security Engineering

This certificate integrates crucial topics spanning the lifecycle of secure systems. Participants are provided hands-on assignments focusing on: technology governance, security requirements, secure system architecture, security system engineering and information assurance.

Select four of the following five courses:

- SES 623 Systems Security Architecture and Design
- SSW 689 Engineering of Trusted Software Systems
- SYS 660 Decision and Risk Analysis
- SES 602 Secure Systems Foundations
- SES 622 Fundamentals of Systems Engineering Security

Urban Resilience

Dedicated to the proposition that coastal cities can increase their resilience to extreme weather while simultaneously improving their quality of life, this four-course certificate program will teach students and professionals of diverse backgrounds the necessary data-driven and science-based tools to make resilience in their communities a reality.

The required courses are:

- ES 520 The Nature of Urban Design
- OE 511 Urban Oceanography
- ES 630 Modeling and Visualization of Complex Systems and Enterprises
- EM 622 Data Analysis and Visualization Techniques for Decision-making

Urban Systems Informatics

This Graduate Certificate will provide students with the necessary introductory educational background both to understand urban systems problems and to analyze large-scale data using a variety of tools and techniques. Upon completion, students will be able to use those tools and techniques in the context of Urban Systems, targeting issues relevant to cities, such as managing disasters, improving public health, and improving quality of life.

The required courses are:

- EM624 Informatics for Engineering Management
- EM622 Data Visualization for Decision-making
- EM 655 Sustainable Transportation Systems
- EM599 Introduction to Smart Cities

SET Graduate Certificates

SET Graduate Certificates are offered as part of a special program provided to a specific Government sponsor and are not offered outside of that program. There are currently four SET Certificates, as follows:

- Modeling and Simulation
- Software Engineering Fundamentals
- Systems Engineering Foundation
- Systems Security

4+1 Program with Drew University

Stevens Institute of Technology (Stevens) and Drew University (Drew) have established a 4+1 and a 4+1.5 Bachelor of Arts / Master of Science partnership. Drew University currently offers students a B.A. in computer science, a minor in computer science and multiple liberal arts degrees. Based on the student's course of study and their academic performance, they will pursue different paths as they work towards a Software Engineering M.S. degree at Stevens. Students with a major or minor in computer science will take two master level software engineering courses at Drew enabling them to complete their Masters, potentially in one academic year at Stevens with the successful completion of 8 courses. Students without a computer science major or minor from Drew will complete their Masters at Stevens with 10 Stevens' courses, which they are expected to complete successfully in a year and half.

The purpose of these programs is to provide qualified students at Drew University with a seamless pathway into the Master of Science in Software Engineering at Stevens Institute of Technology. The details of these programs are explained in more detail below.

4+1 Program

The Drew University / Stevens Institute of Technology 4+1 B.A./M.S. in Software Engineering program allows qualified computer science majors or minors to complete the Bachelor of Arts degree at Drew and the Master of Science degree at Stevens in five years instead of the five and one half years that it would normally require.

Students are eligible to apply to the Drew/Stevens program coordinator for provisional acceptance once they have completed 48 credits towards Drew graduation. The requirements for provisional acceptance are a GPA of at least 3.0 overall and in their computer science courses, recommendation of the Drew/Stevens program coordinator, and no academic integrity violations.

CSCI 540 and 600 successfully completed at Drew with a grade of 3.3 or above will be transferred to Stevens and applied to the M.S. in Software Engineering as the equivalent of SSW 540 and 690. Taking these two courses at Drew reduces the number of credits needed for the M.S. degree, thus allowing the M.S. in Software Engineering to be completed in one calendar year. Drew students admitted to Stevens through this program will complete an additional eight graduate-level courses at Stevens Institute of Technology. N.B., the two graduate-level courses completed at Drew must be above and beyond the 128-credit requirement for the Drew Bachelor of Arts degree.

4+1.5 Program

The Drew University/Stevens Institute of Technology 4+1.5 Bachelor of Arts/Master of Science in Software Engineering program allows Drew students without a major or minor in Computer Science the ability to complete the Drew B.A. and the Stevens M.S. in Software Engineering in five and one half years. Upon completing the Drew degree, students will enroll at Stevens to complete the graduate degree. Meeting the entry requirements for the program will guarantee admission to Stevens.

International Programs

Programs with Instituto Tecnológico y de Estudios Superiores de Monterrey (ITESM)

ITESM - Campus Guadalajara - is a research-intensive university with the mission to form persons with integrity, ethical standards and a humanistic outlook, who are internationally competitive in their professional fields; at the same time, they will be good citizens committed to the economic, political, social and cultural development of their community and to the sustainable use of natural resources.

Stevens and ITESM, in recognition of the value of international cooperation and student mobility, and as a supplement to any exchange agreement, have agreed to conjointly offer encompassing Dual Degree Programs involving:

Master of Engineering in Systems Engineering (MSE) at SIT and Master in Science in Quality Systems and Productivity (MCP) at ITESM.

Candidates take the following four Stevens Institute of Technology Systems engineering courses:

- SYS 625 Fundamentals of Systems Engineering

- SYS 605 Systems Integration

- SYS 650 System Architecture and Design

- EM 612 Project Management of Complex Systems

And two additional courses from either:

- SYS 645 Design for Reliability, Maintainability & Supportability

- EM 680 Designing and Managing the Development System

- SYS 640 System Supportability and Logistics

ITESM Masters in Quality Systems and Productivity candidates take the following courses:

- GI 5000 Research and Innovation Methods

- GI 4000 Leadership for Business Innovation (1.5)

And four out of the five following courses:

- IN 4019 Quality Management and Competitiveness

- MA 4009 Statistical Methods

- IN 4016 Optimization Methods for Decision Making

- IN 4017 Production Engineering

- IN 4018 Supply Chain Management

Students develop a Thesis/Project under guidance of ITESM-SIT Faculty

- GI 5007 Thesis Project 1

- GI 5008 Thesis Project 2

Master of Engineering in Engineering Management (MEM) and Master in International Business (MIB) at ITESM or Master in Business Administration (MBA) at ITESM

Candidates take the following Stevens Institute of Technology courses:

- EM 600 Engineering Economics & Cost Analysis

- SYS 611 Systems Modeling and Simulation

  - *Or* SYS 681 Dynamic Modeling of Systems and Enterprises

- EM 680 Designing and Managing the Development System

  - *Or* EM 612 Project Management of Complex Systems

- EM 624 Informatics for Engineering Management

- SYS 660 Decision and Risk Analysis

- EM 632 Data Science and Knowledge Discovery in Engineering Management

ITESM Masters in International Business candidates take the following International Business courses:

▸ GA 4044 Introduction to Economics

▸ GA 4075 Managerial Accounting

▸ GA 4076 Financial Accounting

▸ GA 4081 Fundamentals of Finance

▸ GA 4043 Interpersonal Skills for International Management

▸ GA 4048 Consulting Project I

▸ GA 4053 Leadership for Sustainable Development

▸ GA 4083 Introduction to Latin American Management

▸ GA 4084 Quantitative Methods

▸ GA 4040 Marketing

▸ GA 4045 NAFTA Business Environment

▸ GA 4042 Elective I

▸ GA 4047 Elective II

ITESM Masters in Business Administration candidates take the following courses:

One course of the following ITESM courses:

▸ AD 4003 Business Policy, Ethics & Corporate Social Responsibility

▸ DS 4002 Leadership for Sustainable Development

And seven of the following ITESM courses:

▸ EC 4005 Managerial Economics

▸ CD 4000 Operations Management

▸ MT 4001 Marketing Management

▸ RH 4000 Leadership and Organizational Behavior

▸ AD 4004 Competitive Strategy and Business Design

▸ AD 4005 Entrepreneurship and Intrapreneurship

▸ AD 5000 Negotiations and Decisions in Multicultural Environments

▸ AD 5001 Seminar in Transnational Management and Corporate Strategy

Applicants should apply to their perspective host university. Cohorts are accepted for both the fall and spring terms.

Program with Nanyang Technological University (NTU)

The SSE in partnership with the School of Mechanical and Aerospace Engineering, Nanyang Technological University (NTU), Singapore, offers a dual degree program leading to Master of Engineering in Systems Engineering (through Stevens) and a Master of Science in Systems and Project Management (through NTU). The program mission is to prepare graduates in the twin competencies of systems engineering and project management, both sharing a common complex systems thinking and perspective. This dual degree program aims to broaden the participants' educational experience and prepare them for a successful career in leadership positions in delivering systems-based products, services and solutions to the industries,

businesses and government especially with countries in or have interest in developing businesses in Southeast Asia, India, and China.

The program is designed to be a resident program with students spending a minimum of one semester at the non-host university. To meet the degree requirements, candidates must earn 30 course credits by taking five courses from Stevens and four courses from NTU, plus an independent study project. Students should take the following courses from the SSE:

▶ SYS 625 Fundamentals of Systems Engineering

▶ SYS 650 System Architecture and Design

▶ SYS 605 Systems Integration

▶ EM 612 Project Management of Complex Systems

▶ SYS 660 Decision and Risk Analysis

  • *Or* EM 680 Designing and Managing the Development Enterprise

While studying at NTU, candidates must select four of the following System and Project Management (SPM) courses:

▶ SPM 21/M6141 Quality Engineering

▶ SPM 22/M6205 Systems Simulation & Modeling

▶ SPM 23/M6601 Human Factors Engineering

▶ SPM 25/M6925 Enterprise IT/IS Project Management

▶ SPM 26/L6103 Supply Chain: Strategy and Design

▶ SPM 29/M6929 Management of Complex Engineering Projects

▶ SPM 30/M6426 Management of Technology and Innovation

▶ SPM 31/M6930 Project Estimation and Cost Management

All students in the program are required to take M6588 Independent Study from NTU producing a three credit hour capstone project. Note that students wishing to pursue a graduate certificate in Systems Engineering Management through Stevens are required to take EM 680 and SPM22.

Applicants should apply to their perspective host university. Cohorts are accepted for both the fall and spring terms.

Program with National University of Malaysia (UKM)

SSE, in partnership with the National University of Malaysia (UKM), offers a dual degree program leading to Master of Engineering (ME) in Systems Engineering or Engineering Management from Stevens and a Master of Science (MSc) in Industrial and Technology Management from UKM. For candidates to gain this dual master's degree they must fulfill a minimum of 33 credits by:

1. Completing 3 core courses at UKM and 2 technical elective, and

2. Completing 4 core courses in Systems Engineering at SIT and 1 technical elective, and

3. Completing 1 project-based UKM independent study.

Applicants should apply to their perspective host university.

Program with University College of South East Norway (UCSEN) (formerly Buskerud)

The SSE in partnership with the University College of South East Norway (UCSEN) in Kongsberg, Norway, offers a dual degree program leading to Master of Engineering in Systems Engineering from Stevens and a Master Degree in Systems Engineering from UCSEN. The dual degree program aims to broaden the participants' educational experience and prepare them for a successful career in leadership positions delivering systems-based products, services and solutions to industries, businesses and government, especially with countries in or who have interest in developing businesses in Scandinavia and Northern Europe. Students should apply to their perspective host universities. The program is designed to be a resident program with students spending a minimum of one semester at the non-host university. To meet the degree requirements, candidates must earn 30 course credits by taking five courses from Stevens and four courses plus a Master Project from UCSEN.

COURSE OFFERINGS

Engineering Management

EM 224   Informatics and Software Development   (3 - 3 - 0)

This course deals with the challenges associated with the variety and volume of information encountered in today's workplace, and working with others in a software development environment. Students will analyze and work with both structured and semi-structured data, using the python programming language. Students will learn about the types of software development environments they are likely to encounter in their careers. The capstone of the course is a small-group project that analyzes real-world data to answer a business or research question. Cross-listed with: ISE 224

EM 275   Project Management   (3 - 3 - 0)

This course presents the tools and techniques for project definition, work breakdown, estimating, resource planning, critical path development, scheduling, project monitoring and control and scope management. Students will use project management software to accomplish these tasks. In addition, the student will become familiar with the responsibilities, skills and effective leadership styles of a good project manager. The role organization design plays in project management will also be addressed.

EM 301   Accounting & Business Analysis   (4 - 3 - 3)

This course introduces students to the fundamental concepts of financial and managerial accounting, with an emphasis on actions managers can take to more effectively address the goals of the firm. Key topics covered include the preparation and analysis of financial statements, particularly creating cash flow statements needed for engineering economic analysis; consideration of variable costs, fixed costs, cost of goods sold, operating costs, product costs, period costs; job costing and process costing; application of accounting information for decision-making: marketing decisions, production decisions; capital budgeting: depreciation, taxation; budgeting process, master budgets, flexible budgets, analysis of budget variances; asset valuation, and inventory costing. The laboratory portion of the course provides the student opportunity to use the personal computer for solving problems related to the major topics of the course, such as spreadsheet analysis, and in addition covers managerial topics, including sessions focused on group dynamics and teamwork, research using the Internet and business ethics

EM 322   Engineering Design VI   (2 - 1 - 2)

This course provides students with experiences and tools for new product and process development. Students will become familiar with systematic approaches to design, and they will explore the design process from problem identification through detailed design, validation, and economic analysis. Tools that have been introduced in earlier engineering management courses may be brought together as part of this pre- senior design experience. Discussions of contemporary design issues and class projects will provide experiences and insights that will serve to improve their senior project experience. Corequisites: EM 345, EM 385

EM 345   Modeling and Simulation   (3 - 3 - 0)

This course covers contemporary decision support models of forecasting, optimization and simulation for management. Students will learn how to identify the problem situation, choose the appropriate methods, collect the data and find the solution. The course also covers handling the information and generating alternative decisions based upon operations research optimization, statistical simulation, and systems dynamic forecasting. Computer simulations will be performed on PCs using user-friendly graphical interface with multimedia report generation for visualization and animation. Students will also be trained in management simulations for group decision support. Prerequisite: EM 365 Cross-listed with: ISE 345

EM 357   Elements of Operations Research   (3 - 3 - 0)

Application of forecasting and optimization models to typical engineering management situations and problems. Topics include: optimization theory and its special topics (linear programming, transportation models, and assignment models), dynamic programming, forecasting models, decision trees, game theory, and queuing theory. Applications to resource allocation, scheduling and routing, location of facilities, and waiting lines will be covered. Prerequisite: EM 365 Cross-listed with: ISE 357

EM 360   Operations Management and Process Engineering   (3 - 3 - 0)

The aim of the course is to provide an introduction to major business process problems, issues with a focus on process solutions that confront managers in highly competitive manufacturing and service environments. The course provides students with conceptual frameworks and qualitative/quantitative tools to deal with these issues. The course also explores the interconnections between business strategy and business processes. A rigorous introduction is provided for people aspiring to a career in designing and managing business processes, or for people aspiring to enter the management consulting world.

EM 364   Statistics For Engineers Laboratory   (1 - 0 - 1)

This one credit course is the lab component of EM 365. The lab provides an integrated experience with statistics and probability on real and manipulated data sets using flipped classroom and project based learning environments. Those students who have taken E 243 at Stevens, or have other credit for statistics, are still required to take this one credit EM Statistics lab.

EM 365   Statistics for Engineering Managers   (4 - 3 - 2)

Provides a working knowledge of basic statistics as it is most often applied in engineering. Topics include: fundamentals of probability theory, review of distributions of special interest in statistics, analysis and enumeration of data, linear regression and correlation, statistical design of engineering experiments, completely randomized design, randomized block design, factorial experiments, engineering applications and use of the computer as a tool for statistical analysis.

EM 385   Innovative System Design   (3 - 3 - 0)

This project-based course addresses the fundamentals of systems engineering. Principles and concepts of systems engineering within a life-cycle perspective are presented through case studies and applied throughout the course to a student-selected team project. The initial focus is on the understanding of business drivers for systems engineering and the generation of innovative ideas. Students then engage in analysis, synthesis, and evaluation activities as they progress through the conceptual and preliminary design phases. Emphasis is placed on tools and methodologies for system evaluation during all phases of the design process with the goal of enhancing the effectiveness and efficiency of deployed systems as well as reducing operational and support costs. Corequisite: EM 365

EM 423   Engineering Design VII   (3 - 0 - 8)

This year long two-course sequence involves the students in a small-team Engineering Management project. The problem for the project is taken from industry, business, government or a not-for-profit organization. Each student team works with a client and is expected to collect data, analyze it and develop a design by the end of the first semester. In the second semester the design solution of the problem is completed and a written report is submitted for binding. During the year, oral and written progress reports are presented to peers and clients. The total project involves the application of the subject areas covered in the EM 385 Engineering Management Laboratory course, as well as skills learned in the other technical and non-technical courses of the Engineering Management curriculum. Prerequisites: EM 275, and EM 301, and EM 322, and EM 345, and EM 385

EM 424   Engineering Design VIII   (3 - 0 - 8)

This year long two-course sequence involves the students in a small-team Engineering Management project. The problem for the project is taken from industry, business, government or a not-for-profit organization. Each student team works with a client and is expected to collect data, analyze it and develop a design by the end of the first semester. In the second semester the design solution of the problem is completed and a written report is submitted for binding. During the year, oral and written progress reports are presented to peers and clients. The total project involves the application of the subject areas covered in the EM 385 Engineering Management Laboratory course, as well as skills learned in the other technical and non-technical courses of the Engineering Management curriculum. Prerequisite: EM 385

EM 450   Logistics and Supply Chain Management   (3 - 3 - 0)

This course will provide an introduction to supply chains, logistics & supply chain management. Topics covered include supply chain performance and metrics related to facilities, inventory, transportation, sourcing, pricing and information. Design of distribution networks, forecasting, and planning of demand & supply would be covered. Contemporary topics like e-business, IT and global supply chains would also be covered. Prerequisite: EM 357 or BT 223

EM 451   Analysis of Networks & Strategies   (3 - 3 - 0)

This course is designed to help students understand the complexity, structure and dynamics of a highly-connected world. The course is comprised of two basic parts: complex network analysis and the social and economic factors that affect decision-making in networked systems. It takes a mathematically rigorous and interdisciplinary look at economics, sociology, information science and applied mathematics to discuss some of the fundamental features of networks and their behavior. Topics such as diffusion and cascading, voting, emergence and evolving networks, and economic and market implications will be explored. Prerequisite: EM 365 Cross-listed with: ISE 451

EM 480   Managing the Development Enterprise   (- -)

This course addresses the design and management of the human activity system that is responsible for developing, and operating an organization. It is built on a fundamental that the successful development of an organizational system is directly contingent on the human system. The course introduces foundational constructs related to organizational behavior and design, including Structure; Organizational Culture; Leadership and Power; Personality & Attitudes; Work Motivation; Group Behavior and Teamwork; analysis of Organizational Networks, Conflict and Politics; Decision Making; Complexity theories and organizational design. Prerequisite: EM 360

EM 489   Data-Mining and Risk Assessment   (3 - 3 - 0)

This course will use tools and techniques which have proven to be of value in recognizing patterns, making predictions, and evaluation risk from both large data sets (using data-mining techniques), and small data sets (using networks constructed from problem definition and discovery). Both approaches are critical to today's engineers and managers, because they span a range of possible data availability and reliability. Using these tools and techniques, the student will survey applications, and have hands-on experimenttaion with both data mining and network construction, using real-world examples and situations. Prerequisites: EM 224 and EM 365

EM 498   Research in Engineering Management I   (- -)

Individual investigation of a substantive character undertaken at an undergraduate level under the guidance of a member of the departmental faculty. A written report is required. Hours to be arranged with the faculty advisor. Prior approval required. This course can be used as a general elective. EM 498 and EM 499 cannot be taken simultaneously.

EM 499   Research In Engineering Management II   (- -)

Individual investigation of a substantive character undertaken at an undergraduate level under the guidance of a member of the departmental faculty. A written report is required. Hours to be arranged with the faculty advisor. Prior approval required. This course can be used as a general elective. EM 498 and EM 499 cannot be taken simultaneously.

EM 522   Parametric Modeling in the Urban Environment   (3 - 3 - 0)

Parametric modeling links mathematical modeling with spatial modeling. The course provides a practical introduction to the concepts and application of parametric modeling, using examples from the built environment to apply those techniques at a number of scales ranging from a city-scale urban grid to the individual building elements within it. The course will be structured around the practical, hands-on application of the techniques addressed, using Grasshopper 3d as the primary parametric programming platform. The history, theory, and broader applications of computational parametric modeling and design will be periodically addressed where needed and more in-depth reading swill be provided as supplementary texts. Cross-listed with: CE 522, ES 522

EM 533   Human Factors in Engineering   (3 - 3 - 0)

This course provides introduction to human factors concepts including physical, cognitive and macro ergonomics and their applications. The students will learn how to design for people-machine interaction, including an introduction to the relevant underlying human sciences, theory, data, and measurement problems in human information processing, anthropometry, training and industrial safety.

EM 570   Data Story Telling   (3 - 3 - 0)

This course teaches students to facilitate decision making by telling stories with data. While data, in general, has become increasingly abundant, raw data and statistical inferences are often insufficient in of themselves to support decision making. Addressing complicated societal problems such as climate change, economic inequality, and cybersecurity requires successful communication of the inferences and findings drawn from the analysis of data. One way to communicate inferences is through storytelling. In this course, students will learn how to tell stories with data through case studies, examples, and hands-on experimentation. While basic methods for research, cleaning, and analysis of datasets will be covered, the focus will be on creative methods of data presentation and storytelling. Students will consider the emotional, aesthetic, and practical effects of different presentation methods as well as how to develop metrics for assessing impact.

EM 585   Introduction to Systems Architecture and Design   (3 - 3 - 0)

EM 585 builds on EM 385 and gives the student a practical introduction to Systems Architecture and Design. Lectures will introduce the students to the motivation for System Architecture and Design, the different views on a System Architecture, as well as theory and best practices on behavioral definition, logical and physical partitioning, and interface definitions. Key aspects of system verification and validation will also be discussed. Tutorials will give the students practical experience using SySML and a commercial modeling tool to model system architectures. The students will apply the principles on a team project, designing and building a robot. Prerequisite EM 385 or instructor approval

EM 599   Introduction to Smart Cities and their Ecosystems   (3 - 3 - 0)

This course provides an introduction to Smart Cities at conceptual, technological and social technical levels. Its aim is to develop an understanding of the concept of a city and the concomitant needs of the citizens and of the city management to make the city smarter and explore how this can be accomplished both from a social and technical level. It also will relate Smart Cities to smart homes, neighborhoods and campuses.

EM 600   Engineering Economics and Cost Analysis   (3 - 0 - 0)

This course presents advanced techniques and analysis designed to permit managers to estimate and use cost information in decision making. Topics include: historical overview of the management accounting process, statistical cost estimation, cost allocation, and uses of cost information in evaluating decisions about pricing, quality, manufacturing processes (e.g., JIT, CIM), investments in new technologies, investment centers, the selection process for capital investments, both tangible and intangible, and how this process is structured and constrained by the time value of money, the source of funds, market demand, and competitive position. Cross-listed with: PME 600, MGT 618

EM 605   Elements of Operations Research   (3 - 0 - 0)

This course brings a strong modeling orientation to bear on the process of obtaining and utilizing resources to produce and deliver useful goods and services so as to meet the goals of the organization. Decision-oriented models such as linear programming, inventory control, and forecasting are discussed and then implemented utilizing spreadsheets and other commercial software. A review of the fundamentals of statistical analysis oriented toward business problems will also be conducted.

EM 612   Project Management of Complex Systems   (3 - 3 - 0)

This project-based course exposes students to tools and methodologies useful for forming and managing an effective engineering design team in a business environment. Topics covered will include: personality profiles for creating teams with balanced diversity; computational tools for project coordination and management; real time electronic documentation as a critical design process variable; and methods for refining project requirements to ensure that the team addresses the right problem with the right solution.

EM 622   Data Analysis and Visualization Techniques for Decision-making   (3 - 3 - 0)

This course provides a hands-on introduction to the modern techniques for visualizing data and leverages such techniques with the corresponding problem solving skills necessary to complement data visualization into specific strategic decision making. The student will first learn to use the latest off the shelf software for data visualization. In specific the student will learn the following languages: R, D3, Google refine and Spot fire. Cross-listed with SYS 622

EM 623   Data Science and Knowledge Discovery   (3 - 3 - 0)

This course provides an hands-on introduction to the major techniques and solutions to discover knowledge in data and text. Traditional data mining along with text mining and network analysis will be presented and will be used by the students via open source software, addressing information mining needs on both structured and unstructured data. Cross-listed with: SYS 623

EM 624   Informatics for Engineering Management   (3 - 3 - 0)

This course enables the Engineering Management student to acquire the knowledge and skills he/she will need to handle the variety and volume of information encountered in today's workplace. The course uses Python, which is rapidly becoming the language of choice for information handling and data analysis. Students will work with both structured and semi-structured data.

EM 630   Introduction to Complexity and Dynamic Systems   (3 - 3 - 0)

This course will introduce and explore complexity and chaos, and investigate a broad range of examples from both natural (biological) and man-made systems. Complex systems, distinct from, but related to, complicated systems, display a range of behaviors. One of the most distinguishing of these behaviors is emergence - behavior that is not predictable from knowledge of specific, individual agent capabilities. In addition, systems are said to be complex when emergent behavior is not resulting from a central control, when they display chaotic characteristics, and when the systems have more frequent occurrences of rare events, especially when initial conditions vary. This course will study and model complex and adaptive (as well as non-adaptive) systems, and will present and discuss the characteristics of complex and chaotic systems. Prerequisites: E 243 and MA 221

EM 650   Quality and Process Management   (3 - 3 - 0)

Principles and techniques of total quality management (TQM) with emphasis on their application to technical organizations. Topics include management philosophy, concepts and critique of quality "Gurus"; TQM modeling and strategy; TQM tools and techniques; Dept. of Defense 5000.51-G TQM guides; review and critique of the Deming and Baldrige Awards; concurrent engineering; quality function, deployment and design for cost. Students will form teams to analyze a case study involving TQM concepts and techniques (Formerly EM750).

EM 655   Sustainable Transportation Systems: Technology, Management and Policy   (3 - 3 - 0)

Transportation systems are the backbone of cities, communities, and the economy. This course aims at teaching students how to use transportation technologies and management strategies to develop effective policies and to achieve sustainable transportation systems. Throughout the course various quantitative decision making methods and tools including decision trees, benefit-cost and cost-effective analyses, and more advanced decision and risk analysis methods including sensitivity analysis, and multi-attribute simulations will be examined. Transportation case studies will be assessed and analyzed using these techniques and tools. By the end of the course students should be able to quantitatively assess transportation systems and their implications on environment, energy issues, land-use, economic development and equity as well as stakeholders' roles and responsibilities to make holistic decisions and policy choices. Integration of risk and uncertainty into formal methods is a fundamental component of this course, which tells us how confident we should be in our analyses while formulating/revising policies.

EM 665   Integrated Supply Chain Management   (3 - 3 - 0)

This course illustrates the theory and practice of designing and analyzing supply chains. It provides tool sets to identify key drivers of supply chain performance such as inventory, transportation, information and facilities. Recognizing the interactions between the supply and demand components, the course provides a methodology for implementing integrated supply chains, enabling a framework to leverage these dynamics for effective product/process design and enterprise operations.

EM 680   Designing and Managing the Development Enterprise   (3 - 3 - 0)

This course addresses the design of the peopled-system that is responsible for designing and testing a product or operational system. There are three keys to designing the development system that are emphasized as part of this course: the fact that the design process should be a discovery process, the critical feedback and control activities that must be implemented for cost-discovery process, the critical feedback and control activities that must be implemented for cost-effective success, and the design of risk management(with an emphasis on adaptive testing) activities. This course will focus on the functional processes that must be performed by the development system, but will also address physical resources(people and software) and associated organizational structures.

EM 690   Selected Topics in Engineering Management   (3 - 3 - 0)

Selected topics from various areas within Engineering Management.

EM 691   Advanced Topics in Infrastructure Systems   (3 - 3 - 0)

Building on the topics presented in ES 690, this course introduces advanced topics in infrastructure systems, focusing on tools and methodologies crucial to infrastructure systems analysis and planning. Topics discussed include CLIOS analysis and dynamic modeling of infrastructure systems, fundamentals of network analysis, decision analysis for infrastructure systems, and infrastructure resiliency. Prerequisite: ES 690 Cross-listed with: ES 691

EM 744   Advanced Data Analysis for Data Mining and Knowledge Discovery   (3 - 0 - 0)

This data driven course focuses on the subjects of both traditional and modern data analysis and mining techniques. The course emphasizes the analysis of business and engineering data using a combination of theoretical techniques and commercially available software to solve problems. Topics such as data analysis and presentation, linear and nonlinear regression, analysis of variance, factor analysis, cluster analysis, neural networks, and classification trees will be presented. The course will make extensive use of the Splus software packages. However, students will be encouraged to use a wide variety of industry standard data analysis and mining tools including SPSS, SAS, MATLAB, and BrainMaker. Cross-listed with: SYS 744

EM 800   Special Problems in Engineering Management (ME)   (3 - -)

Three credits for the degree of Master of Engineering (Engineering Management). This course is typically conducted as a one-on-one course between a faculty member and a student. A student may take up to two special problems course in a master's degree program. A department technical report is required as the final product for this course.

EM 801   Special Problems in Engineering Management (PhD)   (3 - -)

Three credit for the degree of Doctor of Philosophy. This course is typically conducted as a one-on-one investigation of a topic of particular interest between a faculty member and a student and is often used to explore topical areas that can serve as a dissertation. A student may take up to two special problems course in a Ph.D. degree program. A department technical report is required as the final product for this course.

EM 810   Special Topics in Engineering Management   (3 - -)

Selected topics from various areas within Engineering Management. This course is typically taught to more than one student and often takes the form of a visiting professor's course. Prerequisite: consent of instructor.

EM 900   Thesis in Engineering Management (ME)   (1 to 6 - -)

For the degree of Master of Engineering (Engineering Management). A minimum of six credit hours is required. Hours and credit to be arranged.

EM 960   Research in Engineering Management (PhD)   (- - -)

Original work, which may serve as the basis for the dissertation, required for the degree of Doctor of Philosophy. A minimum of 30 hours of EM 960 research is required for the Ph.D. degree. Hours and credits to be arranged.

Socio-technical Systems

ES 520   The Nature of Urban Design   (- - -)

This course is an introduction to the fundamental principles of urban design in shaping cities to achieve resilience. Real world problems in critical infrastructure and urban systems around New York harbor will be approached and taught in a studio environment with solutions applicable globally. The course introduces the premise that cities can be changed purposefully by actors who successfully integrate policy, finance and design parameters to solve technical problems while improving quality of life. How New York uses urban design not just to survive but also to thrive is the subject of this course, introducing the people, products and processes of urban design in the context of the global risk equation

ES 522   Parametric Modeling in the Urban Environment   (3 - 3 - 0)

Parametric modeling links mathematical modeling with spatial modeling. The course provides a practical introduction to the concepts and application of parametric modeling, using examples from the built environment to apply those techniques at a number of scales ranging from a city-scale urban grid to the individual building elements within it. The course will be structured around the practical, hands-on application of the techniques addressed, using Grasshopper 3d as the primary parametric programming platform. The history, theory, and broader applications of computational parametric modeling and design will be periodically addressed where needed and more in-depth reading swill be provided as supplementary texts. Cross-listed with: CE 522, EM 522

ES 621   Fundamentals of Enterprise Systems   (3 - 3 - 0)

Traditional systems engineering techniques must be adapted to understand a broader class of human designed systems that we refer to as an enterprise, of which a technical system is only one part. Students will learn how describe the value of systems engineering on complex projects, provide a (common) global view of the system and enterprise, elicit and write good requirements, and understand how to develop robust and efficient architectures. Students should complete this class with "next steps" knowledge of tools, templates, capability patterns, and community. Case studies and examples are used throughout to give students an appreciation of how systems engineering tools, techniques, and thinking can be applied to the real world enterprises that we encounter daily.

ES 630   Modeling and Visualization of Complex Systems and Enterprises   (3 - 3 - 0)

Addressing complex systems and enterprises such as healthcare delivery, sustainable energy, financial systems, urban infrastructures and national security requires knowledge and skills from many disciplines. This course provides a valuable guide to all the disciplines involved in such endeavors. The central construct in is the notion of phenomena, particularly the essential phenomena that different disciplines address in complex systems and enterprises. Phenomena are observed or observable events or chains of events. Examples include the weather, climate change, traffic congestion, information sharing, and cultural compliance. This course provides a holistic approach that explicitly addresses the interactions among such phenomena and central tradeoffs underlying truly creative solutions.

ES 640   Community and Resilience   (3 - 3 - 0)

Cities, even large global mega-cities, can best be understood as a collection of communities in neighborhoods, all served by common urban infrastructures. To many citizens, those infrastructures were invisible until they failed in times of crisis. Their lack of resilience brought home the point that community needs drive the functional requirements for buildings and infrastructure. Delivered as a combination of lectures and seminars, we can begin to address questions such as "How do we measure functionality at the many scales that affect community?" and "How are their benefits and costs delivered to each significantly different community within the city?" Finally, "How do we measure the resilience we seek to achieve at a community level?"

ES 660   Multi-Agent Socio-technical Systems   (3 - 3 - 0)

Many social-technical systems in healthcare, energy and urban systems can be considered as multi-agent systems where different agents – people, organizations or autonomous technologies- with heterogeneous, and often opposing objectives interact and shape the complex collective behavior and evolving nature of such systems. Analysis, design and governance and design of such systems can be very challenging and require rigorous agent-based thinking rooted in analytical models. This course teaches fundamentals of multi-agent systems, starting from models of single agent decision making and planning under uncertainty, and moves to basic frameworks for multi-agent system analysis tools, with a focus on game theory and complex network analysis . The course will take a combination of analytical and conceptual methods, and will use agent-based simulation techniques rooted in these methods. Students will apply the course material to a real-world project, close to their area of dissertation research.

ES 677   Governing Development   (3 - 3 - 0)

For a variety of business reasons, today's business and government organizations are demonstrating a heightened interest in governance. Development programs and organizations have unique governance concerns due to inherent uncertainty of development efforts. Moving beyond platitudes, this course introduces modern concepts of organizational governance and their application to organizations that develop systems and products. Course topics include the business climate forcing an emphasis on governance; a general governance framework, including definitions of governance elements; governance as a process; governance solutions for the development teams; development governance styles; and advanced topics.

ES 678   Engineering of Agile Systems and Enterprises   (3 - 3 - 0)

Real-time responsiveness characterizes systems at the forefront of competition, enterprise, strategy, warfare, governance, innovation, engineering, development, information, integration, and virtually anything designed today for purpose. This course covers fundamental objectives, performance metrics, analysis frameworks, and design principles for engineering agile and resilient systems. Real examples are analyzed in case studies for their change proficiency and response ability. Response capability frameworks are applied in analysis and requirements development. Architecture and design principles which enable resilient and innovative response are illuminated and then applied in synthesis exercises. Hands-on, minds-on exercises prepare and guide the participant in applying the knowledge. Systems for case study and focus can run the range from products and processes to governance and infrastructure to enterprises and systems-of-systems.

ES 679   Architecting the Extended Enterprise   (3 - 3 - 0)

This course presents a systems architecting process to achieve enterprise integration both within and between corporate boundaries. The process leverages systems thinking - the antithesis of scientific reductionism, which fails to appreciate the interrelationships between components that make-up a system. Systems thinking has proven to be successful in the delivery of integrated technology products, and is now being applied to understanding the structure and dynamics of organizations for which communications and co-stuff in general is a key to business success; in other words inter-relationships are prime in managing an enterprise. The systems approach further emphasizes emergence, wider systems and the environment. These concepts are crucial to architecting an enterprise in consideration of issues of decentralization, alliance advantage, and market phenomena.

ES 683   Design of Agile Systems and Enterprises   (3 - 3 - 0)

The frontier of systems engineering today seeks new levels of system capability and behavior, and expects to find that benefit in higher forms of systems that elude traditional control and creation concepts. Common themes converge here in a study of agility across a seemingly wide variety of interesting system types, characterized principally by aspects of self-organization and systems of systems. Esthetic quality in systems and enterprises makes the difference between enforced compliance and embraced experience; and determines the positive or negative vectors of self-organization and emergence. This module explores the value and nature of esthetic design quality, principles and architectures for harnessing self organized systems of systems, agility as risk management and reality confrontation, and similar issues at the edge of agile system and enterprise knowledge. (Formerly SYS790) Prerequisite: ES 678

ES 684   Systems Thinking   (3 - 3 - 0)

It takes something special for the term system to have such ubiquity. The downside is that it is overused, improperly so, detracting from its power. This class builds upon a solid conceptual foundation to ensure that the system/enterprise is properly defined, conceived, and realized. Uniquely, the class shows how it is possible to use systems in order to think more deeply and to act more decisively. This approach is made possible by emphasizing the simultaneity of perspectives, the role of paradox, and the centrality of soft issues in resolving complexity. The SystemitoolTM is used to structure and conduct analysis of decisions. This class is aimed at policy and decision-makers at all levels in an organization. Prerequisite: SYS 625

ES 690   Introduction to Infrastructure Systems   (3 - 3 - 0)

Selected topics from various areas within Enterprise Systems. This course is typically taught to more than one student and often takes the form of a visiting professors course.

ES 691   Advanced Topics in Infrastructure Systems   (3 - 3 - 0)

Building on the topics presented in ES 690, this course introduces advanced topics in infrastructure systems, focusing on tools and methodologies crucial to infrastructure systems analysis and planning. Topics discussed include CLIOS analysis and dynamic modeling of infrastructure systems, fundamentals of network analysis, decision analysis for infrastructure systems, and infrastructure resiliency. Prerequisite: ES 690 Cross-listed with: EM 691

ES 801   Special Problmes in Enterprise Systems (PhD)   (3 - -)

Three credits for the degree of Doctor of Philosophy. This course is typically conducted as a one-on-one one investigation of a topic of particular interest between a faculty member and a student and is often used to explore topical areas that can serve as a dissertation. A student may take up to two special problems courses in a Ph.D. degree program. A department technical report is required as the final product for this course.

ES 810   Selected Topics in Enterprise Systems   (3 - 3 - 0)

Selected topics from various areas within Enterprise Systems. This course is typically taught to more than one student and often takes the form of a visiting professor's course.

ES 960   Research in Enterprise Systems   (- - -)

Original work, which may serve as the basis for the dissertation, required for the degree of Doctor of Philosophy. A minimum of 30 hours of ES 960 research is required for the Ph.D. degree. Hours and credits to be arranged.

Industrial and Systems Engineering

ISE 224   Informatics and Software Development   (3 - 3 - 0)

This course deals with the challenges associated with the variety and volume of information encountered in today's workplace, and working with others in a software development environment. Students will analyze and work with both structured and semi-structured data, using the python programming language. Students will learn about the types of software development environments they are likely to encounter in their careers. The capstone of the course is a small-group project that analyzes real-world data to answer a business or research question. Cross-listed with: EM 224.

ISE 225   Data Infrastructures   (3 - 3 - 0)

This course provides an introduction to Data Engineering. Data Engineers gather and collect the data, store it, do batch processing or real-time processing on it, and serve it to a data scientist who can query it. This course is designed to give students a broad understanding of modern storage systems, data management techniques, and how these systems are used to store, access and analyze Big Data. Topics include data modeling; storage system design of disk arrays, network attached storage, clusters and data centers: relational databases and techniques for data analytics; no-SQL databases and their advantages; cloud data storage and the use of clouds for big data; data warehouses and data mining; the Apache ecosystem for data management with focus on hadoop file system and the mapreduce paradigm for data analytics; graph database management systems, such as Neo4j. Homework assignments will give students practical experience with important topics covered in the course, including the use of cloud storage, relational databases, NoSQL databases, and hadoop/Map Reduce.

ISE 322   Engineering Design VI   (2 - 1 - 2)

This course provides students with experiences and tools for new product and process development. Students will become familiar with systematic approaches to design, and they will explore the design process from problem identification through detailed design, validation, and economic analysis. Tools that have been introduced in earlier industrial and systems engineering courses may be brought together as part of this pre-senior design experience. Discussions of contemporary design issues and class projects will provide experiences and insights that will serve to improve their senior project experience. Prerequisite: E 232

ISE 345   Modeling and Simulation   (3 - 3 - 0)

This course emphasizes building analytical skills for developing mathematical models and running computer simulations for decision-making. The course provides an introduction to modeling and simulations concepts and analysis techniques for mathematical programming and decision making. Basic computers skills and knowledge of statistics are necessary to solve the problems discussed in the lectures and any assigned for homework. The course emphasis is on problem formulation, model building, data analysis, solution techniques, and evaluation of alternative designs/processes in complex systems. Modeling and simulations techniques and methods for decision analysis in this course will investigate discrete event modeling, and agent-based modeling in depth. Prerequisite: EM 365 Statistics for Engineering Managers Cross-listed with: EM 345

ISE 350   Logistics and Supply Chain Management   (3 - 3 - 0)

Supply chain management is integral to increasing an organization's efficiency, capacity, and cash flow. This course will provide an introduction to supply chains, logistics & supply chain management and provides mainly mathematically based techniques used to analyze various aspects of logistics systems. Topics covered include supply chain performance and metrics related to demand forecasting, facilities location, inventory management, transportation, sourcing, pricing and information. Design of distribution networks, forecasting, and planning of demand & supply would be covered. The course has a strong emphasis on providing analytical skills, critical thinking and managerial insight. Co-requisite: E 243 or EM 365 or BT 221

ISE 357   Operations Research I   (3 - 3 - 0)

This course emphasizes building analytical skills for developing mathematical models for decision-making and optimization. The course provides an introduction to deterministic operations research (OR) concepts and analysis techniques for mathematical programming and decision making. Basic computers skills (Excel) and knowledge of statistics are necessary to solve the problems discussed in the lectures and assigned for homework. The course emphasis is on problem formulation, model building, data analysis, solution techniques, and evaluation of alternative designs/processes in complex systems. Modeling techniques and methods for decision analysis including linear and integer programming, transportation and network models, dynamic programming, goal programming, classical optimization theory, and non-linear programming. Prerequisites: EM 365 Cross-listed with: EM 357

ISE 422   Data Analysis and Visualization Techniques for Decision-Making   (3 - 3 - 0)

Data has the potential to inform decision ¬making and influence public and policies. When situated with appropriate context, visualized data has the power to change the world. This course provides the essential and practical skills necessary to communicate information about data clearly and effectively through graphical means. In this hands-¬on introduction to data visualization, student will learn basic types of plots such scatterplot, bar chart, heatmap, parallel coordinate, geographic map, and word clouds. Advanced and interesting topics such as interactive web application and Chernoff faces will also be introduced. Additionally, this course covers basic data manipulation techniques and machine learning skills. An individual does not necessarily have to be a programmer.

ISE 423
and ISE 424   Senior Design VII and VIII

This year long, two-course sequence involves the students in a collaborative design experience in an area relevant to Industrial & Systems Engineering. The need for the project is taken from industry, business, government, not-for-profit organization, or a student-defined project approved by the course instructor. The need expressed by the Client must lend itself to apply the knowledge, tools and methods the students are exposed to in the ISE curriculum to come up with a viable design. The teams will develop a set of alternative conceptual solutions based on deep analysis of clients' and other stakeholder's needs and expectations as well as gather data and knowledge from relevant sources. They will propose a preferred concept based on a thorough assessment of the alternatives. The proposed conceptual solution will be detailed further into a preliminary design by the end of the fall semester. The second semester will focus on iterating detailed design, implementation and testing to refine the design to fulfill the intent of the design(depending on scope and complexity, this could be ranging from a "proof of concept" prototype, to a solution that the Client can put into production). Throughout the year, the teams will submit written reports at key milestones, and formally present it to clients, faculty, subject matter experts and peers.

ISE 451   Analysis of Networks and Strategies   (3 - 3 - 0)

This course is designed to help students understand the complexity, structure and dynamics of a highly-connected world. The course is comprised of two basic parts: complex network analysis and the social and economic factors that affect decision-making in networked systems. It takes a mathematically rigorous and interdisciplinary look at economics, sociology, information science and applied mathematics to discuss some of the fundamental features of networks and their behavior. Topics such as diffusion and cascading, voting, emergence and evolving networks, and economic and market implications will be explored. Prerequisite: EM 365. Cross-listed with: EM 451.

ISE 457   Operations Research II

This course emphasizes building analytical skills for developing mathematical models for decision-making and optimization, in many cases under uncertainty. The course is an introduction to stochastic operations research (OR) concepts and analysis techniques for mathematical programming and decision making. Basic computers skills (Excel) and knowledge of probability and statistics are necessary to solve the problems discussed in the lectures and assigned for homework. The course emphasis is on problem formulation, model building, data analysis, solution techniques, and evaluation of alternative designs/processes in complex systems.Modeling techniques and methods for decision analysis Markov processes, dynamic programming, metaheuristics, queueing, inventory theory, and forecasting models are covered. Prerequisites: EM 365 and MA 227

ISE 490   Data-Mining and Applied Machine Learning   (3 - 3 - 0)

This course will use tools and techniques which have proven to be of value in recognizing patterns, making predictions and supporting the decision making process based on data. Using these tools and techniques, the student will develop applications, and have hands-on experimentation with data/text mining, applied machine learning and network construction, using real-world examples and situations. Prerequisite – Must be an ISE student

Systems Engineering Security

SES 602   Secure Systems Foundations   (3 - 3 - 0)

SES 602 encompasses all aspects of systemic security issues. Systemic security components include infrastructure as well as information attributes, disruption profiles, identity management, security information management, and recovery alternatives. The course also addresses human and workforce components of security such as governance processes, technology management, and enterprise systems operations. SES 602 provides a solid background in systemic methods, tools, and procedures for value preservation in an environment of changing threats. It covers all concepts important in evaluating enterprise security design alternatives.

SES 622   Fundamentals of Security Systems Engineering   (3 - 3 - 0)

Presents principles and processes for designing secure systems, including how to approach stakeholder needs analysis, to distinguish between needs and solutions, and to translate security requirements into design specifications. Students will learn how the fundamental organization of a system contributes to or detracts from the engineer's ability to provide secure design, and to recognize how security-related components compose a system of interest within any system. The course will provide an understanding of the difference between functional and nonfunctional requirements for security features as well as an understanding of how security requirements may be derived from unintended inputs and undesired outputs. Cross-listed with: SES 623 Prerequisites: SES 602, SES 603

SES 623   Systems Security Architecture and Design   (3 - 3 - 0)

This course enhances the systems security knowledge base introduced in SES 622 with project experience in security design and architecture. It covers systems security considerations in functional analysis, decomposition, and requirements processes, and teaches practical heuristics for developing secure architectures. It demonstrates how to incorporate threat and vulnerability analysis into the architecture and design process. The students execute multiple phases of a project wherein a system security strategy is proposed, designed, architected, and supplemented with operational guidelines. Prerequisite: SES 622

Software Engineering

SSW 215   Individual Software Engineering   (3 - 3 - 0)

In this course students learn to practice a disciplined engineering process for developing software. Individual skills and practices, such as effort estimation and unit testing, are mastered so that students can become successful members of software engineering teams. Best practices in software engineering are followed, including the use of simple design patterns with well-known properties. Students work in small teams to construct a simple web service using the industry standard Ruby programming language, Rails framework and MySQL database technology. Prerequisite: E 115

SSW 315   Object-Oriented Software Development

In this course students learn the fundamentals of object-oriented programming using Java. Standard design notations from UML are used to describe software designs. Students write Java programs that use simple data structures, such as lists, queues and stacks. Fundamental time and space analyses of traditional computing problems are practiced. Students also learn how to develop software that avoids security vulnerabilities and work in small teams to construct a simple network application. Prerequisites: SSW 215 (Individual Software Engineering) or equivalent

SSW 322   Engineering Design VI

This course provides software engineering students with experiences for software design and evolution in the context of engineering design. Students will explore the software design process covering the domain knowledge identification, design modeling and communication, design validation, design risk assessment, and strategic design in software evolution. Students will acquire essential skills for improving "a design that solves a current problem" to "a good design that fits into a domain's context and eases future code maintenance while providing an excellent user experience". Students will practice skills in the roles of software "manager", "designer", "architect" and "developer" in a real-software-project-like setting. Students will employ user centered design, design, implement, maintain, and deliver more than one release of a project along the semester drawing on principles of Engineering Design. Tools that have been introduced in earlier software engineering courses will be brought together as part of this pre-senior design experience, as will new tools in User Centered Design, Engineering Design and testing.

SSW345   Model Based Software Engineering

This course provides an introduction to the development and application of formal models for the specification, design, and automatic analysis of software systems, to increase the reliability and correctness of the software systems, in particular software critical to the safety of systems. Topics include a brief overview of logic and set theory, the use of formalism to describe models and build simulators of software systems, and the emphasis on model-based specification, simulation, and analysis of software systems' properties and performance. Prerequisites: SSW 315 Object Oriented Software Engineering or equivalent and MA 134 Discrete Math or equivalent

SSW 423   Engineering Design VII

This is the first course of a year long, two-course sequence which involves the students in a small-team Software Engineering project. The problem for the project is taken from industry, business, government or a not-for-profit organization. Each student team works with a client and is expected to collect data, analyze it and develop a design by the end of the first semester. In the second semester the design solution of the problem is completed and a written report is submitted for binding. During the year, oral and written progress reports are presented to peers, faculty and clients. The total project involves the application of the subject areas covered in the SSW 322 Software Design Evolution course, as well as skills learned in the other technical and non-technical courses of the Software Engineering curriculum. Prerequisite: SSW215, SSW315, SSW345, SSW322

SSW 424   Engineering Design VIII   (- - -)

This is the second course of a year long, two-course sequence which involves the students in a small-team Software Engineering project. The problem for the project is taken from industry, business, government or a not-for-profit organization. Each student team works with a client and is expected to collect data, analyze it and develop a design by the end of the first semester. In the second semester the design solution of the problem is completed and a written report is submitted for binding. During the year, oral and written progress reports are presented to peers, faculty and clients. The total project involves the application of the subject areas covered in the SSW 322 Software Design Evolution course, as well as skills learned in the other technical and non-technical courses of the Software Engineering curriculum. Prerequisite: SSW215, SSW315, SSW345, SSW322, SSW423

SSW 533   Cost Estimation and Metrics   (3 - 3 - 0)

The course deals with the management of software projects using objective metrics that help developers and managers to understand the scope of the work to be accomplished, the risks that will occur, the tasks to be performed, the resources and effort to be expended, and the schedule to be observed. It provides the student with a thorough introduction to facility with, and understanding of such industry-standard software sizing metrics as Function, Feature, and Object Points and their relationship to the lines-of-code metric. It provides the student with a thorough introduction to and understanding of such industry-standard software estimation tools such as COCOMO II used in cost estimation. Cross-listed with: CS 533

SSW 540   Fundamentals of Software Engineering   (3 - 3 - 0)

This course introduces the subject of software engineering, also known as software development process or software development best practice from a quantitative, i.e., analytic- and metrics-based point of view. Topics include introductions to: software life-cycle process models from the heaviest weight, used on very large projects, to the lightest weight, e.g., extreme programming; industry-standard software engineering tools; teamwork; project planning and management; object-oriented analysis and design. The course is case history and project oriented.

SSW 541   Fundamentals of Software Engineering for Non-software Engineers   (3 - 3 - 0)

This course teaches the fundamentals of software and software engineering for those who need to understand how software systems are developed, but are not expected to have direct responsibility for software development themselves.

SSW 555   Agile Methods for Software Development   (3 - 3 - 0)

In software problem areas that require exploratory development efforts, those with complex requirements and high levels of change, agile software development practices are highly effective when deployed in a collaborative, people-centered organizational culture. This course examines agile methods, including Extreme Programming (XP), Scrum, Lean, Crystal, Dynamic Systems Development Method and Feature-Driven Development to understand how rapid realization of software occurs most effectively. The ability of agile development teams to rapidly develop high quality, customer-valued software is examined and contrasted with teams following more traditional methodologies that emphasize planning and documentation. Students will learn agile development principles and techniques covering the entire software development process from problem conception through development, testing and deployment, and will be able to effectively participate in and manage agile software developments as a result of their successfully completing this course. Case studies and software development projects are used throughout. Cross-listed with: CS 555

SSW 564　　　　Software Requirements Analysis and Engineering　　　　(3 - 0 - 0)

Requirements Acquisition is one of the least understood and hardest phases in the development of software products, especially because requirements are often unclear in the minds of many or most stakeholders. This course deals with the identification of stakeholders, the elicitation and verification of requirements from them, and translation into detailed requirements for a new or to-be-extended software product. It deals further with the analysis and modeling of requirements, the first steps in the direction of software design. The quality assurance aspects of the software requirements phase of the software development process is studied. Also an introduction to several formal methods for requirements specification is presented.

SSW 565　　　　Software Architecture and Component-Based Design　　　　(3 - 0 - 0)

This course introduces students to the software design process and it's models; representations of design/architecture; software architectures and design plans; design methods; design state assessment; design quality assurance; and design verification. Prerequisite: SSW 540

SSW 567　　　　Software Testing, Quality Assurance, and Maintenance　　　　(3 - 3 - 0)

This course introduces students to systematic testing of software systems, software verification, symbolic execution, software debugging, quality assurance, measurement and prediction of software reliability, project management, software maintenance, software reuse and reverse engineering.

SSW 590　　　　DevOps Principles and Practices　　　　(3 - 3 - 0)

This course introduces students to the Software Engineering principles and practices of DevOps. DevOps helps companies to shorten development cycles and deliver higher quality products to customers more quickly by creating a culture of working together in a unified team, using automated processes throughout the product lifecycle, and focusing on continual improvement by monitoring and experimentation. Students will learn about the team culture, processes, technologies, and tools that enable successful DevOps teams to deliver better products faster. Prerequisites: Programming experience with Python, Java, or permission of the instructor.

SSW 689　　　　Engineering of Trusted Software Systems　　　　(3 - 3 - 0)

Trusted systems are dependable, safe, and secure. None of this happens by accident – it all must be engineered in. The course goes beyond the traditional software engineering, quality and development courses to focus on the theory and practical techniques required to create trusted systems. The course covers software reliability engineering, software security engineering, control systems concepts, hazard analysis and management, trusted architecture patterns, and software fault and failure tolerance and management. Specific techniques such as analysis of attack patterns, degraded operation, simplex architectures and rejuvenations, are studied in depth to understand their usefulness and contribution to an overall trusted system solution. Case studies (e.g. Mars Rover) and team projects (e.g. analyzing and reengineering a system to be trustworthy) are used throughout. Prerequisite: SSW 533

SSW 810　　　　Selected Topics in Systems Centric Software Engineering　　　　(3 - 3 - 0)

Selected topics from various areas within Software Engineering. This course is typically taught to more than one student and often takes the form of a visiting professor's course. Prerequisite: consent of instructor.

Systems Engineering

SYS 501　　　　Probability and Statistics for Systems Engineering　　　　(3 - 3 - 0)

This course is designed for students with a background in engineering, technology, or science that have not taken a class in statistics or need a refresher class. In this class we will apply probability and statistics throughout a system's life cycle. Topics include the roles of probability and statistics in Systems Engineering, the nature of uncertainty, axioms and properties of probability models and statistics, hypothesis testing, design of experiments, basic performance requirements, quality assurance specification, functional decomposition, technical performance measurements, statistical verification, and simulation.

SYS 510　　　　Special Topics in Systems Engineering　　　　(3 - 3 - 0)

Special topics in systems engineering not covered in regularly scheduled courses and suitable for both graduates and advanced undergraduates. May be taken more than once.

SYS 511   Systems Engineering Applications to Healthcare   (3 - 3 - 0)

This course provides introduction to process and production of health care in the United States. The students will learn application of industrial and systems engineering (ISYE) methodologies to analyze and solve health systems challenges.

SYS 564   Principles of Optimum Design and Manufacture   (3 - 3 - 0)

Application of mathematical optimization techniques, including linear and nonlinear methods, to design and manufacture of devices and systems of interest to mechanical engineers; optimization techniques include: constrained and unconstrained optimization in several variables, problems for structured multi-stage decision, and linear programming; formulation of design and manufacturing problems using computer- based methods; optimum design of parts and assemblies to minimize the cost of manufacture. Cross-listed with ME 564

SYS 581   Introduction to Systems Engineering   (3 - 3 - 0)

The growing complexity of today's engineered systems presents daunting challenges to those who are charged with creating, operating, enhancing and sustaining them throughout their lifecycles. While the components of these systems require no less design effort than in the past, attention to the components is not sufficient to ensure overall system success. This course focuses on the interactions between the elements of a complex system, the context within which they are designed and operate, and the relationships between the technical systems and the organizations that design them and the enterprises that they serve. Students develop the understanding of techniques and processes that can help them ensure that their individual contributions are not only excellent in themselves, but that they become part of a cohesive, successful whole.

SYS 595   Design of Experiments and Optimization   (3 - 0 - 0)

This course is an application oriented with theoretical arguments approached from an intuitive level rather than from a rigorous mathematical approach. This course teaches the student how statistical analyses are performed while assuring the student an understanding of the basic mathematical concepts. The course will focus on "real world" uses of statistical analysis and reliability theory. The student will use the software to solve problems. Included in this course will demonstrate Markov modeling techniques. This course is a perquisite to the System Reliability and Life Cycle Analysis course.

SYS 605   Systems Integration   (3 - 3 - 0)

This course will explore and discuss issues related to the integration and testing of complex systems. First and foremost, students will be exposed to issues relating to the formulation of system operational assessment and concept. Subsequently, functional modeling and analysis methods will be used to represent the system functionality and capability, leading to the packaging of these functions and capabilities into high-level system architecture. Specific focus will be given to issues of interface management and testability. The course will also address the related management issues pertaining to integrated product teams, vendors and suppliers, and subcontractors. In addition, selected articles will be researched to demonstrate the techniques explored in class.

SYS 611   Systems Modeling and Simulation   (3 - 3 - 0)

This course emphasizes the development of modeling and simulation concepts and analysis skills necessary to design, program, implement, and use computers to solve complex systems/products analysis problems. The key emphasis is on problem formulation, model building, data analysis, solution techniques, and evaluation of alternative designs/ processes in complex systems/products. Overview of modeling techniques and methods used in decision analysis, including Monte Carlo and discrete event simulation is presented.

SYS 622   Data Analysis and Visualization Techniques for Decision-making   (3 - 3 - 0)

This course provides a hands-on introduction to the modern techniques for visualizing data and leverages such techniques with the corresponding problem solving skills necessary to complement data visualization into specific strategic decision making. The student will first learn to use the latest off the shelf software for data visualization. In specific the student will learn the following languages: R, D3, Google refine and Spot fire. Cross-listed with EM 622

SYS 623   Data Science and Knowledge Discovery   (3 - 3 - 0)

This course provides an hands-on introduction to the major techniques and solutions to discover knowledge in data and text. Traditional data mining along with text mining and network analysis will be presented and will be used by the students via open source software, addressing information mining needs on both structured and unstructured data. Cross-listed with: EM 623

SYS 625   Fundamentals of Systems Engineering   (3 - 3 - 0)

This course discusses fundamentals of systems engineering. Initial focus is on need identification and problems definition. Thereafter, synthesis, analysis, and evaluation activities during conceptual and preliminary system design phases are discussed and articulated through examples and case studies. Emphasis is placed on enhancing the effectiveness and efficiency of deployed systems while concurrently reducing their operation and support costs. Accordingly, course participants are introduced to methods that influence system design and architecture from a long-term operation and support perspective.

SYS 630   DAU Level I Certification Examinationion   (3 - 3 - 0)

This will test the knowledge of students who have achieved the equivalent of Level I certification through the Defense Acquisition University or who have completed selected industry training programs. Typically students take 80 hours training for this certification level equivalent. Upon successful completion (graded pass/fail), students will be awarded 3 credits toward a Master of Engineering in Systems Engineering.

SYS 631   Level II Certification Examination   (3 to 6 - -)

This will test the knowledge of students who have achieved the equivalent of Level II certification through the Defense Acquisition University or who have completed selected industry training programs. Typically students take more than 160 hours training for this certification level equivalent. Upon successful completion (graded pass/fail), students will be awarded between 3 and 6 credits toward a Master of Engineering in Systems Engineering.

SYS 632   Designing Space Missions and Systems   (3 - 0 - 0)

This course examines the real-world application of the entire space systems engineering discipline. Taking a process-oriented approach, the course starts with basic mission objectives and examines the principles and practical methods for mission design and operations in depth. Interactive discussions focus on initial requirements definition, operations concept development, architecture tradeoffs, payload design, bus sizing, subsystem definition, system manufacturing, verification and operations. This is a hands-on course with a focus on robotic missions for science, military and commercial applications.

SYS 633   Mission and System Design Verification and Validation   (3 - 0 - 0)

This unique course gives students a hands-on opportunity to apply key principles of space systems engineering. In part 1 of the course, students are given a set of customer expectations in the form of broad mission objectives. Using state-of-the-industry mission design and analysis tools (provided), the task is to apply systems engineering process to define top-level system requirements and design key elements of the system. The end result will be a system design review during which students present and defend their design decisions. In part 2 of the course, students experience system realization processes first-hand by integrating, verifying, validating and delivering the shoe box-sized EyasSAT educational satellite. Lecture is combined with hands-on experience. From the part-level to the system level, students will implement a rigorous assembly, integration, verification and validation plan on real hardware and software applying "test like you fly, fly like you test" principles.

SYS 635   Human Spaceflight   (3 - 3 - 0)

This course provides the conceptual framework for developing space missions of human spacecraft starting from a blank sheet of paper. It describes and teaches the human space mission design and analysis process. The entire course is process oriented to equip each participant with practical tools to complete a conceptual design and analyze the impacts of evolving requirements. At the end of this course you will be better able to tie mission elements together and perform tradeoffs between system design and mission operations that must occur, during the early stages of planning, in order to deliver cost-effective results.

SYS 636   Space Launch and Transportation Systems   (3 - 3 - 0)

This course provides an integrated view of space launch and transportation systems (SLaTS) design and operations. It analyzes customer needs, objectives and requirements, through launch and transportation system design, development, test and manufacturing to creating operations concepts and infrastructure capabilities. Lifecycle cost and the business case will be assessed. The thrust of this course is to identify technical risk and mitigate it in the most cost-effective manner, while maintaining the technical integrity of the vehicle(s) and infrastructure. In the course you will take a fresh look at space launch and transportation systems by emphasizing a process-oriented approach for creating cost-effective concepts to meet customer needs and objectives. This process describes how to translate SLaTS objectives, requirements, and constraints into viable and cost-effective operations concepts. Vehicle design presentations show practical, detailed approaches and tools to analyze and design manned and unmanned, reusable and expendable vehicles for both launch and interplanetary systems, including architecture and configuration, payloads, and vehicle subsystems. Course presentations on launch operations describe the functions to be performed, define and evaluate the key issues, help you develop an appropriate operations concept, and assess the complexity and cost of operations. Special emphasis is placed on describing the interrelationships and tradeoffs between system design and launch operations that must occur during the early stages of planning in order to deliver effective systems.

SYS 637   Cost-Effective Space Mission Operations   (3 - 3 - 0)

This course examines the real-world space mission operations. Taking a process-oriented approach, the course provides an in-depth view of the entirety of space mission operations, including the concept of operations and all functions that are performed in support of a space mission. Interactive discussions focus on initial requirements definition, operations concept development, functional allocation among spacecraft, payload, ground system and operators. A detailed model is provided that allows the user to estimate operations complexity and then prepare an estimate of the number of operators required and overall cost. This is a hands-on course with a focus on space missions for science, military and commercial applications.

SYS 638   Crew Exploration Vehicle Design   (3 - 3 - 0)

This unique course gives participants a hands-on opportunity to apply key principles of space systems engineering. Participants are given a set of customer expectations in the form of broad mission objectives for a crew exploration vehicle with the task of applying systems engineering process to define top-level system requirements and design key elements of the system. The end result will be a system design review during which students present and defend their design decisions. Prerequisites: SYS 632, SYS 635

SYS 640   System Supportability and Logistics   (3 - 0 - 0)

The supportability of a system can be defined as the ability of the system to be supported in a cost effective and timely manner, with a minimum of logistics support resources. The required resources might include test and support equipment, trained maintenance personnel, spare and repair parts, technical documentation and special facilities. For large complex systems, supportability considerations may be significant and often have a major impact upon life-cycle cost. It is therefore particularly important that these considerations be included early during the system design trade studies and design decision-making.

SYS 645   Design for System Reliability, Maintainability, and Supportability   (3 - 0 - 0)

This course provides the participant with the tools and techniques that can be used early in the design phase to effectively influence a design from the perspective of system reliability, maintainability, and supportability. Students will be introduced to various requirements definition and analysis tools and techniques to include quality function deployment, input-output matrices, and parameter taxonomies. An overview of the system functional analysis and system architecture development heuristics will be provided.

SYS 650   System Architecture and Design   (3 - 0 - 0)

This course discusses the fundamentals of system architecting and the architecting process, along with practical heuristics. Furthermore, the course has a strong "how-to" orientation, and numerous case studies are used to convey and discuss good architectural concepts as well as lessons learned. Adaptation of the architectural process to ensure effective application of COTS will also be discussed. In this regard, the course participants will be introduced to an architectural assessment and evaluation model. Linkages between early architectural decisions, driven by customer requirements and concept of operations, and the system operational and support costs are highlighted. Prerequisite: SYS 625

SYS 655   Robust Engineering Design   (3 - 0 - 0)

This course is designed to enable engineers, scientists, and analysts from all disciplines to recognize potential benefits resulting from the application of robust engineering design methods within a systems engineering context. By focusing on links between sub-system requirements and hardware/software product development, robust engineering design methods can be used to improve product quality and systems architecting. Topics such as Design and Development Process and Methodology, Need Analysis and Requirements Definition, Quality Engineering, Taguchi Methods, Design of Experiments, Introduction to Response Surface Methods, and Statistical Analysis of Data will be presented.

SYS 660   Decision and Risk Analysis   (3 - 0 - 0)

This course is a study of analytic techniques for rational decision-making that addresses uncertainty, conflicting objectives, and risk attitudes. This course covers modeling uncertainty; rational decision-making principles; representing decision problems with value trees, decision trees and influence diagrams; solving value hierarchies; defining and calculating the value of information; incorporating risk attitudes into the analysis; and conducting sensitivity analyses.

SYS 670   Forecasting and Demand Modeling Systems   (3 - 0 - 0)

This course covers the theory and application of modeling aggregate demand, fragmented demand and consumer behavior using statistical methods for analysis and forecasting for facilities, services and products. It also aims to provide students with both the conceptual basis and tools necessary to conduct market segmentation studies, defining and identifying criteria for effective segmentation, along with techniques for simultaneous profiling of segments and models for dynamic segmentation. All of this provides a window on the external environment, thereby contributing input and context to product, process and systems design decisions and their ongoing management.

SYS 671   Conception of CPS: Deciding What to Build and Why (3 - 3 - 0)

This first course focuses on the conceptual design portion of the lifecycle of Cyber-Physical systems. Critical elements include the ideas of systems and design thinking, and elegant design. An Ideation process, as pioneered by the likes of IDEA and other prominent design firms is used to spark the creative process. The opportunity is conceived and defined using Kano Maps, marketing segmentation and conjoint analysis techniques. A QFD process is used to collect, organize and analyze customer needs, and transform these into product specifications. Concepts are generated, selected and tested. Finally, these concepts are specified using concept of operation, conceptual design and using case scenarios and technical requires. A workshop on Model-Based Systems Engineering (MBSE), particularly, SysML is used as a means for specification and also to provide a foundation for future modeling work. Lectures are interspersed with individual and group project based activities. the students go through a design review process in preparation for their final report.

SYS 672   Design of CPS: Ensuring Systems Work and Are Robust (3 - 3 - 0)

Ensuring systems work and are robust educates students on the transition from cyber-physical system concept and preliminary requirements to detailed architecture and design based on prioritized, allocated and traceable architecturally significant requirements. Students will create models of system structure and activities, make appropriate technology selections, and perform analyses for reliability, performance, safety and security. Trade space analyses will be performed.

SYS 673   Implementation of CPS: Bringing Solutions to Life (3 - 3 - 0)

This third course focuses on the continuous implementation, integration, testing, analysis, and verification and validation of cyber systems (CPS). This course builds on Course 2 using a metaphor where the students plan on a successful product launch, using our project to work through continuous integration and test and ultimately bringing a robust solution to life in the form of a working CPS system. We intersperse lectures with individual and group project based activities to ensure that the developed system is functional and robust. We discuss and use the most effective techniques for fault and failure tolerance, analysis, and testing method and principles. We plan to capitalize on simulation and physical systems resources for continuous and automated testing and discuss the balance of testing versus analysis. The students will continuously collect evidence of quality, performance measures and traceability information.

SYS 674   Sustainment of CPS: Managing Evolution   (3 - 3 - 0)

This course focuses on managing the evolution of a cyber-physical system after its initial release to the market until its retirement. The course approaches this topic on three levels. The foundation is to put in place policies, processes and infrastructure to support, maintain and respond to quality issues for released instances of the system. The second level is to drive the evolution of the system's capabilities and characteristics based on evolving needs and enabling technologies. The third level is to proactively "disrupt" the market by reframing the opportunity and reinventing they system based on internal innovation, or responding to external disruptions in the marketplace or the technology space. Prerequisites: SYS 671, and SYS 672, and SYS 673

SYS 681   Dynamic Modeling of Systems and Enterprise   (3 - 3 - 0)

The course introduces students to fundamentals of system dynamics modeling of complex systems and enterprises. System Dynamics is a modeling approach that has been developed at MIT in the 1960s. System dynamics is used for variety of applications ranging from supply chain management, decision analysis, innovation diffusion and management and other management as well as engineering applications of complex systems. This course we will cover the basic fundamentals of systems dynamics and enable students to learn and build system dynamic models including causal links and loop diagrams, stock and flows with application to modeling contagion in systems, innovation diffusion, delays in complex systems and many more examples and applications.

SYS 703   Curricular Practical Training   (1 - 0 - 0)

International graduate students may arrange an educationally relevant internship or paying position off campus and receive Curricular Practical Training (CPT) credit via this course. Students must maintain their full time status while receiving CPT. Prior approval of the program director is required for enrollment. To justify enrollment, the student must have a concrete commitment from a specific employer for a specific project, and must provide to the program director for his/her approval a description of the project plus a statement from the employer that he/she intends to employ the student. This information must be provided to the program director with sufficient advance notice so that the program director has time to review the materials and determine if the project is appropriate. The project must be educationally relevant; i.e., it must help the student develop skills consistent with the goals of the educational program. During the semester, the student must submit written progress reports. At the end of the semester, the student must submit for grading a written report that describes his/her activities during that semester, even if the activity remains ongoing. The student must also present his/her activities in an accompanying oral presentation that is also graded. This is a one-credit course that may be repeated up to a total of three credits.

SYS 710   Research Methodologies   (3 - 3 - 0)

Research philosophy, ethics, and methodology will be discussed. Each student will, under the guidance of the instructor, formulate a problem, search the literature, and develop a research design. In addition, the student will examine and criticize research reports with specialemphasis on the statement of the problem, the sampling and measuring techniques that are used, and theanalyses and interpretation of the data. Emphasis is on applying research methodology to real-world organizational problems.

SYS 725   Advances in System of Systems Engineering   (3 - 3 - 0)

The discipline of Systems Engineering (SE) provides us with necessary engineering and management guidance to successfully design and develop a system rather than focus on its separate individual components. However, due to the rapidly increasing complexity of today's dynamic environment, we are faced with the need to engineer multiple integrated complex systems. In response to this emerging paradigm shift, a new discipline of System of Systems Engineering (SoSE) has evolved. This course serves as an overview of the advances in SoSE and provides the students the capability to apply this knowledge in the synthesis, analysis, and evaluation of activities during the lifecycle of a System of Systems (SoS) through case study analysis. Prerequisite: SYS 625

SYS 744   Advanced Data Analysis for Data Mining and Knowledge Discovery   (3 - 0 - 0)

This data driven course focuses on the subjects of both traditional and modern data analysis and mining techniques. The course emphasizes the analysis of business and engineering data using a combination of theoretical techniques and commercially available software to solve problems. Topics such as data analysis and presentation, linear and nonlinear regression, analysis of variance, factor analysis, cluster analysis, neural networks, and classification trees will be presented. The course will make extensive use of the Splus software packages. However, students will be encouraged to use a wide variety of industry standard data analysis and mining tools including SPSS, SAS, MATLAB, and BrainMaker. Cross-listed with EM 744

SYS 750   Advanced System and Software Architecture Modeling and Assessment   (3 - 3 - 0)

This course presents the fundamentals of complex systems architecting using the Object Modeling Group's (OMG) SysML. It addresses the differences between functional decomposition and object oriented decomposition while architecting complex systems. Emphasis is placed on modeling mission objectives to the definition of the system level architecture. Topics include identification of system level architecture alternatives and considerations, including definition of objectives for physical (hardware) and logical (software) structure, information and system assurance, behavior, cost, performance and human integration based on the system concept at every level of system decomposition. System of System (SoS) architecture is examined, addressing composition of multiple systems and engineering new, emergent behavior in the SoS. Examples used will come from a variety of operational environments (e.g. communications systems, space systems, weapon systems, etc) Special consideration is given to the importance of effective construction and transitioning of the SysML models to software engineering for software intensive systems projects. Prerequisites: SYS 625 and SYS 650

SYS 760   Advanced Decision and Risk Analysis   (3 - 3 - 0)

This course is the advanced study of analytic techniques for rational decision making that addresses uncertainty, conflicting objectives, and risk attitudes. This course covers advanced techniques for modeling uncertainty; values and risk preference. The advanced techniques for modeling uncertainty include Bayesian networks and the various approaches for both representing joint probability distributions and computing posterior distributions given new evidence. The techniques for modeling preferences address various degrees of preferential dependence among objectives. Finally, the risk preference techniques address non-exponential risk preference and the associated computation of value of information. These techniques are valuable as part of the risk management process, conduct of systems engineering trade-offs, and managing systems engineering projects Prerequisite: SYS 660

SYS 800   Special Problems in Systems Engineering (ME)   (3 - -)

Three credits for the degree of Master of Engineering (Systems Engineering). This course is typically conducted as a one-on-one course between a faculty member and a student. A student may take up to two special problems courses in a master's degree program. A department technical report is required as the final product for this course.

SYS 801   Special Problems in Systems Engineering (PhD)   (3 - -)

Three credits for the degree of Doctor of Philosophy. This course is typically conducted as a one-on-one one investigation of a topic of particular interest between a faculty member and a student and is often used to explore topical areas that can serve as a dissertation. A student may take up to two special problems courses in a Ph.D. degree program. A department technical report is required as the final product for this course.

SYS 810   Selected Topics in Systems Engineering   (3 - 3 - 0)

Selected topics from various areas within Systems Engineering. This course is typically taught to more than one student and often takes the form of a visiting professor's course. Prerequisite: consent of instructor. Prerequisite: Consent of instructor

SYS 900   Thesis in Systems Engineering (ME)   (1 to 6 - -)

A minimum of six credit hours is required for the thesis. Hours and credits to be arranged.

SYS 960   Research in System Engineering (PhD)   (- - -)

Original work, which may serve as the basis for the dissertation, required for the degree of Doctor of Philosophy. A minimum of 30 hours of SYS 960 research is required for the Ph.D. degree. Hours and credits to be arranged.

SCHOOL OF BUSINESS

SCHOOL OF BUSINESS

FACULTY

Richard Anderson, Ph.D.
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Affiliate Associate Professor

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Intelligence & Analytics Program

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Associate Professor

David Belanger, Ph.D.
Senior Research Fellow

Tal Ben-Zvi, Ph.D.
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James Biagi
Associate Teaching Professor

Stefano Bonini, Ph.D.
Assistant Professor

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Assistant Professor

Ricardo Collado, Ph.D.
Assistant Professor

German Creamer, CFA, Ph.D.
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Director of Veterans Programs

Thomas Lonon
Assistant Teaching Professor

Xi (Victor) Luo
Assistant Professor

Gary Lynn, Ph.D.
Professor

Adriana Madzharov, Ph.D.
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Feng Mai, Ph.D.
Assistant Professor

Murad Mithani, Ph.D.
Assistant Professor

Somayeh Moazeni
Assistant Professor

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Associate Professor

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Associate Dean of Research; Professor and
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Michael Parfett, Ph.D.
Industry Professor

Gregory Prastacos, Ph.D.
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Panagiotis Repoussis, Ph.D.
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Lawrence Gastwirt, Ph.D.
Emeritus Faculty; Director of the Executive Program
in Technical Leadership

C. Timothy Koeller, Ph.D.
Emeritus Professor

Richard Reilly, Ph.D.
Emeritus Professor

Undergraduate Programs

BACHELOR OF SCIENCE IN BUSINESS

A business degree from the School of Business is one of the most challenging, yet rewarding experiences, you'll ever have. Choose from majors that emphasize advancing technologies and cutting-edge research with world class professors. Get real-world experience through corporate partnerships and prepare for exceptional career placement. Enjoy the benefits of our unique location, just minutes away from the world's business capital. You'll find many opportunities in just one place - the School of Business.

Business Majors:

▸ Accounting & Analytics

▸ Business & Technology

▸ Economics

▸ Finance

▸ Information Systems

▸ Management

▸ Marketing Innovation & Analytics

Major in Business & Technology

This major requires four courses in a Business concentration and four courses in Technology concentration (for a total of 8 courses for the major).

Technology Concentration

Choose coursework from approved list, available at the Center for Student Success in Babbio 303. If all 4 courses are taken in the same technology area, then this constitutes a "concentration". Otherwise, they are coonsidered electives.

Business Concentration

Students choose coursework from one of the six business concentrations:

Marketing Concentration (students select 4 courses from the following)

▸ BT 214 Market Analytics and Research

▸ BT 403 Marketing Strategy in a Digital World

▸ BT 435 Social Media and Network Analysis

▸ BT 445 Virtual and Physical Consumer Behavior

▸ BT 465 Integrated Marketing Communications

▸ BT 466 Data Analytics

Finance Concentration (students select 4 courses from the following)

- ▸ BT 325 Financial Statement Analysis or FIN510 Financial Statement Analysis
- ▸ BT 425 Portfolio Management
- ▸ BT 426 Equity Valuation
- ▸ QF 430 Introduction to Derivatives
- ▸ BT 440 Money, Banking and Financial Institutions
- ▸ BT 442 Fixed Income
- ▸ BT 454 International Economics and Finance

International Business Concentration (students select 4 courses from the following)

- ▸ 3-4 courses taken while studying abroad, with approval from Associate Dean
- ▸ Up to 1 international Business course taken at Stevens

Information Systems Concentration (students select 4 courses from the following)

- ▸ Whichever of the 3 courses (BT416 Business Process Management, BT421 Systems Analysis & Design, MIS460 IT Strategy or BT 466 Data Analytics) that the student didn't take as part of their required coursework
- ▸ BT 310 Programming for Mobile Applications
- ▸ BT 333 Database Management
- ▸ BT 353 Project Management
- ▸ BT 422 Decision Making
- ▸ BT 435 Social Media and Network Analysis

Management Concentration (select 4 courses from the following)

- ▸ BT 353 Project Management
- ▸ BT 422 Decision Making
- ▸ BT 447 Creativity and Innovation
- ▸ +1 "Management Elective" from approved list.

Economics Concentration (select 4 courses from the following)

- ▸ BT 343 Intermediate Macroeconomics
- ▸ BT 344 Intermediate Microeconomics
- ▸ QF 200 Financial Econometrics
- ▸ BT 440 Money, Banking and Financial Institutions
- ▸ BT 454 International Economics and Finance

Business & Technology Curriculum

Term I

Course #	Course Name	Lecture	Lab	Study	Credit
MA 117	Calculus for Business and Liberal Arts	3	1	8	4
PEP 123	Physics for Business & Technology I	2	2	4	3
BT 244	Microeconomics	3	0	6	3
MIS 201	Fundamentals of Information Systems	2	2	8	4
PE 200	Physical Education I	0	2	0	0
CAL 103	Writing And Communications Colloquium	3	0	6	3
	Total	**13**	**7**	**32**	**17**

Term II

Course #	Course Name	Lecture	Lab	Study	Credit
CAL 105	CAL Colloquium: Knowledge, Nature, Culture	3	0	6	3
BT 100	Principles of Management	3	0	6	3
MA 119	Multivariable Calculus & Finite Mathematics	3	0	6	4
PEP 124 Or CH 115 Or BIO 281	Physics for Business & Technology II Or General Chemistry I Or Biology and Biotechnology	3	0	6	3
CS 105 Or CS 115	Introduction to Scientific Computing Or Introduction to Computer Science	2	2	6	3
PE 200	Physical Education II	0	2	0	0
	Total	**14**	**4**	**30**	**16**

Term III

Course #	Course Name	Lecture	Lab	Study	Credit
BT 221	Statistics	3	0	6	3
BT 223	Applied Models and Simulation	3	0	6	3
BT 321	Corporate Finance	3	0	6	3
	Humanities	3	0	6	3
PE 200	Physical Education III	0	2	0	0
BT 350	Marketing	3	0	6	3
BT 290	Business Career Seminar	0	1	1	0
	Total	**15**	**3**	**31**	**15**

Term IV

Course #	Course Name	Lecture	Lab	Study	Credit
BT 100	Principles of Management	3	0	6	3
BT 243	Macroeconomics	3	0	6	3
	Humanities	3	0	6	3
BT 215	Managerial Accounting	3	0	6	3
	Information Systems Requirement	3	0	6	3
PE 200	Physical Education IV	0	2	0	0
	Total	**15**	**2**	**30**	**15**

Term V

Course #	Course Name	Lecture	Lab	Study	Credit
	Technology Concentration[1]	3	0	6	3
	Technology Concentration[1]	3	0	6	3
	Business Concentration[2]	3	0	6	3
BT 350	Information Systems Requirement	3	0	6	3
BT 360	International Business	3	0	6	3
	General Elective	3	0	6	3
	Total	**18**	**0**	**36**	**18**

Term VI

Course #	Course Name	Lecture	Lab	Study	Credit
	Technology Concentration[1]	3	0	6	3
BT 372	Entrepreneurship	3	0	6	3
	Business Concentration[2]	3	0	6	3
	General Elective	3	0	6	3
BT 301	Strategy	3	0	6	3
	Total	**15**	**0**	**30**	**15**

Term VII

Course #	Course Name	Lecture	Lab	Study	Credit
	Business Concentration[2]	3	0	6	3
BT 411	Senior Design I	1	2	4	3
BT 401	Advanced Strategy	3	0	6	3
BT 330	Social Psychology and Organizational Behavior	3	0	6	3
ISE 350	Logistics and Supply Chain Management	3	0	6	3
	Total	**13**	**2**	**28**	**15**

Term VIII

Course #	Course Name	Lecture	Lab	Study	Credit
	Business Concentration[2]	3	0	6	3
BT 412	Senior Design II	1	2	6	3
BT 413	Business Law	3	0	6	3
	General Elective	3	0	6	3
	Technology Concentration[1]	3	0	6	3
	Total	**13**	**2**	**30**	**15**

1. Technology Concentrations offer a closer look at a particular technology discipline. Students choose four courses in the area they wish to concentrate.
2. Business concentrations offer a deeper dive into one of five areas- Finance, Marketing, Information Systems, International Business or Management. Students choose four courses in the area in which they wish to concentrate.

Accounting & Analytics Curriculum

Term I

Course #	Course Name	Lecture	Lab	Study	Credit
CAL 103[1]	Freshman Writing	3	0	6	3
MA 117	Calculus I	4	0	8	4
PEP 123	Physics for B&T (I)	3	0	6	3
MIS 201	Fundamentals of Information Systems w/ excel lab	2	2	8	4
BT 244	Microeconomics	3	0	6	3
PE 200[2]	Physical Education I	0	1	0	0
	Total	**15**	**3**	**34**	**17**

Term II

Course #	Course Name	Lecture	Lab	Study	Credit
CAL 105[1]	CAL Colloquium	3	0	6	3
MA 119	Multivariable Calculus & Finite Math	3	0	6	3
PEP 124, CH 115, CH 281, Or BIO 281	Physics for B&T (II), Chemistry I, Biology I Or Into to Biology	3	0	6	3
CS 105	Intro to Scientific Computing	2	2	6	3
BT 200	Financial Accounting	3	0	6	3
PE 200[2]	Physical Education II	0	1	0	0
	Total	**14**	**3**	**30**	**15**

Term III

Course #	Course Name	Lecture	Lab	Study	Credit
HUM[1]	Humanities Requirement	3	0	6	3
BT 223	Applied Models and Simulation	3	0	6	3
BT 221	Statistics	3	0	6	3
BT 321	Corporate Finance	3	0	6	3
BT 350	Marketing	3	0	6	3
BT 290	Business Career Seminar	0	0	2	0
PE 200[2]	Physical Education III	0	1	6	0
	Total	**15**	**1**	**38**	**15**

Term IV

Course #	Course Name	Lecture	Lab	Study	Credit
HUM[1]	Humanities Requirement	3	0	6	3
	Analytics/IS Requirement	3	0	6	3
BT 243	Macroeconomics	3	0	6	3
BT 100	Principles of Management[3]	3	0	6	3
BT 215	Managerial Accounting	3	0	6	3
PE 200[2]	Physical Education IV	0	1	0	0
	Total	**15**	**1**	**30**	**15**

Term V

Course #	Course Name	Lecture	Lab	Study	Credit
ACC 311	Intermediate I	3	0	6	3
ACC 351	Federal Taxation of Individuals	3	0	6	3
CS 115	Introduction to Computer Science	3	2	8	4
	Analytics/IS Requirement	3	0	6	3
BT 360	International Business[3]	3	0	6	3
	General Elective	3	0	6	3
	Total	**18**	**2**	**38**	**19**

Term VI

Course #	Course Name	Lecture	Lab	Study	Credit
ACC 312	Intermediate II	3	0	6	3
ACC 421	Auditing	3	0	6	3
BT 466	Data Analytics	3	0	6	3
BT 301	Strategy	3	0	6	3
	General Elective	3	0	6	3
	Total	**15**	**0**	**30**	**15**

Term VII

Course #	Course Name	Lecture	Lab	Study	Credit
	Accounting Elective[4]	3	0	6	3
	Analytics/IS Requirement[3]	3	0	6	3
ISE 350	Operations Management	3	0	6	3
BT 411	Senior Design I	3	0	6	3
BT 401	Advanced Strategy	3	0	6	3
	Total	**15**	**0**	**30**	**15**

Term VIII

Course #	Course Name	Lecture	Lab	Study	Credit
	Accounting Elective[4]	3	0	6	3
	Analytics/IS Requirement[3]	3	0	6	3
BT 413	Business Law	3	0	6	3
BT 412	Senior Design II	3	0	6	3
	General Elective	3	0	6	3
	Total	**15**	**0**	**30**	**15**

1. Students are required to take two additional Humanities courses other than CAL103 and CAL105. One must be at the 100/200 level and one must be at the 300/400 level.
2. Students can use up to four semesters of Varsity and/or Club sports to fulfill the Physical Education requirement.
3. Choose Analytics/IS Requirement from the approved list.
4. Choose accounting electives from an approved list.

Masters of Science in Management with a Concentration in Accounting

Assumes no graduate courses were taken during undergraduate program, and that students are pursuing a MSM with a concentration in Accounting. Note that these courses do not necessarily need to be taken in this order, and are often taken based on what works best with the students' schedules.

Term VIII (Summer 1)

Course #	Course Name	Lecture	Lab	Study	Credit
MGT612	Leader Development	3	0	6	3
BIA652	Multivariate Data Analytics*	3	0	6	3
	Total	**6**	**0**	**12**	**6**

Term IX (Fall)

Course #	Course Name	Lecture	Lab	Study	Credit
FIN 510	Financial Statement Analysis	3	0	6	3
ACC	Accounting Elective	3	0	6	3
MGT 699	Strategic Management	3	0	6	3
MIS 674	Supply Chain Analytics*	3	0	6	3
	Total	**12**	**0**	**24**	**12**

Term X (Spring)

Course #	Course Name	Lecture	Lab	Study	Credit
ACC	Accounting Elective	3	0	3	3
MGT 671	Technology and Innovation Management	3	0	3	3
MGT 672	Marketing Analytics*	3	0	3	3
BI&A 636	Data Warehousing & Business Intelligence*	3	0	3	3
	Total	**12**	**0**	**12**	**12**

*These courses will allow the student to get a graduate certificate in Business Intelligence and Analytics. Alternatively, students can take another graduate certificate of their choosing such as Healthcare Leadership and Project Management.

Undergraduate Accounting Elective List

▸ Cost Accounting

▸ Advanced Accounting

▸ Advanced Tax

▸ Advanced Audit/Forensic

▸ Accounting Information Systems (AIS)

▸ Financial Statement Analysis

▸ Accounting Research

▸ International Accounting

▸ Government/ Non-profit Accounting

▸ Unstructured Financial Data Analysis (e.g. text mining of financial reports using python or perl)

Economics Curriculum

Term I

Course #	Course Name	Lecture	Lab	Study	Credit
CAL 103	Writing & Communications Colloquium[1]	3	0	6	3
MA 117	Calculus for Business & Lib Arts	4	0	8	4
PEP 123	Physics for B&T	3	0	6	3
MIS 201	Fundamentals of Information Systems	3	0	6	3
BT 244	Microeconomics	2	2	8	4
PE 200	Physical Education I[2]	0	1	0	0
	Total	**15**	**3**	**34**	**17**

Term II

Course #	Course Name	Lecture	Lab	Study	Credit
CAL 105	Knowledge, Nature, Culture[1]	3	0	6	3
MA 119	Multivariate Calculus & Finite Math	3	0	6	3
PEP 124, CH 115, BIO 281, Or BIO 210	Physics for B&T (II), Chemistry I, Bio and Biotech., Or Intro to Bio. for non-sci./eng. majors	3	0	6	3
CS 105	Intro to Scientific Computing[6]	2	2	6	3
BT 200	Financial Accounting	3	0	6	3
PE 200	Physical Education II[2]	0	1	0	0
	Total	**14**	**3**	**30**	**15**

Term III

Course #	Course Name	Lecture	Lab	Study	Credit
	Humanities Requirement[1] 100-200 Level	3	0	6	3
BT 223	Applied Models & Simulation	3	0	6	3
BT 221	Statistics	3	0	6	3
BT 321	Corporate Finance	3	0	6	3
BT 350	Marketing	3	0	6	3
BT 290	Business Career Seminar	0	0	0	0
PE 200	Physical Education III[2]	0	1	2	0
	Total	**15**	**1**	**32**	**15**

Term IV

Course #	Course Name	Lecture	Lab	Study	Credit
	Humanities Requirement[1] 300-400 Level	3	0	6	3
BT 243	Macroeconomics	3	0	6	3
BT 215	Managerial Accounting	3	0	6	3
BT 100	Principles of Management	3	0	6	3
BT 421, BT 416, BT 466 Or MIS 460	IS Requirement[3]	3	0	6	3
PE 200	Physical Education IV[2]	0	1	0	0
	Total	**15**	**1**	**30**	**15**

Term V

Course #	Course Name	Lecture	Lab	Study	Credit
BT 344	Intermediate Microeconomics	3	0	6	3
QF 200	Financial Econometrics	3	0	6	3
BT 421, BT 416, BT 466 Or MIS 460	IS Requirement[3]	3	0	6	3
BT 360	International Business	3	0	6	3
	Technology Elective[4]	3	0	6	3
	General Elective	3	0	6	3
	Total	**18**	**0**	**36**	**18**

Term VI

Course #	Course Name	Lecture	Lab	Study	Credit
BT 343	Intermediate Macroeconomics	3	0	6	3
	Technology Elective[4]	3	0	6	3
BT 372	Entrepreneurship	3	0	6	3
BT 301	Strategy	3	0	6	3
	General Elective	3	0	6	3
	Total	**15**	**0**	**30**	**15**

Term VII

Course #	Course Name	Lecture	Lab	Study	Credit
BT 440	Money, Banking and Financial Institutions	3	0	6	3
BT 330	Social Psychology & Organizational Behavior	3	0	6	3
ISE 350	Logistics and Supply Chain Management	3	0	6	3
BT 411	Senior Design I	3	0	6	3
BT 401	Renamed Advanced Strategy	3	0	6	3
	Total	**15**	**0**	**30**	**15**

Term VIII

Course #	Course Name	Lecture	Lab	Study	Credit
	Economics Elective[5]	3	0	6	3
BT 454	International Economics and Finance	3	0	6	3
BT 413	Business Law	3	0	6	3
BT 412	Senior Design II	3	0	6	3
	General Elective	3	0	6	3
	Total	**15**	**0**	**30**	**15**

1. Students are required to take two additional Humanities courses other than CAL103 and CAL105. One must be at the 100/200 level and one must be at the 300/400 level and be from two different disciplines.
2. Students can use up to four semesters of Varsity and/or Club sports to fulfill the Physical Education requirement.
3. Choose the IS Requirement from BT421 Systems Analysis and Design, BT416 Business Process Management, BT 466 Data Analytics or MIS460 IT Strategy.
4. Choose from an approved list of Technology Electives.
5. Choose from an approved list of Economics Electives (on back).
6. Students with computer science experience can take the more challenging course CS115, all others are advised to take CS105.

Economics Major Electives

▸ BT 214 Market Analytics and Research

▸ BT 403 Marketing Strategy in a Digital World

▸ BT 425 Portfolio Management

▸ BT 426 Equity Valuation

▸ BT 435 Social Media and Network Analysis

▸ QF 430 Derivatives

Finance Curriculum

Term I

Course #	Course Name	Lecture	Lab	Study	Credit
CAL 103	Writing & Communications Colloquium[1]	3	0	6	3
MA 117	Calculus for Business & Lib Arts	4	0	8	4
PEP 123	Physics for B&T	3	0	6	3
MIS 201	Fundamentals of Information Systems	3	0	6	3
BT 244	Microeconomics	2	2	8	4
PE 200	Physical Education I[2]	0	1	0	0
	Total	**15**	**3**	**34**	**17**

Term II

Course #	Course Name	Lecture	Lab	Study	Credit
CAL 105	Knowledge, Nature, Culture[1]	3	0	6	3
MA 119	Multivariate Calculus & Finite Math	3	0	6	3
PEP 124, CH 115, BIO 281, Or BIO 210	Physics for B&T (II), Chemistry I, Bio and Biotech., Or Intro to Bio. for non-sci./eng. majors	3	0	6	3
CS 105	Intro to Scientific Computing[6]	2	2	6	3
BT 200	Financial Accounting	3	0	6	3
PE 200	Physical Education II[2]	0	1	0	0
	Total	**14**	**3**	**30**	**15**

Term III

Course #	Course Name	Lecture	Lab	Study	Credit
	Humanities Requirement[1] 100-200 Level	3	0	6	3
BT 223	Applied Models & Simulation	3	0	6	3
BT 221	Statistics	3	0	6	3
BT 321	Coprorate Finance	3	0	6	3
BT 350	Marketing	3	0	6	3
BT 290	Business Career Seminar	0	0	0	0
PE 200	Physical Education III[2]	0	1	2	0
	Total	**15**	**1**	**32**	**15**

Term IV

Course #	Course Name	Lecture	Lab	Study	Credit
	Humanities Requirement[1] 300-400 Level	3	0	6	3
BT 243	Macroeconomics	3	0	6	3
BT 215	Managerial Accounting	3	0	6	3
BT 100	Principles of Management	3	0	6	3
BT 421, BT 416, BT 466 Or MIS 460	IS Requirement[3]	3	0	6	3
PE 200	Physical Education IV[2]	0	1	0	0
	Total	**15**	**1**	**30**	**15**

Term V

Course #	Course Name	Lecture	Lab	Study	Credit
BT 426	Equity Valuation	3	0	6	3
BT 440	Money, Banking and Financial Institutions	3	0	6	3
QF 103	Intro to Financial Tools & Tech	0	1	2	1
	Technology Elective[4]	3	0	6	3
BT 421, BT 416, BT 466 Or MIS 460	IS Requirement[3]	3	0	6	3
BT 360	International Business	3	0	6	3
	General Elective	3	0	6	3
	Total	**18**	**1**	**38**	**19**

Term VI

Course #	Course Name	Lecture	Lab	Study	Credit
BT 442	Fixed Income Analysis	3	0	6	3
BT 425	Portfolio Management	3	0	6	3
	Technology Elective[4]	3	0	6	3
BT 301	Strategy	3	0	6	3
BT 372	Entrepreneurship	3	0	6	3
	General Elective	3	0	6	3
	Total	**18**	**0**	**36**	**18**

Term VII

Course #	Course Name	Lecture	Lab	Study	Credit
BT 325 Or FIN 510	Financial Statement Analysis	3	0	6	3
BT 330	Social Psychology & Organizational Behavior	3	0	6	3
ISE 350	Logistics and Supply Chain Mgt	3	0	6	3
BT 411	Senior Design I	3	0	6	3
BT 401	Advanced Strategy	3	0	6	3
	Total	**15**	**0**	**30**	**15**

Term VIII

Course #	Course Name	Lecture	Lab	Study	Credit
QF 430	Intro to Derivatives	3	0	6	3
	Finance Elective[5]	3	0	6	3
BT 413	Business Law	3	0	6	3
BT 412	Senior Design II	3	0	6	3
	General Elective	3	0	6	3
	Total	**15**	**0**	**30**	**15**

1. In addition to CAL103 and CAL105, students must also take two more humanity courses. One must be at the 100/200 level and the other at the 300/400 level.
2. Students can use up to four semesters of Varsity and/or Club sports to fulfill the Physical Education requirement.
3. Choose the IS Requirement from BT421 Systems Analysis and Design, BT416 Bus. Process Mgt., BT466 Data Analytics, or MIS460 IT Strategy.
4. Choose from an approved list of Technology Electives.
5. Choose from an approved list of Economics Electives (on back).
6. Students with computer science experience can take the more challenging course CS115, all others are advised to take CS105.

Finance Major Electives

- ▶ BT 343 Intermediate Macroeconomics

- ▶ BT 344 Intermediate Microeconomics

- ▶ BT 454 International Economics and Finance

- ▶ QF 200 Financial Econometrics

- ▶ QF 202 Introduction to Financial Time Series

- ▶ QF 301 Advanced Time Series Analytics and Machine Learning (pre-reqs QF200 & F202)

- ▶ QF 302 Financial Market Microstructure and Trading

- ▶ QF 427 & QF 428 Investment Practicum I & II

(Graduate courses may apply)

Information Systems Curriculum

Term I

Course #	Course Name	Lecture	Lab	Study	Credit
CAL 103	Writing & Communications Colloquium[1]	3	0	6	3
MA 117	Calculus for Business & Lib Arts	4	0	8	4
PEP 123	Physics for B&T	3	0	6	3
MIS 201	Fundamentals of Information Systems	3	0	6	3
BT 244	Microeconomics	2	2	8	4
PE 200	Physical Education I[2]	0	1	0	0
	Total	**15**	**3**	**34**	**17**

Term II

Course #	Course Name	Lecture	Lab	Study	Credit
CAL 105	Knowledge, Nature, Culture[1]	3	0	6	3
MA 119	Multivariate Calculus & Finite Math	3	0	6	3
PEP 124, CH 115, BIO 281, Or BIO 210	Physics for B&T (II), Chemistry I, Bio and Biotech., Or Intro to Bio. for non-sci./eng. majors	3	0	6	3
CS 105	Intro to Scientific Computing[5]	2	2	6	3
BT 200	Financial Accounting	3	0	6	3
PE 200	Physical Education II[2]	0	1	0	0
	Total	**14**	**3**	**30**	**15**

Term III

Course #	Course Name	Lecture	Lab	Study	Credit
	Humanities Requirement[1] 100-200 Level	3	0	6	3
BT 223	Applied Models and Simulation	3	0	6	3
BT 221	Statistics	3	0	6	3
BT 321	Corporate Finance	3	0	6	3
BT 350	Marketing	3	0	6	3
BT 290	Business Career Seminar	0	0	0	0
PE 200	Physical Education III[2]	0	1	2	0
	Total	**15**	**1**	**32**	**15**

Term IV

Course #	Course Name	Lecture	Lab	Study	Credit
	Humanities Requirement[1] 300-400 Level	3	0	6	3
BT 243	Macroeconomics	3	0	6	3
BT 215	Managerial Accounting	3	0	6	3
BT 100	Principles of Management	3	0	6	3
BT 421, BT 416, BT 466 Or MIS 460	IS Requirement[3]	3	0	6	3
PE 200	Physical Education IV[2]	0	1	0	0
	Total	**15**	**1**	**30**	**15**

Term V

Course #	Course Name	Lecture	Lab	Study	Credit
BT 435	Social Media and Network Analysis	3	0	6	3
CS 115	Intro to Computer Science	3	2	8	4
BT 421, BT 416, BT 466 Or MIS 460	IS Requirement[3]	3	0	6	3
BT 360	International Business	3	0	6	3
	Technology Elective[3]	3	0	6	3
	General Elective	3	0	6	3
	Total	**18**	**2**	**38**	**19**

Term VI

Course #	Course Name	Lecture	Lab	Study	Credit
BT 310	Programming for Mobile Applications	3	0	6	3
BT 333	Database Management	3	0	6	3
BT 372	Entrepreneurship	3	0	6	3
BT 301	Strategy	3	0	6	3
	General Elective	3	0	6	3
	Total	**15**	**0**	**30**	**15**

Term VII

Course #	Course Name	Lecture	Lab	Study	Credit
BT 330	Social Psychology & Organizational Behavior	3	0	6	3
ISE 350	Logistics & Supply Chain Management	3	0	6	3
	Technology Elective[4]	3	0	6	3
BT 411	Senior Design I	3	0	6	3
BT 401	Advanced Strategy	3	0	6	3
	Total	**15**	**0**	**30**	**15**

Term VIII

Course #	Course Name	Lecture	Lab	Study	Credit
BT 466	Data Analytics	3	0	6	3
BT 422	Decision Making	3	0	6	3
BT 413	Business Law	3	0	6	3
BT 412	Senior Design II	3	0	6	3
	General Elective	3	0	6	3
	Total	**15**	**0**	**30**	**15**

1. Students are required to take two additional Humanities courses other than CAL103 and CAL105. One must be at the 100/200 level and one must be at the 300/400 level, and be from two different disciplines.
2. Students can use up to four semesters of Varsity and/or Club sports to fulfill the Physical Education requirement.
3. Choose the IS Requirement from BT421 Systems Analysis and Design, BT416 Bus. Process Mgt., BT466 Data Analytics, or MIS460 IT Strategy.
4. Choose technology electives from a list of approved courses
5. Students with computer science experience can take the more challenging course of CS115, all others are advised to take CS105.

Management Curriculum

Term I

Course #	Course Name	Lecture	Lab	Study	Credit
CAL 103	Writing & Communications Colloquium[1]	3	0	6	3
MA 117	Calculus for Business & Lib Arts	4	0	8	4
PEP 123	Physics for B&T	3	0	6	3
MIS 201	Fundamentals of Information Systems	3	0	6	3
BT 244	Microeconomics	2	2	8	4
PE 200	Physical Education I[2]	0	1	0	0
	Total	**15**	**3**	**34**	**17**

Term II

Course #	Course Name	Lecture	Lab	Study	Credit
CAL 105	Knowledge, Nature, Culture[1]	3	0	6	3
MA 119	Multivariate Calculus & Finite Math	3	0	6	3
PEP 124, CH 115, BIO 281, Or BIO 210	Physics for B&T (II), Chemistry I, Bio and Biotech., Or Intro to Bio. for non-sci./eng. majors	3	0	6	3
CS 105	Intro to Scientific Computing[6]	2	2	6	3
BT 200	Financial Accounting	3	0	6	3
PE 200	Physical Education II[2]	0	1	0	0
	Total	**14**	**3**	**30**	**15**

Term III

Course #	Course Name	Lecture	Lab	Study	Credit
	Humanities Requirement[1] 100-200 Level	3	0	6	3
BT 223	Applied Models and Simulation	3	0	6	3
BT 221	Statistics	3	0	6	3
BT 321	Corporate Finance	3	0	6	3
BT 350	Marketing	3	0	6	3
BT 290	Business Career Seminar	0	0	0	0
PE 200	Physical Education III[2]	0	1	2	0
	Total	**15**	**1**	**32**	**15**

Term IV

Course #	Course Name	Lecture	Lab	Study	Credit
	Humanities Requirement[1] 300-400 Level	3	0	6	3
BT 243	Macroeconomics	3	0	6	3
BT 215	Managerial Accounting	3	0	6	3
BT 100	Principles of Management	3	0	6	3
BT 421, BT 416, BT 466 Or MIS 460	IS Requirement[3]	3	0	6	3
PE 200	Physical Education IV[2]	0	1	0	0
	Total	**15**	**1**	**30**	**15**

Term V

Course #	Course Name	Lecture	Lab	Study	Credit
BT 353	Project Management	3	0	6	3
BT 421, BT 416, BT 466 Or MIS 460	IS Requirement[3]	3	0	6	3
BT 360	International Business	3	0	6	3
	Technology Elective[4]	3	0	6	3
	Technology Elective[4]	3	0	6	3
	General Elective	3	0	6	3
	Total	**18**	**0**	**36**	**18**

Term VI

Course #	Course Name	Lecture	Lab	Study	Credit
BT 422	Decision Making	3	0	6	3
	Management Elective[5]	3	0	6	3
BT 372	Entrepreneurship	3	0	6	3
BT 301	Strategy	3	0	6	3
	General Elective	3	0	6	3
	Total	**15**	**0**	**30**	**15**

Term VII

Course #	Course Name	Lecture	Lab	Study	Credit
BT 447	Creativity and Innovation	3	0	6	3
BT 330	Social Psychology & Organizational Behavior	3	0	6	3
ISE 350	Logistics & Supply Chain Mgmt	3	0	6	3
BT 411	Senior Design I	3	0	6	3
BT 401	Renamed Advanced Strategy	3	0	6	3
	Total	**15**	**0**	**30**	**15**

Term VIII

Course #	Course Name	Lecture	Lab	Study	Credit
	Management Elective[5]	3	0	6	3
	Management Elective[5]	3	0	6	3
BT 413	Business Law	3	0	6	3
BT 412	Senior Design II	3	0	6	3
	General Elective	3	0	6	3
	Total	**15**	**0**	**30**	**15**

1. Students are required to take two additional Humanities courses other than CAL103 and CAL105. One must be at the 100/200 level and one must be at the 300/400 level, from two different disciplines.
2. Students can use up to four semesters of Varsity and/or Club sports to fulfill the Physical Education requirement.
3. Choose the IS Requirement from BT421 Systems Analysis and Design, BT416 Bus. Process Mgt., BT466 Data Analytics, or MIS460 IT Strategy.
4. Choose technology electives from a list of preapproved courses.
5. Choose management elective from a list of preapproved courses (on back).
6. Students with computer science experience can take the more challenging course CS115, all others are advised to take CS105.

Management Major Electives

▸ MGT 472 Venture Capital

▸ BT 419 Entrepreneurship Practicum

▸ HPL 456 Ethics of Business and Technology

▸ BT 403 Marketing Strategy in a Digital World

(Graduate courses may apply)

Marketing Innovation & Analytics Curriculum

Term I

Course #	Course Name	Lecture	Lab	Study	Credit
CAL 103	Writing & Communications Colloquium[1]	3	0	6	3
MA 117	Calculus for Business & Lib Arts	4	0	8	4
PEP 123	Physics for B&T	3	0	6	3
MIS 201	Fundamentals of Information Systems	3	0	6	3
BT 244	Microeconomics	2	2	8	4
PE 200	Physical Education I[2]	0	1	0	0
	Total	**15**	**3**	**34**	**17**

Term II

Course #	Course Name	Lecture	Lab	Study	Credit
CAL 105	Knowledge, Nature, Culture[1]	3	0	6	3
MA 119	Multivariate Calculus & Finite Math	3	0	6	3
PEP 124, CH 115, BIO 281, Or BIO 210	Physics for B&T (II), Chemistry I, Bio and Biotech., Or Intro to Bio. for non-sci./eng. majors	3	0	6	3
CS 105	Intro to Scientific Computing[6]	2	2	6	3
BT 200	Financial Accounting	3	0	6	3
PE 200	Physical Education II[2]	0	1	0	0
	Total	**14**	**3**	**30**	**15**

Term III

Course #	Course Name	Lecture	Lab	Study	Credit
	Humanities Requirement[1] 100-200 Level	3	0	6	3
BT 223	Applied Models & Simulation	3	0	6	3
BT 221	Statistics	3	0	6	3
BT 321	Corporate Finance	3	0	6	3
BT 350	Marketing	3	0	6	3
BT 290	Business Career Seminar	0	0	0	0
PE 200	Physical Education III[2]	0	1	2	0
	Total	**15**	**1**	**32**	**15**

Term IV

Course #	Course Name	Lecture	Lab	Study	Credit
	Humanities Requirement[1] 300-400 Level	3	0	6	3
BT 243	Macroeconomics	3	0	6	3
BT 215	Managerial Accounting	3	0	6	3
BT 100	Principles of Management	3	0	6	3
BT 421, BT 416, BT 466 Or MIS 460	IS Requirement[3]	3	0	6	3
PE 200	Physical Education IV[2]	0	1	0	0
	Total	**15**	**1**	**30**	**15**

Term V

Course #	Course Name	Lecture	Lab	Study	Credit
BT 214	Marketing Analytics & Research	3	0	6	3
BT 421, BT 416, BT 466 Or MIS 460	IS Requirement[3]	3	0	6	3
BT 360	International Business	3	0	6	3
	Technology Elective[4]	3	0	6	3
	Technology Elective[4]	3	0	6	3
	General Elective	3	0	6	3
	Total	**18**	**0**	**36**	**18**

Term VI

Course #	Course Name	Lecture	Lab	Study	Credit
BT 403	Marketing Strategy in a Digital World	3	0	6	3
BT 445	Virtual and Physical Consumer Behavior	3	0	6	3
BT 465	Integrated Marketing Communications	3	0	6	3
BT 301	Strategy	3	0	6	3
BT 372	Entrepreneurship	3	0	6	3
	Total	**15**	**0**	**30**	**15**

Term VII

Course #	Course Name	Lecture	Lab	Study	Credit
BT 435	Social Media and Network Analysis	3	0	6	3
BT 330	Social Psychology & Organizational Behavior	3	0	6	3
ISE 350	Logistics & Supply Chain Mgt	3	0	6	3
BT 411	Senior Design I	3	0	6	3
BT 401	Advanced Strategy	3	0	6	3
	Total	**15**	**0**	**30**	**15**

Term VIII

Course #	Course Name	Lecture	Lab	Study	Credit
BT 466	Data Analytics	3	0	6	3
BT 413	Business Law	3	0	6	3
BT 412	Senior Design II	3	0	6	3
	General Elective	3	0	6	3
	General Elective	3	0	6	3
	Total	**15**	**0**	**30**	**15**

1. Students are required to take two additional Humanities courses other than CAL103 and CAL105. One must be at the 100/200 level and one must be at the 300/400 level.
2. Students can use up to four semesters of Varsity and/or Club sports to fulfill the Physical Education requirement.
3. Choose the IS Requirement from BT421 Systems Analysis and Design, BT416 Bus. Process Mgt., BT466 Data Analytics, or MIS460 IT Strategy.
4. Choose from an approved list of Technology Electives.
5. Students with computer science experience can take the more challenging course CS115, all others are advised to take CS105.

Bachelor of Science in Quantitative Finance

The Stevens QF program has been designed to provide students with a thorough and rigorous foundation in this multidisciplinary field. Students will be selected for strong quantitative aptitude, high motivation and work ethic, and a strong interest in the field of business and finance.

Over the course of eight semester terms, through approximately 140 credit-hours of course work, students may choose to follow one out of four main "threads" in the QF curriculum.

Accounting: this thread draws on the advanced accounting curriculum and is designed to give an indepth look into the field of accounting. Students will begin with intermediate Accounting 1 and 2 and choose from several electives that will focus on specialized areas in accounting.

Required Coursework:

‣ ACC 311 Intermediate Accounting I

‣ ACC 312 Intermediate Accounting II

Optional:

‣ ACC 421 Auditing

‣ ACC 431 Advanced Topics in Accounting

‣ ACC 352 Federal Taxation of Business Entities

‣ ACC XXX Accounting Regulation (under construction)

Quantitative Methods: this thread draws on the curriculum of Stevens' Mathematics department and includes a minimum of one year of calculus, and one year of probability and statistics. Electives in this thread extend to more advanced calculus (multivariable, stochastic) and other quantitative techniques used in advanced financial applications.

Required Coursework:

‣ MA 232 Linear Algebra

‣ MA 331 Intermediate Statistics

‣ MA 450 Special Topics

‣ FE 530 Intro to Financial Engineering

Computer Science: this thread draws on the curriculum offered by the Stevens Computer Science department (in the School of Science and Engineering). It begins at the introductory level, and includes seven core courses, building to a reasonable proficiency in C++, basic financial modeling tools and techniques, and an intermediate level of proficiency in web- based programming; beyond the required core. There are elective courses in fields such as data mining, machine learning and computerized trading platform architectures for students interested in developing advanced computer science capabilities.

Required Coursework:

▶ CS 442 Databases

▶ CS 559 Machine Learning

Options:

▶ CS 599 Machine Learning: Fundamentals and Applications

▶ QF 465 Advanced Topics in Financial Computer Science

▶ FE 550 Data Visualization Application

▶ BIA 660 Web Analytics

▶ CS 546 Web Mining

Finance & Economics: (including Financial Engineering): this thread draws on both the Business & Technology Program (Steven's successful undergraduate business degree) and the graduate program in Financial Engineering (in the School of Systems & Enterprises). It encompasses the standard business and finance foundation disciplines such as accounting, economics, corporate and international finance and capital markets—as well as QF—specific topics such as financial engineering, risk management, and market regulation & securities law. Electives drawn principally from the Financial Engineering department cover advanced topics such as derivatives pricing, hedging strategies, fixed income securities and computational finance.

Required Coursework:

▶ BT 426 Equity Valuation

▶ BT 440 Money, Banking and Financial Institutions

▶ BT 442 Fixed Income

▶ BT 454 International Finance and Economics

Options:

▶ BT 343 Intermediate Macroeconomics

▶ BT 344 Intermediate Microeconomics

▶ BT 425 Portfolio Management

▶ BT 426 Equity Valuation

Quantitative Finance Curriculum

Term I

Course #	Course Name	Lecture	Lab	Study	Credit
CAL 103	Writing & Communications Colloquium[1]	3	0	6	3
MA 121; MA 122	Differential Calculus; Integral Calculus	4	0	8	4
QF 1xx	Fundamentals of Probability for QF	3	0	6	3
CS 110	Creative Problem Solving Computing	2	2	6	3
QF 101	Introduction to Quantitative Finance I	3	0	6	3
QF 103L	Intro to Financial Tools & Tech	0	1	2	1
PE 200	Physical Education I[2]	0	1	0	0
	Total	**15**	**4**	**34**	**18**

Term II

Course #	Course Name	Lecture	Lab	Study	Credit
CAL 105	Knowledge, Nature, Culture[1]	3	0	6	3
MA 123; MA 124	Series, Vectors, Functions & Surfaces; Calculus for Two Variable	4	0	8	4
CS 115	Intro to Computer Science	3	1	8	4
QF 102	Introduction to Quantitative Finance II	3	0	6	3
QF 112	Statistics for Quantitative Finance	3	0	6	3
QF 104L	Data Management in R	0	1	2	1
PE 200	Physical Education II[2]	0	1	0	0
	Total	**16**	**3**	**36**	**18**

Term III

Course #	Course Name	Lecture	Lab	Study	Credit
MA 221	Differential Equations	4	0	8	4
CS 135	Discrete Structures	3	1	8	4
QF 200	Financial Econometrics	3	0	6	3
BT 200	Financial Accounting	3	0	6	3
QF2xx	Advanced Probability and Stochastic Processes for QF	3	1	6	3
BT 290	Business Career Seminar	0	0	0	0
PE 200	Physical Education III[2]	0	1	0	0
	Total	**16**	**3**	**34**	**18**

Term IV

Course #	Course Name	Lecture	Lab	Study	Credit
QF 202	Financial Time Series	3	0	6	3
MA 230	Multivariate Calculus & Optimization	3	0	6	3
CS 284	Data Structures	4	0	8	4
BT 321	Corporate Finance	3	1	6	3
BT 244	Microeconomics	3	0	6	3
PE 200	Physical Education IV[2]	0	1	0	0
	Total	**16**	**2**	**32**	**17**

Term V

Course #	Course Name	Lecture	Lab	Study	Credit
QF 301	Advanced Time Series Analytics and Machine Learning	3	0	6	3
QF 435	Risk Management for Capital Markets	3	0	6	3
CS 385	Algorithms	4	0	8	4
BT 325 Or FIN 510	Financial Statement Analysis	3	0	6	3
	QF Concentration[4]	3	0	6	3
	Science Requirement	3	0	0	
	Total	**19**	**0**	**32**	**19**

Term VI

Course #	Course Name	Lecture	Lab	Study	Credit
HPL 456	Ethics of Business & Technology	3	0	6	3
QF 302	Financial Market Microstructure and Trading	3	0	6	3
QF 343	Intro. To Stochastic Calculus for QF	3	1	6	3
	Humanities Elective	3	0	6	3
	QF Concentration[4]	3	0	6	3
	QF Elective[5]	3	0	6	3
	Total	**18**	**1**	**36**	**18**

Term VII

Course #	Course Name	Lecture	Lab	Study	Credit
QF 430	Intro to Derivatives	3	0	6	3
	QF Concentration[4]	3	0	6	3
QF 401	Senior Design Research Projects in Quantitative Finance I	3	0	6	3
	QF Elective[5]	3	0	6	3
	General Elective	3	0	6	3
	Total	**15**	**0**	**30**	**15**

Term VIII

Course #	Course Name	Lecture	Lab	Study	Credit
	Humanities Requirement[1]	3	0	6	3
	QF Concentration[4]	3	0	6	3
QF 402	Senior Design Research Projects in Quantitative Finance II	3	0	6	3
	QF Elective[5]	3	0	6	3
	General Elective	3	0	6	3
	Total	**15**	**0**	**30**	**15**

1. Students are required to take two additional Humanities courses other than CAL103 and CAL105. One must be at the 100/200 level and one must be at the 300/400 level. Courses must cover at least two different disciplines.
2. All students must complete a minimum of four semesters of Physical Education (P.E.) in non-repeating courses. No credit or grades are awarded for P.E. classes. Participation in varsity sports may be used to satisfy up to three credits of the P.E. requirement.
3. Choose from a list of approved science courses.
4. Choose a QF concentration from Quantitative Methods, Computer Science or Finance and Economics
5. Choose from a list of approved QF electives.

1. *Students on a Varsity team only need to take one PE course as their Varsity sport counts for three PE courses. Note that PE courses can be taken at any time before graduating.*

2. *Students must select one course from the following science courses:*

   ▸ PEP 123 Physics for B&T I

   ▸ PEP 111 Mechanics

   ▸ CH 115 General Chemistry I

   ▸ CH 281 Biology

   ▸ PEP 151 Introduction to Astronomy

3. *Students can select one of the following QF concentrations:*

Quantitative Methods (4 courses)

   ▸ MA 232 Linear Algebra

   ▸ MA 331 Intermediate Statistics

   ▸ MA 450 Special Topics

   ▸ FE 530 Intro to Financial Engineering

Computer Science (choose 4 from below)

   ▸ CS 442 Databases

   ▸ CS 559 Machine Learning: Fundamentals and Applications

   ▸ FE 550 Data Visualization Application

   ▸ BIA 660 Web Analytics

   ▸ CS 546 Web Programming

   ▸ QF XXX Web Technologies for Finance (under development*)

   ▸ QF XXX Data Visualization for Finance (under development*)

Finance and Economics (choose 4 from below)

   ▸ BT 343 Intermediate Macroeconomics

   ▸ BT 344 Intermediate Microeconomics

   ▸ BT 425 Portfolio Management

   ▸ BT 426 Equity Valuation

   ▸ BT 440 Money, Banking and Financial Institutions

   ▸ BT 442 Fixed Income

   ▸ BT 454 International Economics and Finance

4. *Students are required to take two additional Humanities courses other than CAL103 and CAL105. Courses must cover at least two different disciplines. One must be at the 100/200 level and one at the 300/400 level.*

5. *Students can choose from a variety of QF electives with approval from advisor. Please see School of Business Student Support Center for a list of approved electives.*

*These courses are being developed. Courses can be substituted.

Business Minors

All students must fullfill the requirement of the minor. In all cases students must take at least 3 courses that are not part of their required degree requirements. General Electives and Tech Electives can be applied towards the minor.

Business Students: BSB/QF students cannot receive a minor in the same field as their concentration or major. For example, a Business and Technology Major concentrating in Finance, cannot also minor in Finance.

Accounting Minor

- ▸ ACC 311 Intermediate Accounting I
- ▸ ACC 312 Intermediate Accounting II
- ▸ ACC 351 Federal Taxation of Individuals
- ▸ ACC 421 Auditing
- ▸ BT 200 Introductory Financial Accounting
- ▸ BT 215 Introductory managerial Accounting

Marketing Minor

- ▸ BT 214 Marketing Analytics & Research (BT 350 prerequisite)
- ▸ BT 350 Marketing (no prerequisite)
- ▸ BT 403 Marketing Strategy in a Digital World (BT 350 prerequisite)
- ▸ BT 435 Social Media and Network Analysis (BT 350 prerequisite)
- ▸ BT 445 Consumer Behavior
- ▸ BT 465 Integrated Marketing Communications (BT 350 prerequisite)

Finance Minor*

- ▸ BT 200 Financial Accounting (no prerequisite)
- ▸ BT 321 Corporate Finance (BT 200 prerequisite)
- ▸ BT 425 Portfolio Management (BT 321 prerequisite)
- ▸ BT 426 Equity Valuation (BT 321 prerequisite)
- ▸ QF 430 Introduction to Derivatives (BT 321 prerequisite)
- ▸ BT 440 Money, Banking and Financial Institutions (BT 321 prerequisite)

  *Quantitative Finance students cannot minor in finance

International Business Minor

- ▸ BT 100 Principles of Management
- ▸ BT 360 International Business

Plus 4 courses in international business, international economics or cross-cultural studies while studying abroad. These courses require approval from an Associate Dean of the School of Business Undergraduate Studies.

Entrepreneurship Minor

Entrepreneurship Minor for Business students

- ▸ BT 244 Microeconomics
- ▸ BT 372 Entrepreneurship (not required major course for QF students)
- ▸ BT 419 Entrepreneurial Practicum (BT 372 prerequisite) (MGT elective)*
- ▸ BT 200 Financial Accounting
- ▸ BT 447 Creativity and Innovation (MGT required course)
- ▸ MGT 472 Assessment and Financing of Technical Business Opportunities (MGT elective)*

*Students majoring in Management may use these courses as Management electives

Entrepreneurship Minor for non-Business students

- ▸ BT 244 Microeconomics (required for Engineering Management majors)
- ▸ BT 372 Entrepreneurship
- ▸ BT 419 Entrepreneurial Practicum (BT 372 prerequisite)
- ▸ E 355 Engineering Economy or BT 200 - Financial Accounting
- ▸ MGT 472 Assessment and Financing of Technical Business Opportunities
- ▸ MGT103 Introduction to Entrepreneurship

Information Systems Minor

Requirements for a minor in Information Systems (not available to majors in Computer Science, Computer Engineering, Cybersecurity, Information Systems, and Service-Oriented Computing):

- ▸ BT 333 Database Management
- ▸ BT 416 Business Process Management*
- ▸ BT 421 Systems Analysis and Design*
- ▸ CS 115 Introduction to Computer Science or CS 105 - Introduction to Programming
- ▸ MIS 201 Fundamentals of Information Systems with Excel Lab
- ▸ MGT 460 IT Strategy*

*Note BSB students are required to take two IS requirements and can choose from BT 416/BT 421/MIS 460

Quantitative Finance Minor

- ▸ QF 101 Introduction to Quantitative Finance I
- ▸ QF 102 Introduction to Quantitative Finance II (no prerequisite but preferred to take QF 101 and QF102 in sequence)
- ▸ QF 103 Basic Financial Tools
- ▸ BT 200 Financial Accounting (no prerequisite)
- ▸ BT 321 Corporate Finance (BT 200 prerequisite)
- ▸ QF430 Introduction to Derivatives (BT 321 prerequisite)
- ▸ FE 535 Introduction to Financial Risk Management

Plus one of the following:

▶ QF 200 Financial Econometrics (QF101/QF102 and Statistics course prerequisites)

▶ QF 202 Financial Time Series (QF101/QF102 and Statistics course prerequisites)

▶ FE 530 Introduction to Financial Engineering (QF101/QF102 and Statistics course prerequisites)

Economics Minor

Economics minor for BSB non-Economic major Students:

Required:

▶ BT 215 (or equivalent, e.g., EM 301) Managerial Accounting

▶ BT 321 Corporate Finance

▶ BT 243 Macroeconomics

▶ BT 244 Microeconomics

▶ BT 343 Intermediate Macroeconomics

▶ BT 344 Intermediate Microeconomics

Plus one course from among the following:

▶ BT 454 International Economics and Finance

▶ QF 200 Financial Econometrics

Economics Minor for Quantitative Finance Students:

Required:

▶ BT 200 Financial Accounting

▶ BT 321 Corporate Finance

▶ BT 243 Macroeconomics

▶ BT 244 Microeconomics

▶ BT 343 Intermediate Macroeconomics

▶ BT 344 Intermediate Microeconomics

Plus one course from among the following:

▶ BT 454 International Economics and Finance

▶ QF 200 Financial Econometrics

Economics Minor for All Non-Business Students:

Required:

▶ E 355 Engineering Economy (E 356 for science, arts & letters majors)

▶ BT 243 Macroeconomics

▶ BT 244 Microeconomics

▶ BT 343 Intermediate Macroeconomics

▶ BT 344 Intermediate Microeconomics

▶ BT 454 International Economics and Finance

▶ QF 200 Financial Econometrics

Graduation Requirements

Physical Education Requirements

▸ All undergraduate students must complete a minimum of four semesters of Physical Education (P.E.). A large number of activities are offered in lifetime, team and wellness areas.

▸ Students can use up to four semesters of Varsity and/or Club sports to fulfill the Physical Education requirement.

Note: Student may repeat Physical Education class but the repeated course (excluding varsity and club sports) will not count toward the graduation requirement.

Humanities Requirement

All undergraduate students are required to fulfill certain Humanities requirements in order to graduate. Please see pages 599-600 for a breakdown of specific requirements by program.

Graduate Programs

Business success in the 21st century is increasingly dependent on the strategic development and use of technology. This is a complex challenge as the solution to many business problems relies on the convergence of a number of technologies and their proper alignment with customer requirements and business strategy.

Our educational programs are directed at:

▸ Technology professionals wishing to acquire business knowledge and management skills

▸ Business professionals wishing to learn about technology and how technology must be managed to achieve business objectives.

The School of Business offers the following master's degree programs:

▸ Master of Science in Business Intelligence and Analytics (BI&A)*

▸ Master of Science in Information Systems (MSIS)*

▸ Master of Science in Management (MSM)

▸ Master of Science in Finance (MFIN)*

▸ Master of Science in Financial Analytics (MFA)*

▸ Master of Science in Financial Engineering (MFE)*

▸ Master of Science in Enterprise Project Management (MS-EPM)

▸ Master of Science in Network & Communication Management & Services (NCMS)*

▸ Master of Business Administration (MBA)

▸ Master of Business Administration in Analytics (AMBA)

▸ Master of Science in Technology Management (MSTM)

▸ Executive MBA (EMBA)

▸ Ph.D. in Business Administration

* Designated STEM program
This catalog describes each of these degree programs in detail.

Educational Approach

The Business School's graduate programs are designed to maximize the management potential of each student. Students can choose concentrations within each degree program or electives that enable students to complement their degree by specializing in a number of areas ranging from soft skills development to technical specialties outside the domain of the concentration. Students may also choose electives from other schools at Stevens.

The School of Business faculty members are leaders in research and education in the business and technical disciplines that are relevant to decision making, innovation and action in an increasingly global, technology-driven world. Our educational programs provide students with knowledge that is both rigorous and relevant. Of equal importance, our programs emphasize the holistic development of each individual student through the development of life-long skills and abilities such as oral and written communication, team participation and leadership, decision making and ethical reasoning.

Ethics and Communications Education

Ethics Workshop: The ethics requirement is incorporated into the course work for the following required courses *MGT 609 Project Management Fundamentals, BIA 650 Optimization and Process Analytics (for BI&A students), MGT 635 Managerial Judgment & Decision Making (for MBA students) and MGT 798 Integration & Application of Technology Management (for MSTM and EMBA students).*

Students are automatically enrolled in *MGT 899 Ethics Workshop* at no cost. This workshop carries zero credit and will not appear on the student's official transcript. Completion of all exercises and the survey associated with the Ethics Workshop is sufficient to satisfy the ethics requirement.

Communication Skills: Written and oral communications training and assessment are conducted in conjunction with the following required courses: *MGT 609 Project Management Fundamentals, BIA 650 Optimization and Process Analytics (for BI&A students), MGT 630 Global Business & Markets (Oral Communications) and MGT 635 Managerial Judgment & Decision Making (Written Communications) (for MBA students.)*

Students in these courses are automatically enrolled in *MGT 898: Writing Support and Assessment Program*. This online workshop carries zero credit and will not appear on the student's official transcript. *Students in the MSTM and EMBA program take EMT 758 Oral & Written Communications, in lieu of MGT 898 for zero credit.* Students who do not pass the written assessment will be required to take *MGT 897: Online Writing Tutorial* for no cost for zero credit.

English Requirements for International Students

International students for whom English is a second language must demonstrate English language proficiency by submitting the results of a TOEFL or an IELTS test. TOEFL and IELTS score requirements are identical to the ELC requirements listed on pages 43-44 of the catalog.

MASTER OF SCIENCE IN BUSINESS INTELLIGENCE AND ANALYTICS (BI&A)

The MS in Business Intelligence and Analytics (BI&A) is designed for full-time and part-time students who have undergraduate degrees in science, mathematics, computer science or engineering. The program produces analytical thinkers who can pursue careers as data scientists in a variety of industries. The BI&A program includes courses in databases, data warehousing, data mining, social networking and risk modeling. The program is both theoretical and applied in that each course combines relevant theories and techniques with a number of examples and student exercises that illustrate industry applications of data analytics. A capstone course provides opportunity for students to apply the concepts, principles, and methods they have learned to real problems in an application domain of their choice.

The BI&A program prepares students for careers as business analysts and data scientists in multiple industries such as finance, manufacturing, retail and media and communications.

Degree Requirements: The MS in Business Intelligence and Analytics consists of 12 courses (36 credits). A minimum GPA of 3.0 is required to graduate.

Admission Requirements: The BI&A program is designed for students with a strong technical background in mathematics, economics, engineering, or computer science. Admissions decisions are made on a rolling basis. Students can apply at any time during the year.

All applicants to the BI&A program must submit a GMAT or GRE score.

Prerequisites: 4-year undergraduate degree; calculus (1 year); at least one course in programming or programming experience and one course covering basic probability, hypothesis testing and estimation.

Structure of the BI&A Program

The 12 required courses for the BI&A program encompass six subject areas that conceptually comprise the field of BI&A. The program culminates in a "practicum" course that applies the concepts and techniques learned in prior courses to real-world problems. Oral and written communications skills, analytical thinking and ethical reasoning are emphasized throughout the curriculum.

Organizational Context

▸ FIN 615 Financial Decision Making

Data Management

▸ BIA 664 Data and Information Quality

▸ MIS 630 Dealing with Data

▸ MIS 636 Data Warehousing & Business Intelligence

Optimization and Risk Analysis

▸ BIA 650 Optimization and Process Analytics

▸ BIA 670 Risk Management & Simulation*

Statistics

▸ BIA 652 Multivariate Data Analytics

▸ BIA 654 Experimental Design

Data Mining and Machine Learning

▸ MIS 637 Data Analytics & Machine Learning

▸ BIA 656 Advanced Data Analytics & Machine Learning*

Social Network Analytics

▸ BIA 658 Social Network Analytics (cross-listed with MIS 669)

▸ BIA 660 Web Mining* (Not an Elective)

Management Applications

▸ BIA 672 Marketing Analytics*

▸ BIA 674 Supply Chain Analytics*

Big Data

▸ BIA 672 Data Stream Analytics: Internet of Things* (Elective)

▸ BIA 678 Big Data Seminar* (Elective)

▸ BIA 662 Cognitive Computing* (Elective)

Practicum

▸ BIA 686 Practicum in Analytics

*Choose two out of these Six Elective courses with permission of an advisor.

Data Science Concentration

In their second semester in the BI&A program, students with strong computational background may apply for admission to the concentration in Data Science. Data Science students are required to take a minimum of three courses offered by the Computer Science, Financial Engineering and Mathematics departments at Stevens.

Electives

Many electives are available for qualified students who get placed out of one or more of the required courses (e.g., FIN 615). For example:

Computer Science

▸ CS 506 Introduction to IT Security

▸ CS 538 Visual Analytics

▸ CS 559 Machine Learning

▸ CS 578 Privacy in a Networked World

▸ CS 581 Online Social Networks

▸ CS 586 Machine Learning for Gaming

▸ SOC 653 Introduction to Text Mining and Statistical Natural Language Processing

Financial Engineering

▸ FE 511 Intro to Bloomberg & Thomson Reuters (1 credit)

▸ FE 515 Introduction to R (1 credit)

▸ FE 520 Intro to Python for Financial Applications (1 credit)

▸ FE 635 Financial Enterprise Risk Engineering

▸ FE 670 Algorithmic Trading Strategies

Information Systems

▸ MIS 714 Service Innovation

▸ MIS 710 Process Innovation and Management

▸ MIS 730 Integrating IS Technologies

International students may also elect to take a Curricular Practical Training (CPT) course (BIA 702) which involves an educationally relevant, practical assignment aimed at augmenting the academic content of the student's program. Students engage in a company project related to the focus of their academic program. The project is conducted under the supervision of a faculty advisor and an industry mentor. The CPT is intended to provide students with practical experience that complements their academic knowledge through active learning under real-world conditions.

MASTER OF SCIENCE IN INFORMATION SYSTEMS (MSIS)

Rapid advancements in technology, dynamic markets, and the changing global business environment have led to intense global competition in which shorter product life cycles and efficient and effective computing services are a competitive necessity. Information systems professionals are required to identify innovative opportunities for leveraging IT for competitive advantage. Close alignment of IT and business is essential. Organizations need IT professionals who are effective at working closely with their business partners, and business people need to better understand how to work closely with their IT partners.

This program is designed for information systems professionals seeking to advance their careers in the IT sector of the business, or as IT experts in other areas of business. It is also suitable for business professionals looking for ways to leverage their IT resources. In addition to strong practical, real-world IT and management skills, graduates of the program leave with improved communication, interpersonal, and team skills.

The MSIS program prepares students for careers such as: Business Analyst, Internal IT Consultant, IT Manager, Management Consultant, Data Analyst, Knowledge Manager, Social Media Expert and Technology Specialist.

In addition to off-campus (corporate-sponsored) programs, the MSIS program is offered on campus on weekdays via Stevens WebCampus platform. Courses are offered year-round, in fall, spring and summer semesters.

Degree Requirements: The MS in Information Systems consists of 12 courses (36 credits). A minimum GPA of 3.0 is required to graduate.

Admission Requirements: The Master of Science in Information Systems program is designed for working professionals with at least two years of work experience. Applicants who do not meet this work experience requirement, but have outstanding academic records, may be considered for admission. Admission to the program requires a bachelor's degree with at least a "B" average. Applications should include two letters of recommendation.

Meeting minimum admissions standards does not guarantee admission; minimum requirements serve as a guide to the minimum expected qualifications necessary to be considered for admission.

Admissions decisions are made on a rolling basis. Students can apply at any time during the year.

International students must also submit a GMAT/GRE score.

Structure of the MSIS Program

The MSIS program comprises eight core courses and two electives:

- ▸ MGT 609 Project Management Fundamentals
- ▸ FIN 615 Financial Decision Making
- ▸ MIS 630 Dealing with Data
- ▸ BIA 610 Applied Analytics
- ▸ MIS 699 Digital Innovation
- ▸ MIS 710 Process Innovation & Management
- ▸ MIS 730 Integrating IS Technologies
- ▸ MIS 760 Information Technology Strategy

MSIS Concentrations

The final 3 courses are free electives that can be chosen with the help of the faculty advisor, or a specific combination of courses selected from one of the designated concentrations in the MSIS program.

MSIS students can choose from specific 3-course concentrations:

- ▸ Business Intelligence & Analytics
- ▸ Business Process Management & Service Innovation
- ▸ Project Management
- ▸ Software Engineering
- ▸ Cybersecurity Risk Management

The courses comprising each of these MSIS concentrations are listed below.

Business Intelligence and Analytics

IT is emerging from an era in which the emphasis was on producing information to one in which competitive advantage can only be obtained by sophisticated analysis of large volumes of information. There is a strong demand on Wall Street and in all areas of business for graduates with the analytic skills provided by this concentration. We recommend that MSIS students with an interest in Business Intelligence and Analytics select courses from the BI&A program, such as BIA 652 Multivariate Analytics, or BIA 660 Web Mining. In addition, specific MIS courses with focus on Business Intelligence & Analytics exist, such as:

- ▸ MIS 635 Designing the Knowledge Organization
- ▸ MIS 636 Data Warehousing and Business Intelligence
- ▸ MIS 637 Data Analytics & Machine Learning

With approval of their advisor students can substitute BIA courses and select FE courses in the Business Intelligence and Analytics concentration.

Business Process Management & Service Innovation

Organizations need effective and efficient processes to execute their strategies and successfully compete in a rapidly changing world of global competition. Business School faculty members are leaders in research and education on business process management (BPM) with a particular emphasis on relationship of processes to organizational strategy and structure and supply chain management. There is strong demand in all areas of business for graduates who can analyze, design and implement effective business processes. Students interested in Business Process Management should choose the following courses:

- ▸ MIS 690 Supply Chain Management and Strategy
- ▸ MIS 712 Advanced Business Process Management
- ▸ MIS 714 Service Innovation

With approval of their advisor students can choose BIA 650 Process Optimization and Analytics and/or BIA 674 Supply Chain Analytics as electives in the Business Process Management & Service Innovation concentration.

Concentration:

- ▸ Cybersecurity Risk Management
- ▸ FIN 545 Financial Cybersecurity
- ▸ MIS 645 Cybersecurity Principles for Managers
- ▸ BIA 670 Risk Management

Student can replace one of the above courses by taking one Stevens CS/ECE Cybersecurity course from the following list:

▸ CS/MA 503 Discrete Mathematics for Cryptography

▸ CS 576 Secure Systems

▸ CS 577 Cybersecurity Laboratory

▸ CS 578 Privacy in a Networked World

▸ CS 579 Foundations of Cryptography

▸ CS 594 Enterprise Security and Information Assurance

▸ CS 665 Network Forensics

▸ CS 675 Threats, Exploits, and Countermeasures

▸ CS 693 Cryptographic Protocols

▸ CS 695 Host Forensics

▸ CPE 592 Multimedia Network Security

▸ EE 584 Wireless Network Security

▸ SSE 623 Systems Security Architecture and Design

Project Management

This concentration deals with project and program management concepts with an emphasis on managing technology-centric projects in private and public enterprises.

▸ MGT 610 Strategic Perspectives in Project Management

▸ MGT 611 Project Analytics

▸ MGT 612 Leader Development

Concentratoin

▸ Software Engineering

▸ SSW 540 Fundamentals of Software Engineering

▸ SSW 555 Agile Development

▸ SSW 567 Software Testing

Free Electives (no concentration option)

MSIS students may elect to take three courses that fit their interests rather than a specific concentration in the MSIS program. Courses may be chosen from within the School of Business or from other Schools at Stevens.

International students may also elect to take a Curricular Practical Training (CPT) course (MIS702) which involves an educationally relevant, practical assignment aimed at augmenting the academic content of the student's program. Students engage in a company project related to the focus of their academic program. The project is conducted under the supervision of a faculty advisor and an industry mentor. The CPT is intended to provide students with practical experience that complements their academic knowledge through active learning under real-world conditions.

MASTER OF SCIENCE IN MANAGEMENT (MSM)

The Master of Science in Management (MSM) program is a generalist graduate business program designed specifically for individuals with non-business academic backgrounds/degrees. Students do not need any professional work experience to be admitted to this 30-credit program. Grounded in the fields of management, economics, applied psychology, and quantitative methods, the unique 10-course curriculum encompasses the primary business disciplines to help you round out your undergraduate training and experience. Students will learn how economics, technology, social science and quantitative methods can be used to solve today's complex and managerial challenges.

In today's competitive global workplace, having the right technical skills is extremely important, but it is often not enough. Businesses need people who can enter the workplace with the ability to transform technical expertise into business solutions. Through the MSM coursework and other learning experiences, students are guided in developing a core set of critical thinking, collaboration, communication and innovation skills that are keys to success at the intersection business and technology. The MSM courses help students master business fundamentals and enrich their capacity to communicate effectively across business and technical domains.

Stevens is renowned for excellence in project management, leadership and innovation management. Not only are these skills important to technical professionals, they also impart a competitive edge regardless of previous field of study or current type of work. Our faculty includes thought leaders who are experienced professionals, many of whom were managers at Fortune 500 organizations. Be a part of a major technical university that on the one hand has a rich tradition of excellence in applied science and engineering, and on the other is also home to original thought leaders in management science.

The MS in Management program is offered on campus on weekdays and via the WebCampus platform. Courses are offered year-round, in fall, spring and summer semesters. Corporate sponsored programs are also offered at company sites.

Degree Requirements: The MS in Management degree comprises 10 courses (30 credits). A minimum GPA of 3.0 is required to graduate.

Admission Requirements: The Master of Science in Management program is designed for students having less than two years work experience. Admission to the program requires a bachelor's degree with at least a "B" average, and two letters of recommendation. Meeting minimum admissions standards does not guarantee admission; minimum requirements serve as a guide to the minimum expected qualifications necessary to be considered for admission.

Students can apply at any time during the year. Admissions decisions are made on a rolling basis.

International students must also submit a GMAT/GRE score.

Structure of the MSM Program

The MSM program comprises eight business core courses and two electives:

Business Core

- ▸ MGT 609 Project Management Fundamentals
- ▸ FIN 615 Financial Decision Making
- ▸ MGT 606 Economics for Managers
- ▸ MGT 641 Marketing Management
- ▸ MGT 657 Operations Management
- ▸ MGT 671 Technology and Innovation Management
- ▸ MGT 689 Organizational Behavior and Design
- ▸ MGT 699 Strategic Management

Students choose two additional electives from an array of courses. Courses may be chosen from within the School of Business or from other Schools at Stevens.

Students may also elect to take a Curricular Practical Training (CPT) course (MGT 702) which involves an educationally relevant, practical assignment aimed at augmenting the academic content of the student's program. Students engage in a company project related to the focus of their academic program. The project is conducted under the supervision of a faculty advisor and an industry mentor. The CPT is intended to provide students with practical experience that complements their academic knowledge through active learning under real-world conditions.

MASTER OF SCIENCE IN FINANCE (MFIN)

The Master of Science in Finance (MFin) is a 36-credit degree program that addresses the needs of students looking to advance their management careers in the financial sector. It consists of core courses covering fundamental topics in finance and economics, the management of financial technologies, and allows students to specialize in topics such as regulatory and market environments, the management of risks, or financial project management.

The Finance curriculum is structured in such a way as to provide students with a rigorous education that will familiarize them with the terminology, methods and application areas of economics, finance and financial technology, while providing an understanding of the financing needs of companies and the market mechanisms available to meet these needs. Graduates will be able to apply financial technologies for analysis, forecasting and management; assess the financial health of an organization; develop comprehensive plans that address financial management needs of an organization; and lead business and technology teams.

Graduates of the Master of Finance program will:

▸ be familiar with terminology, methods, and application areas of economics, finance, and financial technology

▸ understand the financing needs of organizations and the market mechanisms available to meet these needs

▸ be able to apply common financial technologies for analysis, forecasting, and management of financial enterprises

▸ be able to assess the financial health of an organization

▸ be able to develop a comprehensive plans that address the financial management needs of an organization

▸ lead combined business and technology teams in the delivery of change projects

Degree Requirements: The MS in Finance degree comprises 12 courses (36 credits). A minimum GPA of 3.0 is required to graduate.

Admission Requirements: The Master of Science in Finance is designed for working professionals who want to advance their management careers in the financial sector. Applicants should have a minimum of two years of work experience.

Applicants who do not meet the work experience requirement, but have outstanding academic records, may be considered for admission. Admission to the program requires a bachelor's degree with at least a "B" average, and two letters of recommendation. Meeting minimum admissions standards does not guarantee admission; minimum requirements serve as a guide to the minimum expected qualifications necessary to be considered for admission.

Meeting minimum admissions standards does not guarantee admission; minimum requirements serve as a guide to the minimum expected qualifications necessary to be considered for admission.

Admissions decisions are made on a rolling basis. Students can apply at any time during the year.

All applicants to the MS in Finance Program must submit a GMAT/GRE score.

Structure of the MS in Finance Program

Pre-requisites

Students should have taken undergraduate courses in Accounting, Finance, and Statistics, or demonstrable work experience in these areas. Students that lack background in either of these areas will take FIN 623 (for financial management), FIN 600 (for accounting) and/or MGT 620 (for statistics) during a pre-requisite semester.

Curriculum

Economics Core

- ▶ MGT 606 Economics for Managers
- ▶ FIN 620 Financial Econometrics
- ▶ MGT 700 Econometrics

Finance Core

- ▶ FIN 629 Fixed Income
- ▶ FIN 627 Investment Management
- ▶ FIN 638 Corporate Finance
- ▶ FIN 510 Financial Statement Analysis

Financial Technology Core

- ▶ FE 511 Introduction to Bloomberg & Thomson Reuters
- ▶ FE 515 Introduction to R
- ▶ FE 514 Introduction to SAS

Investment Banking and Valuation

This concentration is tailored to students who are aiming to compete for finance positions, primarily in equity analysis, investment banking and commercial banking, at corporations. This concentration is aligned with the CFA Level 1 exam.

Suggested courses:

- ▶ FIN 628 Derivatives*
- ▶ FIN 526 Private Equity and Venture Capital*
- ▶ FIN 530 Investment Banking
- ▶ FE 535 Introduction to Financial Risk Management

  *Recommended for students planning to take the CFA Level 1 exam

Financial Analytics and Risk

Students who are interested in careers in analytics, financial technology and risk management are good fits for this concentration, which provides a thorough overview in regulation, business intelligence and risk. This concentration is aligned with the Financial Risk Manager – GARP exam.

Suggested courses:

- ▶ FIN 628 Derivatives*
- ▶ FE 535 Introduction to Financial Risk Management*

▸ FIN 545 Risk Management for Financial Cybersecurity*

▸ BIA 656 Advanced Data Analytics & Machine Learning

*Recommended for students planning to take the FRM exam

Financial Planning

▸ FIN 550 Financial Planning and Risk Management

▸ ACC 555 Retirement and Estate Planning

▸ FIN 560 Federal Taxation of Individuals

▸ FIN 565 Financial Plan Development

Financial Services Operations

This option was created for the professional who wants to specialize in the operations and technical side of finance, and includes an introduction to Big Data and a look at project management and business processes.

Suggested elective courses:

▸ MGT 609 Project Management Fundamentals

▸ MIS 710 Process Innovation and Management

▸ FIN 535 Introduction to Financial Risk Management

▸ MIS 636 Data Warehousing and Business Intelligence

MASTER OF SCIENCE IN FINANCIAL ANALYTICS (MFA)

Financial Analytics focuses on advanced development in fundamental data processing, machine learning, statistical modeling and optimization. The target of a student in this program is on broader financial services and the financial technology industry. Program graduates are expected to be able to handle complex financial data, build advanced analytical models, deliver effective visualization product, and utilize cloud-based data-driven analytics technology.

Taught by renowned faculty who are practitioners and researchers, the master's degree consists of 11 courses (33 credits): 9 required core courses and 2 electives.

Required Core Courses

▸ FE 530: Introduction to Financial Engineering

• *Or* FE 535: Introduction to Financial Risk Management

▸ FE 582: Foundations of Data Science with

• FE 513: Practical Aspects of Database Design (lab)

▸ FE 541: Applied Statistics with Application in Finance

▸ FE 550: Data Visualization Application

• *Or* EM 622: Data Analysis & Visualization for Decision-Making

▸ FE 542: Time Series with Applications to Finance

• *Or* MA 641: Time Series Analysis I

- ▸ FE 590: Introduction to Knowledge Engineering

    - • *Or* MIS 637: Statistical Learning

    - • *Or* BIA 656: Data Analytics & Machine Learning

    - • *Or* CS 513/SOC 550: Data Analytics & Machine Learning

- ▸ FE 595: Financial Technology

    - • *Or* CS 549: Distributed Systems and Cloud Computing

- ▸ FE 630: Portfolio Theory and Applications

    - • *Or* FE 646: Optimization Models and Methods in Finance

    - • *Or* MA 629: Convex Analysis and Optimization

- ▸ FE 800: Special Projects in Financial Engineering

Elective Courses

Students are encouraged to take an integrated four-course sequence leading to a graduate certificate for the two electives; or choose the electives from our course catalog. All elective courses must be approved by an advisor. A list of available graduate certificates is included in this catalog and on the School of Systems and Enterprises website.

MASTER OF SCIENCE IN FINANCIAL ENGINEERING (MFE)

The vast complexity of financial markets compels industry to look for experts who not only understand how they work, but also possess the mathematical knowledge to uncover their patterns and the computer skills to exploit them. To achieve success, banking and securities industries must come to grips with securities valuation, risk management, portfolio structuring, and regulation-knowledge embracing applied mathematics, computational techniques, statistical analysis, and economic theory. The goal of the degree is to produce graduate who can make pricing, hedging, trading, and portfolio-management decisions in the financial services enterprise. With sharply honed practical skills complimented by strong technical elements, graduates are in demand in the industries-investment banking, risk management, securities trading and portfolio management. Students wishing to enroll in any of the FE programs must have an undergraduate degree in an engineering or science discipline and strong quantitative background.

This master's degree is also available in the 4+1 program; please see further information in the Undergraduate Programs section.

The master's degree requires 10 courses (30 credits): six core required courses and four elective courses.

Required Core Courses

- ▸ FE 610: Stochastic Calculus for Financial Engineers

- ▸ FE 620: Pricing and Hedging

- ▸ FE 621: Computational Methods in Finance

- ▸ FE 630: Portfolio Theory and Applications

- ▸ FE 680: Advanced Derivatives

- ▸ FE 800: Special Problems in Financial Engineering (3 credits)

    - • *Or* FE 900: Thesis in Financial Engineering (6 credits)

Students are encouraged to take an integrated four-course sequence leading to a graduate certificate for the four electives; or choose the electives from our course catalog. All elective courses must be approved by an advisor. A list of available graduate certificates is included in this catalog and on the School of Business website.

For example, the certificate in Financial Risk Engineering is very popular. Courses in this certificate program emphasize a blend of mathematics and finance that will help graduates to see the financial landscape from a market, credit, and systemic risk perspective and to analyze and manage the risk efficiently.

The following courses are required for this certificate:

- FE 535 Introduction to Risk Management

- FE 610 Stochastic Calculus for Financial Engineers

- FE 635 Financial Enterprise Risk Engineering

- FE 655 Systemic Risk and Financial Regulation

Another popular choice is the Algorithmic Trading Strategies certificate. This graduate certificate is designed to provide aspiring financial engineers with the necessary understanding of the design and implementation of financial trading systems, with an emphasis on the role of software and automated decision support systems in trading strategies. The certificate also is suitable for technical professionals interested in applying their unique skills to the fast-changing realm of finance.

The following courses are required for this certificate:

- FE 545 Design, Patterns and Derivatives Pricing

- FE 570 Market Microstructure and Trading Strategies

- FE 620 Pricing and Hedging

- FE 670 Algorithmic Trading Strategies

MASTER OF SCIENCE IN ENTERPRISE PROJECT MANAGEMENT (MS-EPM)

The 30-credit Stevens master's degree in Enterprise Project Management emphasizes a strategic perspective that's crucial to modern project management. The program prepares forward-thinking leaders through courses in strategic perspectives, project planning, project portfolio management and cross-project leadership, ensuring graduates can direct complex, enterprise-level initiatives on time and on budget. The curriculum is unique for its concentration on business, analytical and leadership skills, and is designed to both prepare technical professionals to become skilled managers while offering the opportunity to pursue a concentration in a field where industry desperately needs leadership, such as software engineering and construction management.

This curriculum encompasses a strategic approach to project management that goes beyond the traditional tools, tactics, and PMI Certification preparation taught in most PM programs. The Stevens EPM program prepares students to:

- Lead transformational, large-scale projects and project teams across units, enterprises and multiple organizations;

- Gain insight and skills pertaining to leadership, cultural and behavioral project environment

- Lead change and span boundaries across complex enterprise systems

- Bridge cultural and organizational gaps

The program offers a unique blend of small class sizes, intense collaboration, and global professional networking opportunities.

Graduates will leave Stevens with better communications, interpersonal and team skills enabling them to plan, implement and manage complex enterprise level projects.

Degree Requirements: The MS in Enterprise Project Management degree comprises 10 courses (30 credits). A minimum GPA of 3.0 is required to graduate.

Admissions Requirements: The Master of Science in Enterprise Project Management is designed for working professionals who want to excel in managing enterprise-level projects, programs, portfolios, and project management offices. Applicants should have a minimum of one-year work experience. Applicants who do not meet the work experience requirement, but have outstanding academic records, may be considered for admission. Admission to the program requires a bachelor's degree with at least a "B" average, and two letters of recommendation. Meeting minimum admissions standards does not guarantee admission; minimum requirements serve as a guide to the minimum expected qualifications necessary to be considered for admission.

Students can apply at any time during the year. Admissions decisions are made on a rolling basis.

International students must also submit a GMAT/GRE score.

Curriculum of the MS-EPM Program

The Master of Science in Enterprise Project Management (MS-EPM), a 30-credit degree program (10 courses) that encompasses courses in strategic perspectives, project planning, project portfolio management and cross-project leadership for an applied curriculum that teaches you to manage and serve as a leader. The three concentrations available are Software Engineering, Construction Management, and General Management.

Degree Requirements (Core 24 credits)

- ▸ MGT 609 Project Management Fundamentals
- ▸ MGT 610 Strategic Perspectives of Project Management
- ▸ MGT 611 Project Analytics
- ▸ MGT 612 Leader Development
- ▸ MGT 613 Project Portfolio Management and the Project Management Office
- ▸ MGT 619 Leading Across Projects

Concentrations

General Management

- ▸ MGT 641 Marketing Management
- ▸ MGT 699 Strategic Management
- ▸ FIN 615 Financial Decision Making
- ▸ MIS 710 Process Innovation

Software Engineering

- ▸ SSW 540 Fundamentals of Software Engineering
- ▸ SSW 565 Requirements Analysis
- ▸ SSW 555 Agile Development
- ▸ SSW Software Testing

Construction Management

- ▸ CM 510 Fundamentals of Construction Management

- ▸ CM 530 Strategic Responses to Cyclical Environments

- ▸ CM 650 Sustainable Design

- ▸ CM 590 Construction Management II

MASTER OF SCIENCE IN NETWORK & COMMUNICATION MANAGEMENT & SERVICES (MS-NCMS)

The Network & Communication Management & Services graduate program is an interdisciplinary program between the School of Business and the Electrical and Computer Engineering Department of the School of Engineering and Science. The School of Business administers the program. This program is STEM (Science, Technology, Engineering and Mathematics)-designated by the Department of Homeland Security. A CoOP is an available option for students seeking work experience.

The Network & Communication Management & Services curriculum addresses the demanding requirements of the global communications industry, businesses, and government for technical expertise combined with business skills. The program provides students with advanced technical knowledge of applied communications integrated with business management.

This program prepares students to plan, implement and manage leading edge communications capabilities. The goal of this student is to become a technical business and management professional responsible for planning communications products and services; for leading the resources required to implement the plan, including people, product, networks, and systems, and for the decisions and budgeting for development, acquisition, installation, and maintenance of products and services. Each sector of industry (government, regulatory, service providers, financial, equipment vendor, consultant, and R&D) will have corresponding profiles of professionals who need such technical expertise and management skills. This degree program builds an advanced foundation for more specialized study while enabling professionals from all industry sectors to understand and interact with customers and communications professionals who make the decisions on how businesses will exploit communications capabilities.

Specialized courses are available in the areas of management of wireless networks, broadband communications, communications security, and project management.

In addition to off-campus (corporate-sponsored) programs, Network & Communication Management & Services is offered on campus on weekdays and via the WebCampus platform. Courses are offered year-round, in fall, spring and summer semesters.

Degree Requirements: The MS in Network & Communication Management & Services degree comprises 12 courses (36 credits). A minimum GPA of 3.0 is required to graduate.

Admission Requirements: Admission to the Master of Network & Communication Management & Services program requires a bachelor's degree with at least a B average, including a semester of calculus. For students who lack this prerequisite, Stevens offers a non-credit calculus course for telecommunications management (e.g., TM 500).

Admissions decisions are made on a rolling basis. Students can apply at any time during the year.

International students must also submit a GMAT/GRE score.

Structure of the Network and Communication Management and Services Program

The MS in Network and Communication Management and Services program has 3 components:

1. Common Business Core (3 courses)

2. Degree Requirements (6 courses)

3. Concentrations (3 courses)

Common Business Core

- ▸ MGT 609 Introduction to Project Management
- ▸ FIN 615 Financial Decision Making
- ▸ MGT 689 Organizational Behavior and Design

Network and Communication Management and Services Degree Requirements

- ▸ TM 601 Principles of Applied Telecommunications Technologies
- ▸ TM 605 Probability and Stochastic Processes
- ▸ TM 610 Business Information Networks
- ▸ TM 612 Regulation & Policy in the Telecommunications Industry
- ▸ TM 615 Wireless Communications & Mobile Computing
- ▸ TM 630 Broadband Networking: Services & Technology

Network and Communication Management and Services Concentrations

The final 3 courses may be selected from one of two specific concentrations within the MS Network & Communication Management & Services program, or from within a general concentration category designed to accommodate a broad choice of electives.

The MS Network and Communication Management and Services program offers two concentrations.

- ▸ Management of Broadband and Converged Networks
- ▸ Management of Wireless Networks

The courses required to complete each of these concentrations are listed below.

Management of Broadband and Converged Networks

Students selecting this major will be eligible for a Graduate Certificate in the Management of Broadband Communications and Converged Networks.

- ▸ TM 617 Next Generation Wireless Networks
  - • *Or* TM 650 Software Defined Networks and Network Function Virtualization
- ▸ TM 631 Broadband Service Management

Management of Wireless Networks Concentration

Students selecting this major will be eligible for a Graduate Certificate in the Management of Wireless Networks.

- ▸ TM 616 Global Wireless Industry
- ▸ TM 617 Next Generation Wireless Networks
- ▸ TM 618 Performance of Emerging Wireless Networks
  - • *Or* TM/EE 584 Wireless Systems Security
  - • *Or* TM 650 Software Defined Networks and Network Function Virtualization

Students may also choose from a broad range of electives to meet a student's specific growth objective in other domains intended to broaden his/her perspective while complementing the MS Network & Communication Management & Services degree. Students can select elective courses from the Business Intelligence & Analytics, Electrical Engineering, Financial Engineering, Computer Science, Management, and others. This option requires approval of a faculty advisor.

Courses may be chosen from within the School of Business or from other schools at Stevens.

Students may also elect to take a Curricular Practical Training (CPT) course (TM 702) which involves an educationally relevant, practical assignment aimed at augmenting the academic content of the student's program. Students engage in a company project related to the focus of their academic program. The project is conducted under the supervision of a faculty advisor and an industry mentor. The CPT is intended to provide students with practical experience that complements their academic knowledge through active learning under real-world conditions.

The courses that are available in each of these areas are described later in a separate section of the catalog.

MASTER OF BUSINESS ADMINISTRATION (MBA)

To stand out in today's business world, you need three essential competencies. First, you need to be proficient in the basic business disciplines, such as finance, accounting, and marketing. These three courses are prerequisites to the program (if you have not taken them previously you must take them as part of the program). Second, you must possess the key skills that enable you to collaborate and lead, communicate, be creative and think strategically. Third, with technology being essential to running nearly every facet of business, you need to understand how to nurture and leverage technology for business success.

The Stevens MBA is uniquely designed to equip you with these three essential elements. It will position you to operate effectively at the intersection of business and technology, which is where 21st century businesses need you to be.

You will learn from faculty members who remain connected with high-tech organizations around the globe and engage in cutting edge research in such areas as entrepreneurship, innovation and project management. You will draw upon Stevens' rich heritage in the management sciences, and its 140+ years as an applied technological university, which puts technology at the core of your learning experience.

There are three MBA program options - the Stevens MBA for full-time and part-time students having a minimum of two years work experience, the Analytics MBA for full time students who want to accelerate their studies and complete the program in one year, and the Experienced Professional MBA that is a weekend, cohort-based program that is offered on the Stevens campus on alternate Saturdays. Applicants to the EMBA must have 5+ years of work experience.

The following sections pertain to the Stevens MBA program. The Analytics MBA and the Experience Professional MBA program is discussed later in the catalog.

Incorporating a technology-centric approach with skills development the Stevens MBA program is designed to help students succeed in today's fast-paced technology-driven environment. Graduates from the program will be able to apply their skills to contribute to excellence at the intersection of business and technology, and lead their organizations in an increasingly complex and competitive world.

The Stevens MBA program is offered on campus on weekdays and via Stevens Online. It can also be delivered off-campus in corporate-sponsored programs,

Degree Requirements: The Stevens MBA degree comprises 13 courses (39 credits) plue the three prerequisite courses. A minimum GPA of 3.0 is required to graduate. Students with a master's degree from the Business School may be able to apply courses from their MS towards their MBA degree. Depending on concentration chosen, as few as eight additional courses may be required for the MBA degree.

Admission Requirements: Applicants to the Stevens MBA program are required to have completed a four-year bachelor's degree and it is preferred that they have at least two years of work experience. All applicants must submit transcripts showing academic achievement in prior studies (bachelor's degree with at least a "B" average), two letters of recommendation, and a resume. All applicants (domestic and international) to the MBA program must submit a GMAT score (or GRE score if taken previously). Note: The GMAT requirement is waived for domestic candidates possessing an MS degree and 5 years of work experience. Meeting minimum admissions standards does not guarantee admission; minimum requirements serve as a guide to the minimum expected qualifications necessary to be considered for admission.

Admission decisions are made on a rolling basis. Students can apply at any time during the year.

International students for whom English is a second language must demonstrate English language proficiency by submitting the results of a TOEFL or an IELTS test.

Structure of the Stevens MBA program

Prerequisite courses

The three prerequisite courses are intended to provide students with a solid foundation in basic business skills, to ensure their ability to meaningfully engage in high-level discussions with their classmates. Students with business degrees or backgrounds in these fields may speak with the program director about waiving one or more of these courses.

> ▸ FIN 623 Financial Management
>
> ▸ FIN 600 Financial and Managerial Accounting
>
> ▸ MGT 606 Economics for Managers

MBA curriculum

> ▸ MGT 612 Leader Development
>
> ▸ MGT 620 Statistical Models *
>
> ▸ MGT 630 Global Business & Markets*
>
> ▸ MGT 699 Strategic Management
>
> ▸ MGT 641 Marketing Management
>
> ▸ MGT 657 Operations Management
>
> ▸ MGT 635 Managerial Judgment and Decision Making
>
> ▸ MGT 671 Technology and Innovation Management
>
> ▸ MGT 663 Discovering & Exploiting Entrepreneurial Opportunities
>
> ▸ MGT 798 Integration and Application of Technology Management**
>
>   *Choose one. MGT 620 is required for students pursuing concentrations in Business Intelligence & Analytics, Finance or Project Management.

**Full time students may substitute this course with MGT 810 Field Consulting Program, subject to availability.

<u>Concentrations</u>

Stevens recognizes that modern managers must be well versed in the use of technology to accomplish goals and solve problems. To provide future leaders with the skills required in their industries, the School of Business offers five technology-flavored concentrations that go beyond the basics to explore the ways technology will continue to evolve each particular discipline.

Each of the five concentrations of the Stevens MBA offers a deep dive into the ethical questions, technology issues and strategic concerns of these areas, preparing students for leadership roles in the most in-demand disciplines in business.

Business Intelligence & Analytics

As organizations better understand how Big Data is revolutionizing business, those companies need leaders with strong analytical skills and the ability to turn the numbers into actionable business insight. The Business Intelligence & Analytics concentration gives you the analytical skills to needed to work in this high-demand field, enabling you to pursue careers in data-rich environments and craft practical growth strategies.

- BIA 672 Marketing Analytics

- BIA 674 Supply Chain Analytics

- BIA 658 Social Network Analytics

- BIA 670 Risk Management & Simulation

Finance

The Finance concentration provides the basic theory and practice of corporate financial management and examines the structure of financial markets and major financial instruments. Stevens' proximity to Wall Street makes this major a natural choice for many students.

- FIN 638 Corporate Finance

- FIN 526 Private Equity and Venture Capital

- FIN 627 Investment Management

- FIN 628 Derivatives

Financial Analytics

Students are required to take the following courses:

- FE 511 Introduction to Bloomberg and Thomson Reuters

- FE 513 Database Design

- FE 515 Introduction to R

- FE 520 Introduction to Python for Financial Applications

- FE 582 Foundations of Financial Data Science

- FE 595 Financial Technology

and one of the following

- FE 550 Data Visualization Applications

- FE 590 Statistical Learning

Financial Engineering

The following courses are required:

- ▸ FE 543 Introduction to Stochastic Calculus for Finance
- ▸ FE 535 Introduction to Financial Risk Management
- ▸ FE 630 Portfolio Theory and Risk Management
- ▸ FE 620 Pricing and Hedging
- ▸ FE 610 Probability and Stochastic Calculus*
- ▸ FE 621 Computational Methods in Finance**

  *FE 610 can be taken in lieu of FE 543

  **FE 621 can be taken in lieu of FE 535 for MS Financial Engineering students

Information Systems

In today's globally connected world, information systems are integral to company operations. This concentration blends both strategic and tactical perspectives, providing you with skills that enable you to advance to the highest ranks within a corporate IT department.

- ▸ MIS 620 Analysis and Development of Information Systems
- ▸ MIS 630 Dealing with Data
- ▸ MIS 710 Process Innovation and Management
- ▸ MIS 730 Integration Information Systems Technologies

Marketing

Advances in technology are dramatically changing the way in which products and services are marketed. The Marketing concentration gives you an understanding of those changes and what is driving them, and provides you with the skills and technological savvy to pursue a successful marketing career.

- ▸ MGT 648 Consumer Behavior
- ▸ MIS 661 Marketing Online
- ▸ BIA 672 Marketing Analytics
- ▸ MGT 646 Marketing Strategy

Network & Communication Management & Services

Students are required to take the following courses:

- ▸ TM 601 Principles of Applied Telecom Tech
- ▸ TM 610 Business Information Networks
- ▸ TM 612 Regulation & Policy in Telecom Industry

and one of the following

- ▸ TM 615 Wireless Network Mobile Computing
- ▸ TM 630 Broadband Networking Service & Technology
- ▸ TM 650 Software Defined Networking & Network Function Virtualization

Project Management

Excellence in project execution is the hallmark of successful companies. This concentration provides you with the skills to lead complex projects and programs within organizations. It leverages new concepts in strategic project management and leadership that were developed by School of Business faculty and have achieved international acclaim.

▸ MGT 609 Project Management Fundamentals

▸ MGT 610 Strategic Perspectives on Project Management

▸ MGT 611 Project Analytics

▸ MGT 619 Leading Across Projects

Structure of the Analytics MBA

The analytics MBA at Stevens is structured around three areas of greatest need for the managers of tomorrow's technology-driven organizations, who must be able to speak the language of business, understand how to apply new innovations within business units and across the enterprise, and interpret data to make strategic recommendations and capitalize on new trends.

The curriculum is further enhanced by personal and career development threads that include intensive mentorship and leadership training, ensuring students complete the program as well-rounded professionals able to understand how the technical and specialized aspects of the company enable the business to function and fit into the overall growth strategy of the organization.

Prerequisites

The three prerequisite courses to the MBA are designed to provide a basic foundation in management principles to students from non-business backgrounds. Students may be exempt from these courses with relevant work history or an undergraduate business degree. Please consult the program director for information on whether you are eligible to waive these courses. The three courses can be taken in the month prior to the start of classes in the fall.

▸ FIN 623 Financial Management

▸ FIN 600 Financial and Managerial Accounting

▸ MGT 606 Economics for Managers

Language of business

One of the greatest points of frustration for technical employees is an inability to influence decision-making, as they are unable to translate their findings in ways that resonate with the C-suite. Courses in this block go beyond the basics to give you thorough command of how to understand scientific and technical advances from the viewpoint of a manager who must carefully deploy limited resources to ensure the pursuit of truly innovative developments.

▸ MGT 641 Marketing Management

▸ MGT 663 Discovering & Exploiting Entrepreneurial Opportunities

▸ FIN 638 Corporate Finance

▸ MGT 699 Strategic Management

Leadership and innovation

Courses in this block are designed to work in tandem with the curricular thread of personal development, nurturing aspiring leaders to think critically about problems and creatively about resources in order to attack corporate missions with fearlessness.

▸ MGT 612 Leader Development

▸ EMT 695 Leading Creative Collaboration

▸ EMT 696 Human-Centered Design Thinking

▸ MIS 714 Service Innovation

Analytical thinking

Most technical professionals are capable analysts who are most comfortable delving into technical, rather than financial or managerial, challenges. Courses in this block emphasize highly advanced analytics techniques that will teach you the ways successful managers look at and use data in understanding how markets work and making better recommendations to guide the enterprise.

▸ BIA 600 Business Analytics: Data, Models and Decisions

▸ BIA 652 Multivariate Data Analytics

▸ BIA 656 Advanced Data Analytics & Machine Learning

▸ BIA 610 Applied Analytics

Capstone

After completing the rest of the curriculum, students may choose one of the three capstone courses:

▸ MGT 678 Technology Commercialization Practicum.

▸ MGT 810 Field Consulting Program.

▸ MGT 798 Application and Integration of Technology Management.

Each of these courses demand the application of the lessons in analytics, leadership and innovation taught throughout the curriculum. Technology Commercialization Practicum is an opportunity for students to use what they've learned about entrepreneurship to start a business or create a product. The Field Consulting Program gives students real-world experience by putting them to work with managers at a company on an industry problem, concluding with a formal recommendation to corporate leadership. The application course is a high-intensity business simulation in which students manage the entire spectrum of a business as it attempts to grow through turbulent market changes.

Structure of the EMBA

The EMBA curriculum is designed to offer a high-level perspective on data-driven decision-making, strategic management, teaming and leadership, global business, and innovation and new product development. Coursework is supplemented by a leadership retreat that allows students to test what they've learned about trust, teamwork, communication and ethics by working together to complete an obstacle course. Furthermore, a global business seminar brings students to a foreign country, where meetings with local executives demonstrate firsthand how cultural differences shape the ways economies work and businesses function.

Core curriculum

- ▸ EMT 740 Team Leadership Development
- ▸ EMT 606 Economics
- ▸ EMT 642 Marketing Strategy
- ▸ EMT 624 Financial and Managerial Accounting
- ▸ EMT 623 Financial Management
- ▸ EMT 677 Managing Emerging Technology
- ▸ EMT 696 Design Thinking
- ▸ EMT 715 Strategic Management
- ▸ EMT 752 Corporate Entrepreneurship
- ▸ EMT 657 Operations Management *
- ▸ EMT 635 Managerial Judgment and Decision Making
- ▸ BIA 678 Big Data Seminar
- ▸ EMT 695 Leading Creative Collaboration
- ▸ EMT 638 Corporate Finance
- ▸ EMT 630 Global Business and Markets
- ▸ EMT 798 Integration & Application of TM / Business Simulation

*Can be substituted with a technology elective

MASTER OF SCIENCE-MASTER OF BUSINESS ADMINISTRATION

The MS-MBA is a coordinated dual degree program enabling students who graduate with a Business School MS to apply relevant courses from their MS to their MBA degree. In most cases, the MBA degree can be obtained with 24-36 credits (8-12 courses) of additional course work depending on the chosen MBA concentration. MS graduates must submit an application for admission to the MBA program.

The combination of courses comprising the MS and MBA degrees provides in-depth preparation for graduates wishing to assume either general management or technology-related managerial positions. The program is designed to allow students to specialize in areas that are relevant to their careers.

MASTER OF SCIENCE IN TECHNOLOGY MANAGEMENT (MSTM)

The Master of Science in Technology Management (MSTM) is a part-time program specifically designed for experienced professionals wishing to move to a broader role in technology and business management. The MSTM program focuses on the effective management and use of technology in technology-intensive businesses. It integrates business and technology topics aimed at educating students to manage technology creatively in order to enhance business competitiveness in a global business environment. Students learn general business skills, such as accounting, finance and marketing, along with emphasis on development of technology management skills encompassing technology strategy, emerging technology and corporate entrepreneurship to assure alignment of technology strategy with business strategy.

The MSTM program consists of twelve courses that are completed in six trimesters. The courses are supplemented with workshops and practicums utilizing business simulation tools that reinforce classroom concepts, while providing students

with experience running a high-tech company. The Global Business and Markets course also encompasses an international study tour where students travel abroad to countries such as China where they participate in company visits and lectures, as well as some cultural and sightseeing activities, in order to gain first-hand experience and understanding of the unique business culture and context of that country.

Courses are scheduled on alternating Saturdays on the Stevens campus from 8:30 a.m. to 5:15 p.m. In the final semester, the capstone course requires 5 consecutive Saturday sessions on the Stevens campus. Students complete their MSTM degree in 21 months.

Degree Requirements: The MS in Technology Management consists of 10 courses (30 credits). A minimum GPA of 3.0 is required to graduate.

Admission requirements: Admission to the MSTM program requires that applicants have:

- A bachelor's degree in a relevant technical discipline.*

- 5 + years of relevant full-time work experience — managerial experience is preferred but is not required for admission to the program.

   *Consideration will be given to prospective students with non-technical undergraduate degrees provided they have appropriate technology-based work experience.

Meeting minimum admission requirements does not guarantee admission; minimum requirements serve as a guide to the minimum expected qualifications to be considered for admission. Consideration will be given to prospective students with non-technical undergraduate degrees provided they have appropriate technology-based work experience.

Note: The GMAT is not required for admission to the MSTM program.

Structure of the MSTM Program

- EMT 740 Technology Leadership Development

- EMT 606 Economics

- EMT 642 Marketing Strategy

- EMT 624 Financial and Managerial Accounting

- EMT 623 Financial Management

- EMT 677 Managing Emerging Technology

- EMT 696 Design Thinking

- EMT 715 Strategic Business Management

- EMT 752 Corporate Entrepreneurship

- EMT 657 Operations Management

Master of Philosophy

The Master of Philosophy (M.Phil.) is a postgraduate research degree. It is offered to enrolled Ph.D. students who achieve a record of distinction during the pre-dissertation phase. Because the Master of Philosophy is not designed as a terminal degree, its requirements are integrated with the requirements for the Doctor of Philosophy degree: potential candidates for the Master of Philosophy degree must be qualified to pursue the doctorate and have been advised to apply for admission to a doctoral program.

This degree requires a minimum of two years of advanced study beyond the baccalaureate degree. Placed between the Master's degree and the Doctor of Philosophy, the Master of Philosophy marks a student's successful completion of all requirements for the doctorate, except the final phase of research and the dissertation. The degree is intended to provide recognition that a prospective doctoral candidate has successfully and expeditiously completed a major phase of graduate study and has achieved a comprehensive mastery of the general field of concentration.

PH.D. IN BUSINESS ADMINISTRATION

The School of Business Ph.D. in Business Administration program defines itself at the intersection of three research domains: Information Systems & Analytics, Entrepreneurship & Innovation Management and Finance. These three research domains are strongly represented by the faculty of the Business School and provide different perspectives on business administration.

The design of the Ph.D. program is based on the assumption that novel research ideas often occur at the intersection of different knowledge domains. The unique combination of these three research domains and their integrated discussion will lead to creative and innovative research questions within and across these domains. The combination will also encourage the development of the interdisciplinary skill sets necessary to conduct innovative research. The majority of Ph.D. programs focus on theory and analytical skills. The integration of three research domains complements this fundamental skill set with the skills necessary for creating and applying this knowledge. Our students are challenged to create new technologies for analyzing relevant research questions related to important problems we face today.

Students of the program will chose one of the three research domains as their research focus and they can study aspects of the other two domains as part of the program. Because of the specific integration of the knowledge domains the program offers a truly interdisciplinary experience. This is achieved by a common set of required courses and by the selection of individual courses.

Degree Requirements: The Ph.D. program in Business Administration consists of a minimum of 36 credits of coursework and a maximum of 18 research credits.

Admission Requirements: The Ph.D. program is designed for the exceptional student possessing a strong quantitative background and a degree in management or related topics. Students who are interested in joining the program must fulfill the following requirements:

▸ Students must have earned a 4-year undergraduate degree from an accredited college or university.

▸ Students must have earned a master's degree in Business, Finance, MIS or related field.

▸ Students must have attained a basic knowledge of statistics comparable to MGT620 Statistical Models.

▸ Students must have completed undergraduate course work in mathematics including the equivalent of two semesters of calculus and one semester of linear algebra, or they must acquire this background before entering the program.

International students for whom English is a second language must demonstrate English language proficiency by submitting the results of a TOEFL or an IELTS test.

All students are required to submit GMAT or GRE test scores not older than 3 years.

Admissions decisions are made beginning in February for the following fall semester. Students are encouraged to apply at any time during the year but it is preferred that complete applications are submitted by January 31.

Depending on the student's background, several non-credit business, information technology and finance foundation courses may also be required.

Structure of the Ph.D. Program

Course work (36 credits). All courses are worth 3 credits unless otherwise specified.

- Five common core courses addressing research methods, economic theory and research design.
- Two domain specific courses addressing fundamental research questions.
- Four elective courses that could involve independent study as well as master's and doctoral courses.
- Signature doctoral course PRV 961 required for all doctoral students at Stevens.
- Special Method Workshops (SEM, Conjoint Measurement etc.)
- MGT 960 Dissertation/ Research (18 credits)

A preliminary examination is usually taken after the second semester of fulltime study. A qualifying examination is usually taken after finishing the 4th semester of full-time study.

A proposal for the student's PhD dissertation is usually defended at the end of the third year of full-time study.

The final PhD dissertation is usually defended at the end of the fourth year of full-time study.

Program Learning Objectives

The program's learning objectives are to prepare students to pursue an academic or industry research career.

The program's required common courses will provide students with the foundations needed to conduct independent research.

The domain specific courses will introduce students to the foundations of the three research domains and equip them with the knowledge required to conduct research within a domain.

These courses develop skills in understanding and analyzing as well as in creating and applying.

- Understanding and analyzing skills are addressed by discussing the theoretical foundations of the domains and fundamental methods.
- Creating and applying skills are developed by theory building and developing tools to analyze specific social and economic phenomena.

PH.D. IN DATA SCIENCE

The PhD in Data Science is an interdisciplinary program managed jointly by the School of Engineering and Sciences and the School of Business. The program prepares students for research careers in academia or industry that involve the use of methods and systems for extracting insights from rich data sets, especially as applied to the fields of finances and the life sciences. The program responds to the demand by industry for data scientists with a deep knowledge of the theories, techniques and applications associated with "Big Data" and artificial intelligence. The program also recognizes the broad range of skills needed to successfully apply the tools of the digital revolution in industry. This is reflected in the four core areas of (1) mathematical and statistical modeling, (2) machine learning and artificial intelligence, (3) computational systems, and (4) data management at scale, all of which provide a strong foundation for a thorough strong understanding of (5) a field of application.

Programs of study in two application areas, Financial Services and Life Sciences, are described below. Students may design a program of study in another field of application with support of their advisor and approval of the department chair/program director.

To make progress on leading-edge subjects in a fast moving field like data science requires full-time study. Accordingly, students will be admitted only for full-time on-campus study in partnership with a full-time faculty advisor.

Admission Requirements. The PhD in Data Science is primarily designed for students with technical backgrounds. e.g., an undergraduate or master's degrees in computer science, computer engineering, business analytics, science or engineering from Stevens or other universities. Applicants to the program must fulfill the following requirements:

▸ A 4-year undergraduate degree from an accredited college or university.

▸ International students for whom English is a second language must demonstrate English language proficiency by submitting the results of a TOEFL or an IELTS test.

▸ GMAT or GRE test scores not older than 5 years.

Admissions decisions are made beginning in February for the following fall semester. Students are encouraged to apply at any time during the year but it is preferred that complete applications are submitted by January 31.

Credit Requirements. The PhD in Data Science requires 84 credits beyond the bachelor's degree. A prior master's degree may be transferred for up to 30 credits without specific course descriptions. The remaining 54 credits must include at least 12 credits of core courses, a minimum of 9 credits of field-specific courses and a minimum of 15 dissertation credits. Approval to enter the PhD in Data Science is generally only given when a student has completed work equivalent to a master's degree.

Structure of the Ph.D. Program in Data Science

▸ Course work.

All courses are worth 3 credits unless otherwise specified.

- A minimum of 1 course and a maximum of 3 courses in each of the four core areas (mathematical modeling, machine learning and artificial intelligence, computational systems, and data management at scale).

- Completion of the signature doctoral course PRV 961 (3 credits, required of all doctoral students at Stevens) and MGT 719 Research Design (3 credits).

- A minimum of three courses (9 credits) in a field of application (e.g., financial services or life sciences).

- Doctoral students are expected to maintain a 3.7/4.0 cumulative grade-point average. Students failing to meet this requirement may be placed on probation at the discretion of the faculty.

▸ Scholarly work

- **Research seminars.** PhD students are required to attend research seminars. Students failing to meet this requirement may be put on probation at the discretion of the faculty.

- **Qualifying Exam.** The qualifying exam is an oral examination on a syllabus consisting of research papers, prepared jointly by the student and a committee including the advisor and two tenure-track faculty members. The goal is to establish scholarship in an area of research. The exam needs to be completed by the end of the 4th semester in the program. It consists of a presentation, followed by open-door questions from the audience and a closed-door examination from the committee. The committee can pass, fail, or request re-examination (either written or oral).

- **Dissertation Work.** Students must complete a minimum of 15 credits of DS 960 Dissertation / Research. The dissertation must demonstrate the student's mastery of the associated topic area, it must exhibit sound research methodology and it must make a unique and substantial contribution to an area of data science research.

- **Thesis Proposal.** By the end of their fourth semester, students must write and present a thesis proposal, where they lay out an intended course of research for their dissertation. The proposal should contain an explanation of the problem and why it is important, a sketch of the proposed solution, and background

information that serves to indicate that the problem is unsolved and what prior or related approaches to this or similar problems have already been investigated.

- **PhD Dissertation Defense.** The final PhD dissertation is usually defended at the end of the fourth year of full-time study.

- **Exceptions.** The faculty reserve the right to make exceptions to any of the rules and procedures described above in order to promote and preserve the health of the doctoral program and to ensure each student's prompt and effective progress through the program.

Prerequisites

A number of prerequisites are expected to be satisfied by the student's prior undergraduate or master's degrees before entering the program:

▸ Calculus (2 semesters)

▸ Statistics (1 semester)

▸ Probability (1 semester)

▸ Linear algebra (1 semester)

▸ Fluency in a programming language such as C++ or Java (2 semesters)

▸ Database management (1 semester)

These prerequisites could, for example, be satisfied during the students master of science degree by taking courses equivalent to the following Stevens courses: *MA 547 Advanced Calculus I, MA 541 Statistical Methods, MA 540 Introduction to Probability Theory, MA 552 Axiomatic Linear Algebra, CS570 Introduction to Programming, Data Structures, and Algorithms, CS590 Algorithms, and CS 561 Database Management Systems.*

Core Courses (Minimum of 12 and maximum of 24 credits)

To acquire the breadth of knowledge necessary for successful research in data science, students must complete at least one and at most three courses in each of the four core areas. Students who demonstrate competency in the topics covered by a core course may, with permission of their advisor, waive the core course and take an approved elective in its place. Students are also required to take the doctoral signature course PRV 961 and MGT719 Research Methods.

1. Mathematical and Statistical Modeling

BIA 652 Multivariate Analytics

FE 542 Time Series with Applications in Finance

MA 661 Stochastic Optimal Control & Dynamic Programming

2. Machine Learning and Artificial Intelligence

BIA 656 Advanced Data Analytics & Machine Learning

CS 541 Artificial Intelligence

CS 559 Machine Learning: Fundamentals and Applications

FE 690 Advanced Financial Analytics

3. Data management at Scale

BIA 678 Big Data Technologies

CS 522 Mobile Systems and Applications

CS 609 Data Management and Exploration on the Web

4. Computational Systems

BIO 668 Computational Biology (for Life Sciences majors)

FE 595 Financial Technology (for Finance majors)

CS 549 Distributed Systems and Cloud Computing

CS 600 Advanced Algorithm Design and Implementation

5. Signature Doctoral Course (3 credits)

PRV961 Doctoral Signature Credit Seminar/Project/TA

6. Research Methodology (3 credits)

MGT 719 Research Design

Students who demonstrate competency in the subject area of a particular core course may waive the course with the permission of their advisor and the program director.

Application (Major) Area (Minimum of 9 and maximum of 21 credits)

Depending on their major area of study, and with approval of their advisor, students choose at least three courses from either of the following two lists.

Financial services:

FE 546 Optimization Models & Methods in Finance

FE 545 Design Patterns and Derivative Pricing

FE 550 Data Visualization Applications

FE 610 Stochastic Calculus for Financial Engineers

FE 635 Financial Enterprise Risk Engineering

FE 680 Derivatives

FIN 638 Corporate Finance

FIN 628 Derivatives

FE 655 Systemic Risk and Financial Regulation

FE 670 Algorithmic Trading Strategies

FE 621 Computational Methods in Finance

FIN 703 Microeconomic Theory

FIN 704 Econometrics

FIN 705 Asset Pricing Theory and Applications

Life sciences

CH 664 Computer Methods in Chemistry

CH 760 Chemoinformatics

CHE 660 Advanced Process Control

CHE 661 Design of Control Systems

CPE 610 Introduction to Bioinformatics Engineering

CPE 686 Software Tools in Bioinformatics

CS 544 Health Informatics

CS 691 Introduction to System Biology

CS 694 Advanced Computational Modeling in Biology and Biomaterials Science

General Electives

Students who satisfy the minimum requirements for the program may, with approval of their advisor, take elective courses to make up the 54-credit total course requirement. Available elective courses include:

BIA 654 Experimental Design

BIA 660 Web Mining

BIA 662 Cognitive Computing

BIA 672 Marketing Analytics

BIA658 Social Network Analysis

CPE 646 Pattern Recognition and Classification

CPE 695 Applied Machine Learning

CS 522 Mobile Systems and Applications

CS 549 Distributed Systems and Cloud Computing

CS 582 Causal Inference

CS 598 Visual Information Retrieval

CS 600 Advanced Algorithm Design and Implementation

CS 601 Algorithmic Complexity

CS 609 Data Management and Exploration on the Web

CS 677 Parallel Programming for Many-core Processors

CS 696 Database Security

FE 541 Applied Statistics

FE 622 Simulation Methods in Comp. Finance and Economics

FE 635 Financial Enterprise Risk Engineering

FE 641 Advanced Multivariate Statistics

FE 646 Opt. Models & Methods in Finance

FE 655 Systemic Risk and Financial Regulation

FE 670 Algorithmic Trading Strategies

FE 672 Modern Market Structure and HFT Strategies

FE 710 Applied Stochastic Diff Equation

FE 720 Volatility Surface - Risk & Models

MA 541 Statistical Methods

MA 611 Mathematical Probability

MA 612 Mathematical Statistics

MA 623 Stochastic Processes

MA 629 Nonlinear Optimization

MA 630 Advanced Optimization Methods

MA 641 Time Series Analysis I

MA 655 Optimal Control Theory

MA 661 Stochastic Optimal Control & Dynamic Programming

PH.D. IN FINANCIAL ENGINEERING

As the first Financial Engineering doctoral program to be developed in the nation, the Doctor of Philosophy (Ph.D.) degree is designed to prepare students to perform research or high-level design in financial engineering.

With an emphasis on an interdisciplinary approach requiring knowledge in finance, economics, mathematics, probability/statistics, operations research, engineering, computer science and systems thinking, the program gives graduates substantial expertise in key disciplines such as financial mathematics, risk management, financial statistics, portfolio optimization, financial standards, systemic risk, behavioral finance, microstructure finance, investment banking, data analytics, securities trading to name a few examples.

Students work alongside with faculty and perform transformative research in four crucial areas: Quantitative Finance, Financial Services Analytics, Financial Risk & Regulation, and Financial Systems. Graduates of the program are typically employed in world-class financial investment firms and academic research institutions.

The Ph.D. program requires completion of 54 credits beyond a relevant and approved Master's degree. The students are required to pass a qualifying exam within 2 years of starting their doctoral studies and maximum of 6 years to complete the program and defend their dissertation.

Graduate Certificate Programs

The School of Business offers the following programs leading to a graduate certificate of Special Study. Students are required to meet regular admission requirements for the master's program and complete the courses listed below. Each graduate certificate program is self-contained and highly focused, carrying 12 graduate credits. All of the graduate certificate courses may also be applied toward the master's degree.

Algorithmic Trading Strategies

Recent years have seen unprecedented change in financial systems technology. Algorithmic trading has become a dominant component of trade volumes on exchanges. The implementation of software and automatic decision support systems in dynamic markets has become part of the skills needed to succeed in the domain of algorithmic finance. This four-course certificate is designed to provide financial engineers with the necessary understanding of architecting and implementing a financial trading systems. The required courses are:

▸ FE 545 Design, Patterns and Derivatives Pricing

▸ FE 570 Market Microstructure and Trading Strategies

▸ FE 620 Pricing and Hedging

▸ FE 670 Algorithmic Trading Strategies

Financial Computing - 15 credits

The Financial Computing certificate will enable students to operate effectively in the complex financial computing environment. Students will develop expertise in implementation of financial computing models, knowledge of financial databases, financial engineering software and specialized programming languages. The hands-on skills combined with a real-life financial computing project will enable them to compete in the financial industry.

The required courses are:

▸ FE 505 Technical Writing in Finance - 1 credit

▸ FE 522 C++ Programming in Finance - 3 credits

▸ FE 511 Introduction to Bloomberg and Thomson Reuters - 1 credit

▸ FE 621 Computational Methods Finance - 3 credits

▸ FE 699 Project in Financial Computing - 2 credits

Choose one elective between:

▸ FE 543 Introduction to Stochastic Calculus for Finance - 3 credits

▸ FE 610 Stochastic Calculus for Finance - 3 credits

Choose two electives between:

▸ FE 513 Practical Aspects of Database Design - 1 credit

▸ FE 514 VBA in Finance - 1 credit

▸ FE 515 Introduction to R - 1 credit

▸ FE 516 MATLAB for Finance - 1 credit

▸ FE 517 SAS for Finance - 1 credit

▸ FE 518 Mathematica for Finance - 1 credit

▸ FE 519 Advanced Bloomberg - 1 credit

▸ FE 520 Introduction to Python in Financial Applications - 1 credit

▸ FE 521 Web Design - 1 credit

▸ FE 529 GPU Computing - 1 credit

Financial Engineering

The components of financial problem solving are embedded in the methods of applied mathematics, computational techniques, statistical analysis and economic theory. In a financial engineering program, those components are directed towards solving problems in securities valuation, risk management, portfolio structuring and regulatory concerns with emphasis on tools and training in stochastic modeling, optimization and simulation techniques.

The required courses are:

- FE 610 Stochastic Calculus for Financial Engineers
- FE 620 Pricing and Hedging
- FE 621 Computational Methods in Finance
- FE 630 Portfolio Theory and Applications

Financial Planning

The Graduate Certificate in Financial Planning is designed for working professionals or part-time and full-time MS in Finance students who are looking to specialize in the area of financial planning and become personal financial advisors. The core curriculum of the Graduate Certificate is aligned with the material covered in the CFP® Certification exam, including the completion of a financial plan development (capstone) course which is registered with the CFP Board.

Certificate Requirements: The Graduate Certificate in Financial Planning consists of 6 courses (18 credits).

FIN 510	ACC 555	FIN 565
FIN 550	FIN 560	FIN 627

Financial Risk Engineering

The recent turbulence in the financial system heightened the need for a much stronger understanding of the financial system, its environment and the risk measures applied in the industry to quantify risk it in its multiple hierarchies. This certificate enables the graduate to fill this need and play an important role in balancing the interests of shareholders with the appropriate levels of risk taken by the managers and decision makers.

The required courses are:

- FE 535 Introduction to Risk Management
- FE 610 Stochastic Calculus for Financial Engineers
- FE 635 Financial Enterprise Risk Engineering
- FE 655 Systemic Risk and Financial Regulation

Financial Services Analytics - 5 course, 15 credits

Financial services analytics (FSA) is the science and technology of creating data-driven insights and analytics decision-making for the financial services industry. These insights increase the effectiveness of business operations, enhance customer relationships, improve product offerings, and improve risk analysis and risk management. This certificate will prepare students with an array of statistical learning methods and database skills in order to create end-to-end business decision making data analytic tools from an enterprise level systems approach.

The required courses are:

▸ FE 582 Foundations of Financial Data Science - 2 credits

▸ FE 513 Practical Aspects of Database Design (lab) - 1 credit

▸ FE 590 Statistical Learning - 3 credits

▸ FE 595 Financial Technology (Analytical Financial Systems Design) - 3 credits

▸ FE 550 Data Visualization Applications - 3 credits

▸ FE 800 Special Projects in Financial Engineering - 3 credits

Financial Software Engineering

This graduate certificate is aimed at intra-system super structural software applications (ISSS). Retail software platforms, web trading desks, pricing software tools for new instruments including derivatives products and stochastic portfolio simulators, and cutting edge information and knowledge discovery tools in a firm are all examples of software engineering or ISSS in financial institutions. This certificate explores these applications and how they work within a financial institutions overall enterprise system.

The required courses are:

▸ SSW 540 Fundamentals of Software Engineering

▸ SSW 565 Software Architecture and Component-based Design

▸ FE 610 Stochastic Calculus for Financial Engineers

▸ FE 620 Pricing and Hedging

Financial Statistics

In our data driven world the capability of analyzing and drawing meaningful conclusions from said data is paramount. This statement is valid to all areas of science and engineering, particularly to finance. The certificate as designed will allow a student to have all the necessary tools to be able to analyze data in a scientific and fundamentally correct way.

The required courses are:

▸ FE 541 Applied Statistics with Applications in Finance

▸ FE 542 Time Series and Applications to Finance

▸ FE 590 Statistical Learning

▸ FE 610 Stochastic Calculus for Financial Engineering

Machine Learning in Finance

The Machine Learning in Finance certificate will provide the technical and programming knowledge needed to excel in new roles such as technical financial analyst and Data Scientist in Finance as well as be capable of implementing the models developed and put them in production. The certificate is designed to cover probability, statistics then machine learning techniques used in Finance. The final course in the certificate provides the FinTech know how to be able to produce an end-to-end solution from data to customers. Knowledge of R and Python is required throughout the certificate.

The required courses are:

- ▸ FE 540 Probability Theory for Financial Engineering
- ▸ FE 541 Applied Statistics with Applications in Finance
- ▸ FE 690 Machine Learning in Finance
- ▸ FE 595 Financial Technology

Software Engineering in Finance

Clearing systems, payment systems and settlement systems are all examples of inter-system infrastructural software (ISIS). For example the Clearing House Interbank Payments System (CHIPS) is a patented algorithm for payment netting whose participants must have an account with the New York Federal Reserve Bank. The FedWire, SWIFT and SunGard are at the core of ISIS where the "Buy" side of the market meets the "Sell" side of the market through intermediaries and Banks with clearinghouses and custodians. The graduate certificate in software engineering in finance explores this class of problems dealing with inter-financial systems information flows.

The required courses are:

- ▸ SSW 540 Fundamentals of Software Engineering
- ▸ SSW565 Software Architecture and Component-based Design
- ▸ FE 595 Financial Technology
- ▸ MGT 623 Financial Management
  - • *Or* MGT 638 Corporate Finance

Industry-Oriented Certificates

Healthcare Management (4 courses, 12 credits)

- ▸ MGT 616 Healthcare Leadership and Management
- ▸ MGT 609 Project Management Fundamentals
- ▸ MGT 612 Leader Development

One elective chosen from the following:

- ▸ MGT 614 Advanced Project Management
- ▸ MIS 689 IT Management for the Healthcare Professional.
- ▸ MGT 689 Organizational Behavior & Design

Discipline-Based Certificates

Business Intelligence and Analytics (4 courses, 12 credits)

All graduate certificate students will normally take:

- ▸ MIS 636 Data Warehousing & Business Intelligence*
- ▸ MIS 637 Data Analytics & Machine Learning*

Practitioners will normally take 2 of the following 3 courses:

▸ BIA 652 Multivariate Data Analytics*

▸ BIA 658 Social Network Analytics*

▸ BIA 672 Marketing Analysis

▸ BIA 674 Supply Chain Analysis

People intending to go on to the BI&A MS Degree will normally take 2 of the following 3 courses:

▸ BIA 652 Multivariate Data Analytics

▸ BIA 656 Advanced Data Analytics & Machine Learning

▸ BIA 660 Web Mining

*These four graduate certificate courses are available online.

Marketing Analytics

▸ BIA 672 Marketing Analytics*

Choose 3 out of the following courses:

▸ BIA 652 Multivariate Data Analytics

▸ BIA 658 Social Network Analytics

▸ BIA 660 Web Mining

▸ MIS 637 Data Analytics & Machine Learning

*Required for a Graduate Certificate in Marketing Analytics

Supply Chain Analytics

▸ BIA 672 Supply Chain Analytics*

Choose 3 out of the following courses:

▸ BIA 650 Process Analytics and Optimization

▸ MGT 657 Operations Management

▸ BIA 658 Social Network Analytics

▸ MIS 637 Data Analytics & Machine Learning

* Required for a Graduate Certificate in Supply Chain Analytics

Business Process Management & Service Innovation (4 courses, 12 credits)

Choose four of the following courses:

▸ MIS 690 Supply Chain Management and Strategy

▸ MIS 710 Process Innovation & Management

▸ MIS 712 Advanced Business Process Management

▸ MIS 714 Service Innovation

▸ BIA 650 Optimization and Process Analytics

▸ BIA 657 Supply Chain Analytics

Information Management (4 courses, 12 credits)

- ▸ MIS 620 Analysis and Development of Information Systems
- ▸ MIS 630 Dealing with Data
- ▸ MIS 710 Process Innovation & Management
- ▸ MIS 760 Information Technology Strategy

Project Management (4 courses, 12 credits)

- ▸ MGT 609 Introduction to Project Management
- ▸ MGT 610 Strategic Perspectives on Project Management
- ▸ MGT 611 Project Analytics
- ▸ MGT 612 Leading People and Projects

Fundamentals of Management (4 courses, 12 credits)

- ▸ MGT 612 Leader Development
- ▸ MGT 641 Marketing Management
- ▸ MGT 657 Operations Management
- ▸ MGT 699 Strategic Management

Fundamentals of Finance (4 courses, 12 credits)

- ▸ MGT 606 Economics for Managers
- ▸ FIN 600 Financial And Managerial Accounting
- ▸ FIN 623 Financial Management
- ▸ FIN 638 Corporate Finance

Network and Communication Management and Services (4 courses, 12 credits)

- ▸ TM 601 Principles of Applied Telecommunications Technology
- ▸ TM 605 Probability and Stochastic Processes
- ▸ TM 610 Business Information Networks
- ▸ TM 612 Regulation and Policy in the Telecommunications Industry

Management of Broadband and Converged Networks (4 courses, 12 credits)

- ▸ TM 612 Regulation & Policy in the Telecommunications Industry
- ▸ TM 617 Next Generation Wireless Networks
  - • *Or* TM 650 Software Defined Networks and Network Function Virtualization
- ▸ TM 630 Broadband Networking: Services & Technology
- ▸ TM 631 Broadband Service Management

Management of Wireless Networks (4 courses, 12 credits)

▶ TM 615 Wireless Communications & Mobile Computing

▶ TM 616 Global Wireless Industry

▶ TM 617 Next Generation Wireless Networks

▶ TM 618 Performance of Emerging Wireless Networks

- *Or* TM/EE 584 Wireless Systems Security

- *Or* TM 650 Software Defined Networks and Network Function Virtualization

International Programs

Master of Science in Financial Engineering (MFE) at SIT and Master in Finance (MAF) at ITESM, Master in International Business (MIB) at ITESM or Master in Business Administration (MBA) at ITESM

Candidates take the following Stevens Institute of Technology financial engineering courses:

▶ FE 610 Stochastic Calculus for Financial Engineers

- *Or* FE 543 Introduction to Stochastic Calculus for Finance

▶ FE 620 Pricing and Hedging

▶ FE 621 Computational Methods in Finance

And three out of the following electives:

▶ FE 630 Portfolio Theory and Applications

▶ FE 680 Advance Derivatives

▶ FE 635 Financial Enterprise Risk Engineering

▶ FE 655 Systemic Risk and Financial Regulation

ITESM Masters in International Business candidates take the following international business courses:

▶ GA 4044 Introduction to Economics

▶ GA 4075 Managerial Accounting

▶ GA 4076 Financial Accounting

▶ GA 4081 Fundamentals of Finance

▶ GA 4043 Interpersonal Skills for International Management

▶ GA 4048 Consulting Project I

▶ GA 4053 Leadership for Sustainable Development

▶ GA 4083 Introduction to Latin American Management

▶ GA 4084 Quantitative Methods

▶ GA 4040 Marketing

▶ GA 4045 NAFTA Business Environment

▶ GA 4042 Elective I

▶ GA 4047 Elective II

ITESM Master in Finance candidates take the following courses:

One course of the following ITESM courses:

▸ AD 4003 Business Policy, Ethics & Corporate Social Responsibility

▸ DS 4002 Leadership for Sustainable Development

And seven of the following ITESM courses:

▸ FZ 5004 Finance Project

▸ S 4009 Financial Econometrics

▸ FZ 4005 Financial Economics

▸ FZ 4006 Introduction to Corporate Finance

▸ FZ 4008 Investments

▸ FZ 5000 International Financial Management

▸ FZ 4007 Advanced Corporate Finance

▸ FZ 5003 Capstone Seminar in Finance

ITESM Masters in Business Administration candidates take the following courses:

One course of the following ITESM courses:

▸ AD 4003 Business Policy, Ethics & Corporate Social Responsibility

▸ DS 4002 Leadership for Sustainable Development

And seven of the following ITESM courses:

▸ EC 4005 Managerial Economics

▸ CD 4000 Operations Management

▸ MT 4001 Marketing Management

▸ RH 4000 Leadership and Organizational Behavior

▸ AD 4004 Competitive Strategy and Business Design

▸ AD 4005 Entrepreneurship and Intrapreneurship

▸ AD 5000 Negotiations and Decisions in Multicultural Environments

▸ AD 5001 Seminar in Transnational Management and Corporate Strategy

COURSE OFFERINGS

Accounting

ACC 351   Federal Taxation of Individuals   (3 - 3 - 0)
This course deals with the methods and principles of US Federal income taxation. It is concerned with the history and politics behind the federal income tax laws and regulations, including major emphasis on tax provisions common to all types of taxpayers, particularly individuals. Topics include: tax authority, research, compliance and planning; gross income and exclusions; individual deductions and credits; tax rate schedules and calculation; filing status; investments and property transactions; self-employment income; retirement planning; home ownership and professional ethics. Prerequisite: BT 200 Financial Accounting

ACC 352   Federal Taxation of Business Entities   (3 - 3 - 0)

This course presents the legal and income tax applications relative to various types of taxable entities, including sole proprietorship, corporations, partnerships, limited liability companies and S-Corporations. This course also presents an overview of the applicable tax problems associated with the organization, operation, and distribution from and liquidation/dissolution of each type of entity. Prerequisite: ACC 311 Intermediate Accounting I and ACC 312 Intermediate Accounting II

ACC 620   Accounting Regulations: Research and Applications   (3 - 3 - 0)

Research skills are important for success in accounting, regardless of specific career path. This course focuses primarily on applied research done in practice, often in conjunction with the preparation or review of financial statements or tax returns. Applied accounting research typically involves qualitative skills, but the course also introduces academic accounting research. Students will acquire an understanding of different research skills in applying those skills to conduct research projects in accounting, auditing, and taxation. The course emphasizes communication and problem-solving while also extending the students' technical accounting knowledge and ability to apply accounting rules and regulations.

ACC 311   Intermediate Accounting I   (3 - 3 - 0)

The course is the first of a two-semester course of intensive study of accounting theory and its application. The course will focus on the accounting principles that shape the financial reporting practices followed by entities that prepare financial statements in accordance with generally accepted accounting principles (GAAP). After taking this course, students should be able to: - demonstrate an understanding of the conceptual framework of financial reporting; - apply steps in the financial reporting process (record transactions and prepare a trial balance) and prepare financial statements; - explain and apply time value of money concepts using present value and future value tables; and - demonstrate an in-depth understanding of specific assets and liabilities such as cash, receivables, inventories, property and equipment, intangibles, current liabilities, contingencies, and long-term liabilities. Prerequisite: BT 200 Financial Accounting

ACC 312   Intermediate Accounting II   (3 - 3 - 0)

This course is a continuation of ACCXXX Intermediate Accounting I. The primary objectives of this course are to advance your knowledge of GAAP applicable to specific topics, including: current liabilities, bonds and long-term notes, stockholders' equity, taxes, pensions, leases, derivatives, and the Statement of Cash Flows. Prerequisite: ACC 311 Intermediate Accounting I

ACC 555   Retirement and Estate Planning   (3 - 3 - 0)

This course introduces students to the principles of retirement and estate planning as well as current issues in these areas. The course is designed to enable students to understand and be conversant with the basic language of retirement and estate planning, and to understand the pertinent provisions of the US Internal Revenue Code related to these topics. The course focuses on training an individual's ability to use this information for making both short-term and long-term planning decisions. The course progresses at a rapid pace and requires students to prepare regularly for each class session instead of waiting until the exams. Topics include retirement planning tools, techniques and plans, estate and gift tax calculation and compliance, estate planning tools and techniques (both pre and post death), probate and non-testamentary disposition of assets, the use and purpose of trusts, family gifting strategies, estate liquidity, business succession planning, Social Security, Medicare and Medicaid and retirement plan distributions.

Business and Technology

BT 100   Principles of Management   (3 - 3 - 0)

This course designed to provide a foundation of knowledge on the subject of management, while moving you closer to being an effective manager yourself. We discuss the functions, tasks, and responsibilities of managers in modern organizations. And we will focus on how managers engage their resources to achieve their goals. As this in an introductory course, we will survey a broad range of topics relevant to management scholars and managers.

BT 181   Seminar in Business   (1 - 0 - 0)

This course will broadly address the issue of how management decisions are made in a corporate business environment. The focus will be on understanding the tools, people and processes that are used in large public companies to make major decisions. We will explore this in the context of the major decisions made by senior management, as opposed to day-to-day decision-making. As a survey course we will only highlight the theory and detailed mechanics of complex decision-making. Our focus will be to discuss the issues faced by executives in solving complex problems that require their attention and review the methods used by business executives to handle uncertainty, mitigate risk and create outcomes that address the needs of the business. Throughout the course we will examine the decision-making process from the perspective of different departments; marketing, sales, corporate planning, production, financing, etc.While many of the planning, financial and analytical tools are common, their application within different departments can and will vary. The course will consist of two components: 1. Lectures and reading on decision-making tools, methods and procedures. 2. Business case discussion on the application of decision-making tools to timely issues faced by leading corporations.

BT 200   Financial Accounting   (3 - 3 - 0)

This course deals with the methods and principles of financial accounting. It is concerned with the measurement of the results of business activities and with the preparation and use of financial reports such as the balance sheet and income statement. Topics include: the accounting cycle, principles of accrual accounting, the measurement and reporting of detailed balance sheet items and the analysis of financial reports. Ethical issues in accounting will be addressed.

BT 214   Marketing Analytics and Research   (3 - 3 - 0)

This course exposes students to the entire marketing research process, from the problem formulation stage(at the very beginning) to the research findings report(at the very end). This objective is achieved in two ways: in the classroom, where the approach is one of discussion, lecture, and in-class exercises; and in the real world, where students are required to work closely with an actual business client on a marketing research project concerning an actual product or service.(The instructor assists the students in securing a business client.) During the course, the topics covered include: the marketing research process and problem formulation , research design, primary data collection, data collection forms, attitude measurement, sampling procedures, sample size, collecting the data, data analysis interpretation of results, and the final research report. The course builds heavily on the statistical foundation laid down during the prerequisite BT221 Statistics. A statistical package (SPSS) will be used during the analysis stage of the research process. Prerequisites: BT 221 or QF 112

BT 215   Managerial Accounting   (3 - 3 - 0)

This course deals with the mothods and principles of managerial accounting. It is concerned with the use of accounting data by individuals within a business in order to enhance managerial decision-making and control. Topics include costs estimation, cash flow statements and financial statement analysis. Prerequisite: BT 200

BT 221   Statistics   (3 - 3 - 0)

This course provides students with an understanding of the use of statistical methods as applied to business problems, in general, and to marketing research applications in particular. Topics include: descriptive statistics; probability theory, discrete and continuous probability distributions; sampling theory and sampling distributions; interval estimation; hypothesis testing; statistical inference about means, proportions, and variances; tests of goodness-of-fit and independence; analysis of variance and experimental design; simple and multiple regression; correlation analysis.

BT 223   Applied Models and Simulation   (3 - 3 - 0)

This course covers contemporary decision support models of forecasting, optimization and simulation for business activity. Students learn how to identify the problem situation, choose the appropriate methods, collect the data and find the solution. Handling the information and generating of alternative decisions based on operations research optimization, statistical simulation and system dynamic forecasting. Computer simulations will be performed on PCs equipped by user-friendly graphical interface with multimedia reports generation for visualization and animation. Students will also be trained in business game simulations for group decision support.

BT 243   Macroeconomics   (3 - 3 - 0)

The forces which govern the overall performance of the national economy are covered. Areas discussed include the essence of the economic problem, supply and demand analysis, national income theory, the monetary system, alternative approaches to economic policy, current macroeconomic problems, and international economics.

BT 244   Microeconomics   (3 - 3 - 0)

The focus of this course is on the behavior of and interactions between individual participants in the economic system. In addition to providing a theoretical basis for the analysis of these economic questions, the course also develops applications of these theories to a number of current problems. Topics include: the nature of economic decisions, the theory of market processes, models of imperfect competition, public policy towards competition, the allocation of factors of production, discrimination, poverty and earnings, and energy.

BT 290   Business Career Semimar   (1 - 0 - 0)

This seminar is a no-credit, pass-fail course designed to provide sophomore students in their fall semester with tools, resources and support to start their job search and manage their careers. Each week, students will learn about a different aspect of strategic career planning and get practice applying lessons learned to their own future careers. Students will also get some exposure to the underlying theory of strategic career planning - e.g., motivational, network, and job satisfaction theories - as well as to major research findings.

BT 301   Introduction to Strategy   (3 - 3 - 0)

Students learn how to set preliminary goals, objectives, and strategies. They begin to develop the specific aspects of their business plan, including an actual sales/revenue plan. Topics covered also include preparing an research and development plan and the use of historical information to prepare sales, revenues, and marketing expense estimates. Students work independently and in class, individually and in teams.

BT 310   Programming for Mobile Applications   (3 - 3 - 0)

This course will introduce application development for mobile devices using the MIT App Inventor. In addition, we will examine the basic operation of a mobile wireless network with the focus of understanding the limitations of programming in a mobile environment. The course will also examine best practices for mobile application design. If we are able to cover all planned topics in mobile app development, we will also introduce Internet web-site design. Prerequisites: One semester programming course

BT 321   Corporate Finance   (3 - 3 - 0)

This course will focus on the appropriate capital structure for a corporation. Topics covered include financial statement analysis, time value of money, valuation of financial instruments, risk and reward, capital structures, the capital asset pricing model and cash management. Prerequisite: BT 200

BT 325   Financial Statement Analysis   (3 - 3 - 0)

This course will review how firms communicate through financial statements. It discusses how accounting regulations and managerial discretion influence financial statements. The course will cover how to use financial statement analysis as an integral part of the strategic analysis of firms. The course will focus on how to interpret financial statements, analyze cash flows and make judgments about earnings quality. Prerequisites: BT 200 , BT 321

BT 330   Social Psychology and Organizational Behavior   (3 - 3 - 0)

Using an applied and experiential format, this course exposes students to theory, methods and research in organizational behavior and social psychology. Topics relating to individual differences and group dynamics in organizational settings are stressed. Learning occurs through discussion, group activities, and the completion of assessment instruments. Emphasis is on helping students understand and improve their skills in key areas, including decision-making, leadership, negotiation, and conflict resolution.

BT 333   Database Management   (3 - 3 - 0)

The course addresses the application of relational databases to solve business problems. It focuses on relational database model, multi-table query languages, file and index organization and integrity. Advanced topics include calculations in creating professional and useful reports, pivot tables and charts for data mining, database maintenance and the customization of a database with programming languages. Upon completion of this course students will be able to design, implement and maintain a relational database. Prerequisite: MIS 201

BT 343 — Intermediate Macroeconomic Theory (3 - 3 - 0)

This is an intermediate macroeconomics course designed with the goal of providing a deeper understanding of current events, macroeconomic theory and economic policy. The course will cover long-run economic performance and its determinants, as well as short-run dynamics and economic fluctuations. This distinction should allow students to comprehend the implications of public policies that have a persistent impact on the economy, such as those that address growth, structural unemployment, inflation and government debt, from the monetary and fiscal policies that have a more immediate effect on economic outcomes. The role of central banks, governments, financial institutions, and globalization will also be addressed. Throughout the course, examples of the real world will be considered and the final part of the course will address recent issues in the macroeconomic debate. Prerequisite: BT243

BT 344 — Intermediate Microeconomic Theory (3 - 3 - 0)

This is a course in intermediate microeconomics designed with the goal of providing students with a deeper understanding of economic analysis. It broadly involves the study of consumer and firm behavior starting from the standard perfect competiton paradigm and introducing models of imperfect competition. Throughout the course, formal models will be motivated and discussed. The theory will be accompanied by the study of real world applications, as well as considering economic policies targeted at specific industries or sectors. Prerequisite: BT244

BT 350 — Marketing (3 - 3 - 0)

The purpose of this course is to provide the conceptual frameworks and decision tools required for the success in both technology-based and non-technology-based markets: the student learns to define and select specific customer segments; to monitor the business environment for both opportunities and threats, with particular attention to the ever changing technological and global context; and to develop marketing strategies for serving each targeted customer segment profitably. Although this course introduces the student to the basic theory and analytical methods characterizing modern marketing practice, there is an emphasis on both the marketing of technology products/services as well as the impact of technology on the general practice of marketing. Students are required to present both detailed marketing plans and several rigorous case analyses.

BT 353 — Project Management (3 - 3 - 0)

This course will describe the problems of managing a project within a permanent organization for the purpose of achieving a specific objective. It will broadly cover the operational and conceptual issues faced by modern project managers. At the end of this course, students should be able to develop, execute, and control a basic project plan capable of supporting business objectives linked to measures of success for a single project.

BT 360 — International Business (3 - 3 - 0)

The International Business course focuses on the impact of variation in the economic, political, legal, social, and cultural contexts of nations on the competitive business strategies of local and multinational firms.

BT 372 — Entrepreneurship (3 - 3 - 0)

Students are confronted with the challenges, problems and issues faced by inventors who seek to transform their inventions into economic viable innovations. This integrative course develops the fundamental business skills necessary to identify, evaluate, develop and exploit business opportunities.

BT 401 — Should be Advanced Strategy (3 - 3 - 0)

Students learn how to use their business plan, deal with problems encountered, update, and get funding. They are exposed to the issues of law, ethics, and negotiation as applied to business implementation. Students are required to make their first full-plan presentation to peers and faculty. Topics include type of capital and alternative sources, venture capital, and building the organizational infrastructure for plan support. Prerequisite: BT301

BT 403 — Marketing Strategy in a Digital World (3 - 3 - 0)

Marketing Strategy in a Digital World is a course designed to give Marketing students an intensive and application-oriented look at how marketing strategy works in the real world. The emphasis of the case is going to be on cases, analysis, real life examples, and presentations. Prerequisite: BT 350

BT 411   Senior Design I   (3 - 2 - 2)

BT411 is divided into two segments. The first segment involves working in teams on a pre-defined problem; working through one full cycle of Lean Business Processes. For the second segment, armed with this stem-to-stern experience, students then plan and focus on work for a client's business. Teams form into project teams, propose a project for approval, submit a project plan, work though several cycles of each stage of Lean Business development, to test, refine, and build a sustainable program to help your client's business.

BT 412   Senior Design II   (3 - 2 - 2)

BT 412 is the second of a two-semester sequence. In this course students focus on refining their business models and consulting plans, especially by clarifying their diagnoses and hypotheses, systematically testing assumptions, prototyping and testing solutions, and working to execute their recommendations. Teams will present their final 'product' (business model & prototype, consulting analysis & solution) to their client and to the School of Business community. Prerequisite: BT 411

BT 413   Business Law   (3 - 3 - 0)

The course introduces students to the fundamental concepts and legal principles that they can expect to encounter in various roles as managers/professionals in public and private companies, consultants and/or entrepreneurs, together with the ethical criteria, moral values and social norms in the environments they will face. The course will cover the American judicial system, international law in a global economy, ethics and business decision making, and different forms of business structure, contracts, business torts, products liability, insurance, employment law, criminal law and the recent Dodd-Frank Wall Street Reform & Consumer Protection Act.

BT 416   Business Process Management   (4 - 4 - 0)

The course addresses the methods and techniques required to analyze, design, implement, automate, and evaluate business processes. Structured along the phases of the Business Process Management (BPM) life cycle, students learn to analyze organizational performance from a process perspective, redesign processes using value-focused techniques, design workflows and implement them in BPM systems, simulate new process designs, and create process analytics applications using dashboards. The course leads students from process discovery through conceptual and technical process design through the implementation and management of workflows to the structure of process-aware information systems. Upon completion of this course students will be able to assess the efficiency and effectiveness of an organization from a process perspective, conduct process improvement projects, and determine the role of technology in supporting corporate processes. Prerequisite: MIS 201

BT 419   Entrepreneurship Practicum   (3 - 3 - 0)

This capstone course within the Entrepreneurship minor is designed to develop the content and presentation of the technical and business elements of students' entrepreneurial business plans. Starting with the technical aspects of the design project, students are led through the components of a complete business plan, with instruction and practice in the writing and presentation of the plan. As a capstone exercise, students complete the course by presenting their business plans in an 'Elevator Pitch' event at which venture capitalists and other investors rate the quality of student presentations and entrepreneurial business ideas. Prerequisite: BT 372 or MGT 472

BT 421   Systems Analysis and Design   (3 - 3 - 0)

This course focuses on the analysis and development of systems to meet the increasing need for information within organizations. It presents and analyzes various topics such as systems development life cycle, analysis and design techniques, information systems planning and project identification and selection, requirements collection and structuring, process modeling, data modeling, design of interface and data management, system implementation and operation, system maintenance, and change management implications of systems.

BT 422   Decision Making   (3 - 3 - 0)

The objective is to acquaint you with the research and principles of judgment and decision making. Most of the material covered is about understanding and improving the judgment and decision making processes of managers and other professionals. Understanding decision making involves examining how decision makers think about difficult problems and characterizing the limitations of human decision making ability. By understanding how decisions are made, we can provide guidelines and techniques for overcoming limitations and improving the quality of decision making. This includes understanding statistically-based decision making, the psychological aspects of decision making and rational approaches to decision making. The course's goal is to provide insights and tools that will enable you to support and improve your own decision making, to understand the decision making of others, and to enhance the decision quality of team and groups that you lead.

BT 425 Portfolio Management (3 - 3 - 0)

An introduction to the investment management process emphasizing measuring and managing investment risk and return. Topics will include investment objectives and constraints, modern portfolio theory, CAPM, efficient markets, stock and bond valuation models, performance evaluation, futures and options. Cross-listed with: BT321

BT 426 Equity Valuation (3 - 3 - 0)

This is an advanced course that is designed to provide you with a comprehensive perspective of how financial theory is applied to valuation problems. The tools and techniques that will form the foundation of the course can be applied to a broad range of valuation topics that extend beyond securities (or public equities) and will encompass pricing for: private enterprise valuation and term sheets; intellectual property rights and patents; marketing and distribution agreements; commercial real estate leases; licensing agreements; options and insurance contracts. The course will center on intrinsic enterprise or project evaluation and will build upon the concepts introduced in the basic Corporate Finance course. Cross-listed with: BT321

BT 435 Social Media and Network Analysis (3 - 3 - 0)

Recently, the advent of electronically mediated social networks has transformed the way we interact in government, educational, and business institutions. A set of social network analysis methods, with roots in sociology, graph theory, and computer science, can help us make sense of this complicated phenomenon. This course will provide a basic understanding of electronically mediated social networks in the context of the management discipline of marketing. In order to provide this understanding, we will survey ideas that have surfaced in, management, psychology, computer science, and sociology. By the end of the course, students will be capable of understanding electronically mediated social networks: the way they form, the way they grow, and the way they are applied in business. Students will be capable of analyzing existing networks, and will also be able to build new networks. That is, there will be labs in which tools and techniques for both understanding and designing electronically mediated social networks will be explained and used. Students will also be asked to actively participate in creating a part of an electronically mediated social network: working in teams, they will attempt to create ideas or applications that will go viral: they will attempt to create an information cascade. Prerequisite: BT350

BT 440 Money, Banking and Financial Institutions (3 - 3 - 0)

This course explores the economics of banking and financial markets. Topics to be discussed include: an overview of finanical markets and institutions, the theory of interest rates, rational expectations theory, the Efficient Market Hypothesis, the roles, functions, and structures of financial institutions, the U.S. banking industry, and central banking and the conduct of monetary policy. Prerequisite: BT 321

BT 442 Fixed Income Analysis (3 - 3 - 0)

The aim of this course is to provide you with an introduction to the valuation of fixed income securities and the management of fixed income investment portfolios. We will start with the basics of bond pricing - the relationship between the price of a bond, measures of return on the bond and measures of risk. Next, we will discuss the credit rick assessment and bond issuance process from a market practitioner perspective. The tools for the valuation of bonds, fixed income derivatives and credit derivatives will be the focus of the third segment of the course. Prerequisites: BT 321, BT 440

BT 445 Virtual and Physical Consumer Behavior (3 - 3 - 0)

Marketing begins and ends with the consumer. The purpose of this course is to introduce students to the study of consumer behavior. This is an interdisciplinary course that integrates perspectives from marketing, psychology, sociology, anthropology, and economics in order to examine the elements of the consumer decision-making process and to enable formulation of marketing strategies. Students will take the perspective of a marketing manager who needs knowledge of consumer behavior in order to develop, evaluate and implement effective marketing strategies. The course integrates lectures, case analysis, and discussions to focus on the implications of social science concepts for marketing strategy. Prerequisite: BT350

BT 447 Creativity and Innovation (3 - 3 - 0)

This course is about creativity and innovation, which are now the main sources of competitive advantage in many industires. Many firms now rely on products developed within the prior three to five years for a large portion of their revenues and profits. In this course, we will explore such key topics as the industry dynamics of technological innovation, the formualtion of technological innovation strategy, and the implementaion of technological innovation strategy. We will strive to go beyond simply learining concepts, although understanding major concepts is of critical improtance to hte management of technology and innovation. Throughout the course, key conceptual frameworks will be linked to applications in a variety of organizational inad industrial settings.

BT 450   Global Management Seminar   (3 - 3 - 0)

This seminar will examine the processes of globalization for multi-national companies and why they seek markets in other countries. US and foreign countries cultural, labor and management issues will be compared. How management practices transfer across cultures will also be examined. Includes visits to overseas companies as part of a field study experience.

BT 454   International Economics and Finance   (3 - 3 - 0)

"This course applies principles of economics and finance to the international setting. The first half of the course deals with microeconomic and macroeconomic issues of international trade and covers such issues as (i) why countries trade, (ii) the theory and practice of trade policy including multilateral trade liberalization within the WTO and regional economic integration, (iii) exchange rates. The second half of the course teaches students how to be effective global financial managers. To achieve this goal, the course focuses on important topics that include the fundamentals of the macroeconomic environment of international financial management, the financial environment in which the multinational firm and its managers must function, and foreign exchange management and financial management in a multinational firm." Prerequisites: BT 243 or BT 244, and BT 321

BT 465   Integrated Marketing Communications   (3 - 3 - 0)

This course will give students an insightful overview of the practice and power of public relations, and its role in the marketing mix. No longer an industry relegated to sending out press releases as a means to communicate, this course will help students understand the power of communication across all genres, and appreciate the role of communication/reputation management in all aspects of business. From corporate earnings announcements to employee relations and philanthropic endeavors, this course will relay the basic elements for this effective tool. This course, taught by a practicing professional, will give an overview of outside PR counsel; internal PR departments; and how to manage the specialty function.

BT 499   Independent Study   (1 to 3 - -)

Independent study allows the student to participate in research, explore a topic not covered by existing courses, or continue to study in greater depth a topic introduced by a course. Independent study courses must be conducted under the guidance of a full time faculty member, whose approval is required prior to enrollment. The student and faculty member must agree on the scope and details of participation in advance. The Associate Dean of the Undergraduate Enterprise must also give approval before the enrollment of the student. Independent Study courses carry one to three credits.

Business Intelligence and Analytics

BIA 600   Business Analytics: Data, Models & Decisions   (3 - 3 - 0)

Many managerial decisions—regardless of their functional orientation—are increasingly based on analysis using *quantitative* models from the discipline of management science. Management science tools, techniques and concepts (e.g., data, models, and software programs) have dramatically changed the way businesses operate in manufacturing, service operations, marketing, transportation, and finance. Business Analytics explores data-driven methods that are used to analyze and solve complex business problems. Students will acquire analytical skills in building, applying and evaluating various models with hands-on computer applications. Topics include descriptive statistics, time-series analysis, regression models, decision analysis, Monte Carlo simulation, and optimization models.

BIA 610   Applied Analytics   (3 - 3 - 0)

Applied Analytics is a capstone course for the analytic-focused MBA program. It is intended to integrate all previously taken coursed in the program by presenting a set of increasingly complex business problems. These problems can be solved through analytic skill taught in this and previous courses. In particular, the course is intended to reinforce the understanding of analysis as way to build models that can focus attention on parts of the system that can be improved through intervention. The early part of the course uses synthetic data and empirical data readily available for analysis. The second part of the course encourages students to state and solve their own problem, gathering their own data as a part of the analytic process.

BIA 650   Optimization and Process Analytics   (3 - 3 - 0)

This course covers basic concepts in optimization and heuristic search with an emphasis on process improvement and optimization. This course emphasizes the application of mathematical optimization models over the underlying mathematics of their algorithms. While the skills developed in this course can be applied to a very broad range of business problems, the practice examples and student exercises will focus on the following areas: healthcare, logistics and supply chain optimization, capital budgeting, asset management, portfolio analysis. Most of the student exercises will involve the use of Microsoft Excel's "Solver" add-on package for mathematical optimization.

BIA 652   Multivariate Data Analysis I   (3 - 3 - 0)

This course introduces basic methods underlying multivariate analysis through computer applications using R, which is used by many data scientists and is an attractive environment for learning multivariate analysis. Students will master multivariate analysis techniques, including principal components analysis, factor analysis, structural equation modeling, multidimensional scaling, correspondence analysis, cluster analysis, multivariate analysis of variance, discriminant function analysis, logistic regression, as well as other methods used for dimension reduction, pattern recognition, classification, and forecasting. Students will build expertise in applying these techniques to real data through class exercises and a project, and learn how to visualize data and present results. This proficiency will enable students to become sophisticated data analysts, and to help make more informed design, marketing, and business decisions. Prerequisite is MGT 620 or equivalent; basic knowledge of descriptive and inferential statistics is expected.

BIA 654   Experimental Design II   (3 - 3 - 0)

This course introduces basic methods underlying multivariate analysis through computer applications using R, which is used by many data scientists and is an attractive environment for learning multivariate analysis. Students will master multivariate analysis techniques, including principal components analysis, factor analysis, structural equation modeling, multidimensional scaling, correspondence analysis, cluster analysis, multivariate analysis of variance, discriminant function analysis, logistic regression, as well as other methods used for dimension reduction, pattern recognition, classification, and forecasting. Students will build expertise in applying these techniques to real data through class exercises and a project, and learn how to visualize data and present results. This proficiency will enable students to become sophisticated data analysts, and to help make more informed design, marketing, and business decisions. Prerequisite is MGT 620 or equivalent; basic knowledge of descriptive and inferential statistics is expected.

BIA 656   Advanced Data Analytics & Machine Learning   (3 - 3 - 0)

The significant amount of corporate information available requires a systematic and analytical approach to select the most important information and anticipate major events. Statistical learning algorithms facilitate this process understanding, modeling and forecasting the behavior of major corporate variables. This course introduces time series and statistical and graphical models used for inference and prediction. The emphasis of the course is in the learning capability of the algorithms and their application to finance, direct marketing, operations, and biomedicine. Students should have a basic knowledge of probability theory, and linear algebra.

BIA 658   Social Network Analysis   (3 - 3 - 0)

This course introduces concepts and theories of social networks as well as techniques to conduct marketing research from a network perspective. Network concepts covered include graph-theoretic fundamentals, centrality, cohesion, affiliations, equivalence, and roles. Network theories covered include embeddedness, social capital, homophily, and models of network growth. Design issues will also be covered, including data sampling and hypothesis testing. Another focus of this course is on marketing applications of social network analysis, in particular the use of knowledge about network properties and behavior, such as hubs and paths, the robustness of the network, and information cascades, to better broadcast products and search targets. Application areas include customer profiling, community detection, targeting, sentiment analysis, and development of recommendation systems. Prerequisites are BIA 652, BIA 654, MIS 637, and BIA 656. Knowledge and skills learned in these required courses (e.g., R, python, machine learning) are applied to social network analysis.

BIA 660   Web Mining   (3 - 3 - 0)

In this course, students will learn through hands-on experience how to extract data from the web and analyze web-scale data using distributed computing. Students will learn different analysis methods that are widely used across the range of internet companies, from start-ups to online giants like Amazon or Google. At the end of the course, students will apply these methods to answer real scientific question or to create a useful web application. Prerequisites: BIA 652, MIS 637, BIA 656

BIA 662   Cognitive Computing   (3 - 3 - 0)

This course explores the area of cognitive computing and its implications for today's big data analytics and evidence-based decision making. Topics covered as part of this seminar include: cognitive computing design principles,natural language processing,knowledge representation,advanced analytics,as well as IBM's Watson DeepQA and Google's TensorFlow deep learning architectures. Students will have an opportunity to build cognitive a as well as explore how knowledge-based artificial intelligence and deep learning are the field of data science. This course is open to students in Business Intelligence and Analytics, Information Systems, and Masters of Business Administration, or with the permission of the instructor.

BIA 670   Risk Management & Simulation   (3 - 3 - 0)

Theoretical and practical aspects of risk assessment and management will be covered. Major topics include: Importance of innovation and technological changes in current competitive environment, risk and uncertainty, decision trees, binomial methods and derivation of Black-Scholes option pricing formula, extension of option methodology to non-financial (real) options, VAR (value at risk), a framework of risk assessment, and several real-world case studies. The course is designed for all students in the School of Technology Management. Prerequisites: TM 605 or CS 505, TM 500

BIA 672   Marketing Analytics   (3 - 3 - 0)

In this course, students will learn about marketing analytics techniques such as segmentation, positioning, and forecasting, which form the cornerstone of marketing strategy in the industry. Students will work on cases and data from real companies, analyze the data, and learn to present their conclusions and make strategic recommendations. Prerequisite: BIA 656

BIA 674   Supply Chain Analytics   (3 - 3 - 0)

Supply chain analytics is one of the fastest growing business intelligence application areas. Important element in Supply Chain Management is to have timely access to trends and metrics across key performance indicators, while recent advances in information and communication technologies have contributed to the rapid increase of data-driven decision making. The topics covered will be divided into strategic and supply chain design and operations, including -among others- supplier analytics, capacity planning, demand-supply matching, sales and operations planning, location analysis and network management, inventory management and sourcing. The primary goal of the course is to familiarize the students with tactical and strategic issues surrounding the design and operation of supply chains, to develop supply chain analytical skills for solving real life problems, and to teach students a wide range of methods and tools -in the areas of predictive, descriptive and prescriptive analytics- to efficiently manage demand and supply networks.

BIA 676   Data Streams Analytics: Internet of Things   (3 - 3 - 0)

In recent years, the progress in sensor technologies, RFID (Radio Frequency Identification) tags, smart phones and other smart devices has made it possible to measure, record, and report large streams of transactional data in real time. Such data sets, which continuously and rapidly grow over time, are referred to as Big Data Streams. Analysis of streaming data poses a number of unique challenges which are not easily solved through direct applications of well-known data mining methods and algorithms developed for traditional static data. This course will serve as a first course on the emerging field of "Data Streams Analytics". It will provide an introduction to IoT, sensors & devices, the architecture and environment in which these devices generate data streams, the data quality & data cleaning, data acquisition, and emerging methodologies and algorithms for knowledge discovery from data streams. Topics include: synopsis & sampling techniques, sliding windows, computing the entropy in streams, data streams correlations, change detection, outliers & anomaly detection.

BIA 678   Big Data Technologies Seminar   (3 - 0 - 0)

The field of Big Data is emerging as one of the transformative business processes of recent times. It utilizes classic techniques from business intelligence & analysis (BI&A), along with a new tools and processes to deal with the volume, velocity, and variety associate with big data. As they enter the workforce, a significant percentage of BIA students will be directly involved with big data as technologists, managers, or users. This course will build on their understanding of the basic concepts of BI&A to provide them with the background to succeed in the evolving data-centric world, not only from the point of view of the technologies required, but also in terms of management, governance, and organization.

BIA 680   Applied Analytics/Life Sciences   (3 - 3 - 0)

The capstone course brings together the key elements of the business intelligence and analytics curriculum. Students have an opportunity to apply the concepts, principles, and methods they have learned to real problems in an application domain associated with their area of interest. At the end of the course, students present their projects in a poster session for review by industry practitioners in pharmaceutical and life sciences.

BIA 686   Practicum in Analytics   (3 - 3 - 0)

Business intelligence and analytics is key to enabling successful competition in today's world of "big data". This course focuses on helping students to not only understand how best to leverage business intelligence and analytics to become more effective decision makers, making smarter decisions and generating better results for their organizations. Students have an opportunity to apply the concepts, principles, and methods associated with four areas of analytics (text, descriptive, predictive, and prescriptive) to real problems in an application domain associated with their area of interest.

BIA 702   Curricular Practical Training   (1 to 3 - 0 - 0)

This course involves an educationally relevant, practical assignment that augments the academic content of the student's program. Students engage in a project in a company project related to the focus of their academic program. The project is conducted under the supervision of a faculty advisor and an industry mentor. During the semester, the student must submit written progress reports and at the end of the semester, a detailed written report that describes his/her activities and knowledge gained during that semester. This is a one-credit course that may be repeated up to a total of three credits.

Data Science

DS 801   Special Problems in Data Science (PhD)   (1 to 6 - -)

With permission of the instructor. Limit of six credits for the degree of Doctor of Philosophy.

Finance

FIN 510   Financial Statement Analysis   (3 - 3 - 0)

This course deals with (1) interpretation of financial statements, (2) evaluation of the alignment between business strategies and financial performance, (3) identification of potential business risks, and (4) comparison of performance of different companies. The course introduces business analysis and valuation techniques and utilizes real world data to help students comprehend financial statement analysis tools. Topics covers financial statement information, tools of financial statement analysis, and forecasting and valuation techniqes.

FIN 526   Private Equity and Venture Capital   (3 - 3 - 0)

This course addresses the fundamentals of venture capital, which includes the venture capital industry, the structure of venture capital firms and venture capital investments. It addresses in some detail the relationship between venture risk and return, the cost of venture capital and the valuation of high growth companies. The course covers a variety of valuation methods as well as analysis of company capital structure or "cap tables".

FIN 550   Financial Planning and Risk Management   (3 - 3 - 0)

This course will review the fundamental principles of financial planning, professional conduct, education planning, risk management and regulation. The course is aligned with the principle knowledge topics evaluated on the CFP® Certification Examination. The course introduces you to the financial planning process and teaches you how to work with clients to set goals and assess risk tolerance. Learn how to process and analyze information, construct personal financial statements, develop debt management plans, recommend financing strategies, and understand the basic components of a written comprehensive financial plan. The course also covers the regulatory environment, time value of money, and economic concepts.

FIN 560   Federal Taxation of Individuals   (3 - 3 - 0)

This course will review the fundamental principles of financial planning, professional conduct, education planning, risk management and regulation. The course is aligned with the principle knowledge topics evaluated on the CFP® Certification Examination. The course introduces you to the financial planning process and teaches you how to work with clients to set goals and assess risk tolerance. Learn how to process and analyze information, construct personal financial statements, develop debt management plans, recommend financing strategies, and understand the basic components of a written comprehensive financial plan. The course also covers the regulatory environment, time value of money, and economic concepts.

FIN 565   Financial Plan Development   (3 - 3 - 0)

This course integrates the different aspects of the financial planning process and demonstrates how to apply this knowledge to the development of a comprehensive financial plan. Students learn how to solve the main problems related to the financial planning process: cash management, debt management, taxation, insurance, retirement, investment, portfolio optimization, and estate planning. At the end of the course, students should be able to construct a plan according to the CFP Board's Financial Planning Practice Standards and client objectives. The course is appropriate for students who want to become financial planners and especially for those that plan to take the CFP® Certification Examination. Prerequisites: FIN 550, ACC 555, FIN 560

FIN 600   Financial and Managerial Accounting   (3 - 3 - 0)

This course will develop accounting analysis useful for managerial decision-making purposes. Topics will include an introduction to elements of financial accounting, cost-profit-volume analysis, manufacturing costs and elements of cost accounting, special decision analysis, budgeting, variances, and controllability and responsibility accounting.

FIN 615   Financial Decision Making   (3 - 3 - 0)

Corporate financial management requires the ability to understand the past performance of the firm in accounting terms; while also being able to project the future economic consequences of the firm in financial terms. This course provides the requisite survey of accounting and finance methods and principles to allow technical executives to make effective decisions that maximize shareholder value.

FIN 620   Financial Econometrics   (3 - 3 - 0)

This course introduces the main concepts of data analysis and econometrics applied to financial problems. The course explores data analysis techniques; time series models; multivariate, factor and Bayesian models applied to high frequency trading, volatility forecast, risk management, portfolio optimization, and asset pricing. Students will work with historical databases, conduct their own analysis, and test trading and/or investment strategies based on the techniques reviewed during the class. Prerequisite: BIA 652 or MGT 700

FIN 623   Financial Management   (3 - 3 - 0)

This course covers the fundamental principles of finance. The primary concepts covered include the time value of money, principles of valuation and risk. Specific applications include the valuation of debt and equity securities as well as capital budgeting analysis, financial manager's functions, liquidity vs. profitability, financial planning, capital budgeting, management of long term funds, money and capital markets, debt and equity, management of assets, cash and accounts receivable, inventory and fixed assets. Additional topics include derivative markets. Prerequisites: MGT 600 or MGT 615 or FIN 615

FIN 625   Capital Markets   (3 - 0 - 0)

This course is designed to familiarize the student with the current workings of the capital markets. This course describes fundamental analytical techniques and state-of-the-art financial instruments. It begins with the time value of money and progresses to bond mathematics, portfolio management, and derivatives. The role of information technology is emphasized in both the development and delivery of financial instruments. Students will learn to structure IT applications to meet the needs of a trader or broker. Topics include the time value of money, bond math, the yield curve, analytical tools, trading and investment strategies, money market instruments and repurchase agreements, corporate bonds, macroeconomic dynamics, derivatives, securitization, equities, and the role of IT in capital markets Prerequisites: MGT 600

FIN 627   Investment Management   (3 - 3 - 0)

This course takes a practical approach to managing investments. It covers a wide variety of investment vehicles ranging from pure equity and debt offerings to complex derivatives and options. Various investment strategies are presented which are focused on the different fundamental approaches and tactics used by leading investors to achieve their financial goals. The course also focuses on investment styles, including momentum, growth, income, distressed, asset allocation, and vulture investing, to name just a few. Students participate in real time simulation experiences to create viable portfolios of stocks, bonds and other investments; while tracking their performance against the overall market and the class on a weekly basis throughout the course. Prerequisites: MGT 623

FIN 628   Derivatives   (3 - 0 - 0)

This course covers the fundamentals of financial derivatives, including the basic properties and the pricing of futures, options and swaps. It also explores trading and hedging strategies involving financial derivatives. Special topics, such as exotic options and credit derivatives, are explored. The course provides the foundation of financial derivatives and lays the ground for a rigorous risk management course and other advanced quantitative courses, such as stochastic finance.

FIN 629   Fixed Income   (3 - 0 - 0)

This is an intermediate/advanced level course that addresses money flows and the cost of credit for major money market institutions, including banks, bank holding companies and the "shadow banking" system. It entails a broad survey of the structure and financial condition of the banking industry. The course provides a theoretical and practical understanding of why these markets exist, who the key players are; how the markets work, the rules governing their operation and how they are evolving. We will spend considerable time in discussing regulation of the financial markets and financial services industry.

FIN 638　　　Corporate Finance　　　(3 - 3 - 0)

"This course serves as a second semester sequence in corporate finance. Students enrolling should have a mastery of the topics of covered in Managerial Finance I (EMT 623), including time value of money, capital budgeting, risk adjusted hurdle rates, managerial accounting, and ratio analysis. Among the topics covered in EMT 723 are: leverage on the balance sheet and weighted average cost of capital; bankruptcy, turnarounds, and recapitalizations; international currency hedging; stock options; private equity valuation; mergers and acquisitions; and the issuance of public and private securities." Cross-listed with: EMT 638 Prerequisites: BT 221, MGT 600, and MGT 623

FIN 681　　　Financial Service Industry Trends and Issues　　　(3 - 3 - 0)

This course concentrates on IT trends and issues in the financial services industry. Due to the diversity of this industry (banking, brokerage, and insurance), along with the assortment of customer characteristics (i.e. retail vs. institutional), we will modularize the lectures by industry and customer partitions. This segregation will provide for a better understanding of this ever-changing industry. Upon successful completion of this course, students will have a solid understanding of the industry, market dynamics, and how their roles in technology have an immense impact in the industry. This course will cover the structure and functioning of financial services, from the perspective of banking, insurance, capital markets, and brokerage. Topics include industry consolidation and globalization, investment banking, fixed-income markets, the equity markets, the regulatory environment, and financial analysis approaches. Trends in IT and its effect on each of these areas will be discussed.

FIN 683　　　Financial Services Industry Back Office　　　(3 - 3 - 0)

This course is designed to provide the student with an in-depth understanding of the back-office trade process and the role of information technology (IT) in this process, with the goal of helping the student to be an effective provider of information system development and operations in this arena. The various phases of the trade process will be described, including key regulatory requirements. The current contributions of IT to the process will be reviewed, including straight-through processing, T+1 and foreign exchange trades. Topics include the structure and vocabulary of a trade and trade processing, the street-side view of a process flow, global processing, regulatory and compliance, back-office best practices, improving efficiencies and real-time processing.

FIN 684　　　Financial Services Industry Marketing and Sales　　　(3 - 3 - 0)

This course concentrates on effective selling and marketing IT strategies in the financial services industry. Due to the diversity of this industry (banking, brokerage, and insurance), along with the multiplicity of customer characteristic (retail vs. institutional), we will modularize the lectures by industry and customer partitions. This segregation will provide for a better understanding of this ever-changing industry. Upon successful completion of this program, students will identify client constituent's product needs and the ability for financial services companies to deliver this product (service) in a timely, cost-effective fashion. Corporate branding and marketing strategies will be reviewed and challenged by the student. Topics include the "sell-side", the "buy-side", the selling distribution process, e-business selling strategies, marketing strategies and corporate bonding, the role of data warehousing and sales data mining, and partnership with the client.

FIN 702　　　Curricular Practical Training　　　(1 to 3 - 0 - 0)

This course involves an educationally relevant, practical assignment that augments the academic content of the student's program. Students engage in a project in a company project related to the focus of their academic program. The project is conducted under the supervision of a faculty advisor and an industry mentor. During the semester, the student must submit written progress reports and at the end of the semester, a detailed written report that describes his/her activities and knowledge gained during that semester. This is a one-credit course that may be repeated up to a total of three credits. With approval of the Program Director and faculty supervisor, students may also take this course for up to three credits in one semester.

FIN 705　　　Asset Pricing Theory and Applications　　　(3 - 3 - 0)

This course is a review of asset pricing theory, with an emphasis on discount-factor models and generalized method of moments (GMM) procedure. The discount factor, as a unifying framework, calculates prices of stocks, bonds and options in terms of price-dividend ratios, expected return-beta representations, returns, moment conditions, continuous versus discrete-time implication, etc. The topics presented in the course provide a rigorous grounding in key aspects of the field of asset pricing that allows the student to conduct academic research in topics related to portfolio optimization, investment or risk management, among others. At the same time, the student will gain an appreciation of the common foundation of the topics presented.

FIN 708   Corporate Finance Theory and Applications   (3 - 3 - 0)

This course is designed to provide Ph.D. students of the Business Administration track (and also some other disciplines) with a rigorous foundation in modern corporate finance theory. This PhD course considers a number of topics that are at the center of ongoing research in contract theory/corporate finance. FIN 800A provides an introduction to Contract Theory (and in particular its contributions to Corporate Finance) and considers the main theoretical contributions to Corporate Finance. The class material will be divided in three parts: (i) Fundamentals of Contract Theory; (ii) The Theory of Corporate Finance and (iii) Empirical Topics on Corporate Finance. This is mostly a research-oriented course. I expect students to come up with new ideas and are able to put these ideas into models and test them empirically.

FIN 730   Seminar in Information Economics   (3 - 3 - 0)

Information economics studies economic interactions where imperfect or asymmetric information impacts behavior of people and organizations. Methods of information economics help explain observed phenomenon and are used to guide design of economic mechanisms, institutions, organizations, and government policies. Applications span corporate finance, banking, accounting, marketing, strategy, and healthcare among others. The course discusses the tools of information economics and game theory that form the building blocks for most theoretical research in social sciences and surveys research articles exemplifying applications in finance and various other fields. Students gain an appreciation of how information economics shapes business world, acquire ability to understand and critique theoretical research models, and develop a toolkit to model their research insights.

FIN 800   Special Problems in Finance (MS)   (1 to 6 - -)

With permission of the instructor. Limit of six credits for the degree of Master of Science.

FIN 801   Special Problems in Finance (PHD)   (1 to 6 - -)

With permission of the instructor. Limit of six credits for the degree of Doctor of Philosophy.

FIN 810   Special Topics in Finance   (3 - -)

A participating seminar on topics of current interest and importance in Management of Finance.

FIN 900   Thesis in Finance (MS)   (1 to 12 - -)

For the degree of Master of Science. Hours and credits to be arranged.

Financial Engineering

FE 505   Financial Lab: Technical Writing in Finance   (1 - 0 - 1)

This course teaches financial engineers how to write well-constructed, persuasive technical papers, and how to make oral presentations more effectively. It uses practical examples, in-class assignments, and homework exercises. This course reduces the anxiety that is frequently associated with technical writing and speaking. It emphasizes the collaborative aspects of the technical writing and revision process. It teaches the use of the LaTeX typesetting system for preparing technical manuscripts and presentations. In addition, the course teaches students how to present their work to both technical and not-technical audiences by creating cogent, striking, and well-designed figures and presentation slides.

FE 511   Introduction to Bloomberg and Thomson Reuters   (1 - 0 - 1)

This course is designed to teach students the nature and availability of the financial data available at Stevens. The focus of the course will be on equity, futures, FX, options, swaps, CDS's, interest rate swaps etc. They will learn to how use a Bloomberg terminal. As part of the course the students will be certified in the 4 areas that Bloomberg offers certification. We will cover the Thomson–Reuters Tick history data and basics of using this data. The course also introduces basics of applied statistics. Bloomberg terminal access will be required for any student taking the course on the web.

FE 512   Database Engineering   (3 - 2 - 1)

The course provides an introduction to SQL databases and NoSQL databases as available to the Hanlon Financial Systems Lab. At the end of the course the students will be familiar with all the lab resources as well as a working knowledge on how to use them. The students will receive hands on instructions about setting up and working with databases. Most of the software will be introduced using case studies or demonstrations, followed by a lecture of related fundamental knowledge. The course covers SQL (MySQL, WinSQL, PosgreSQL), NoSQL (IBM DB2, OneTick) and database managers Aqua. The course will cover accessing databases using API, SQLConnect and Access methods for DB2.

FE 513   Financial Lab: Practical Aspects of Database Design   (1 - 0 - 1)

The course provides a practical introduction to SQL databases and Hadoop cluster systems as available in the Hanlon Financial Systems Lab. Students will receive hands on instruction about setting up and working with databases. Most of the software will be introduced using case studies or demonstrations, followed by a lecture of related fundamental knowledge. The course covers SQL, NoSQL, and database management systems. The course will cover accessing databases using API.

FE 514   Financial lab: VBA in Finance   (1 - 0 - 1)

This course is an introduction to programming with VBA - the Visual Basic for Applications language. In particular, we will be using VBA within MS Excel, and time permitting, MS Access as well. Excel is used everywhere in finance, and VBA allows practitioners to go beyond standard spreadsheet calculation and modeling. Programming with VBA (and using macros) enhances the versatility and power of Excel. The goal of this course is to teach our students Excel usage at a high level using VBA, for front office applications in financial institutions. Financial and mathematical applications will be presented and studied throughout the course.

FE 515   Introduction to R   (1 - 0 - 1)

In this course the students will learn the basics of the open source programming language R. The language will be introduced using financial data and applications. Basic statistical knowledge is required to complete the course. The course is designed so that upon completion the students will be able to use R for assignments and research using data particularly in finance.

FE 516   MATLAB for Finance   (1 - 0 - 1)

In this course the students will learn the basics of Matlab programming using financial data and applications. The language will be introduced using financial data and applications. This short course is intended for students with little or no experience with the software covering Matlab's basic operations and features. In addition, the course works through several simple applications, to give the students the necessary knowledge on developing their own projects. Topics covered include iteration, functions, arrays, and Matlab graphics. Assignments are designed to build an appreciation for randomness, simulation, and the role of approximation.

FE 517   SAS for Finance   (1 - 0 - 1)

In this course the students will learn the basics of SAS programming using financial data and applications. The course provides an introduction to programming, graphics, and data analysis using SAS Software. The course concentrates on fundamental components of SAS Software: data processing, managing SAS libraries, graphical and statistical procedures, creating, formatting and exporting reports. In addition, several advanced topics will be introduced: SAS SQL procedures and SAS Macro Language. The supporting applications illustrate financial data analysis with special emphasis on large data sets.

FE 518   Mathematica for Finance   (1 - 0 - 1)

The course provides an introduction to programming, graphics, and financial data analysis using Mathematica. Students will learn programming in Mathematica Software, starting with elementary but quickly moving to advanced programming. They will learn it as an integrated quantitative methodology for analysis of markets, and optimal trading in stocks and options. The course is based on "hands-on" projects dealing with contemporary topics in financial mathematics and it complements theoretical courses of finance.

FE 520   Introduction to Python for Financial Applications   (1 - 0 - 1)

This course is a primer on Python (language syntax, data structures, basic data processing, Python functions, modules and classes). The remainder of the course covers open source Python tools relevant to solving financial programming problems. The lecture, supporting examples, and practical applications are intertwined. The content will be delivered in a fully equipped financial computing laboratory where the students are immersed in case studies of real life applications. There will be reading assignments of the corresponding chapters in the textbook and additional materials will be provided.

FE 521   Web Design   (1 - 0 - 1)

This course is designed to teach students how to configure and code using PHP Hypertext Processor. Students will also learn how to create dynamically generated web pages using PHP and how to connect to databases.

FE 522   C++ Programming in Finance   (3 - 0 - 3)

This course is a hands on C++ introduction for Financial applications. The course will teach the basics of C++ and will teach the student how to program for finance. Very little time will be spent on the philosophy and much more time on the actual programming. QT and Visual Studio will be used as IDE's throughout the course. The course will be designed as a prerequisite for other advanced courses at Stevens.

FE 529   GPU Computing in Finance   (1 - 0 - 1)

In this course the students will learn the basics of CUDA programming using financial data and applications. They will learn how to use C++, Matlab and R to access the GPU in their computer and to use the Stevens GPU cluster. The course is designed for Nvidia CUDA but the basics are easily transferable to Open CL. Prerequisite: FE 522

FE 530   Introduction to Financial Engineering   (3 - 0 - 0)

This course introduces a range of topics that the current scope of financial engineering encompasses. Topics include basic terminology and definitions, markets, instruments, positions, conventions, cash flow engineering, simple derivatives, mechanics of options, derivatives engineering, arbitrage-free theorem, efficient market hypothesis, introductory pricing tools, and volatility engineering.

FE 535   Introduction to Financial Risk Management   (3 - 3 - 0)

This course deals with risk management concepts in financial systems. Topics include identifying sources of risk in financial systems, classification of events, probability of undesirable events, risk and uncertainty, risk in games and gambling, risk and insurance, hedging and the use of derivatives, the use of Bayesian analysis to process incomplete information, portfolio beta and diversification, active management of risk/return profile of financial enterprises, propagation of risk, and risk metrics.

FE 540   Probability theory for FE   (3 - 3 - 0)

Topics include discrete and continuous distributions, multivariate probability, transformations, pattern appearance, moment generating functions, Laws of large numbers, Markov chains and diffusion processes, prices in markets as random variables and processes, filtrations and information. Applications target financial engineering examples.

FE 541   Applied Statistics with Applications in Finance   (3 - 0 - 0)

The course prepares students to employ essential ideas and reasoning of applied statistics. Topics include data analysis, data production, maximum likelihood, method of moments, Bayesian estimators, hypothesis testing, tests of population, multivariate analysis, categorical data analysis, multiple regression, analysis of variance, nonlinear regression, risk measures, bootstrap methods and permutation tests. The course is designed to familiarize students with statistical software needed for analysis of the data. Financial applications are emphasized but the course serves areas of science and engineering where statistical concepts are needed. This course is a graduate course and is covering topics for a deeper understanding than undergraduate courses such as MA331 and BT221. Furthermore, the course will cover fundamental statistical topics which are the basis of any advanced course applying statistical notions such as MGT718, BT652 as well as courses on machine learning, knowledge discovery, big data, time series, etc.

FE 542   Time Series with Applications to Finance   (3 - 3 - 0)

In this course the students will learn how to estimate financial data model and predict using time series models. The course will cover linear time series (ARIMA) models, conditional heteroskedastic models (ARCH type models), non-linear models (TAR, STAR, MSA), non-parametric models (kernel regression, local regression, neural networks), non-parametric methods of evaluating fit such as bootstrap, parametric bootstrap and cross-validation. The course will also introduce multivariate time series models such as VAR. Prerequisite: FE 541 or MA 331 or MA 541 or MA 612

FE 543   Introduction to Stochastic Calculus for Finance   (3 - 3 - 0)

This course introduces the stochastic calculus to students of finance and financial engineering. The course deals with Markov chains, Poisson processes, random walks, Brownian motion, asset prices as processes, limits of stochastic sequences, Ito sums and integral, fundamental models in modern finance, price dynamics and elementary examples of stochastic differential equations.

FE 545   Design, Patterns and Derivatives Pricing   (3 - 3 - 0)

This course covers the design and implementation of financial models using object oriented programming. It discusses advanced applications on quantitative finance with special emphasis on derivatives pricing.

FE 550   Data Visualization Applications   (3 - 3 - 0)

Effective visualization of complex data allows for useful insights, more effective communication, and making decisions. This course investigates methods for visualizing financial datasets from a variety of perspectives in order to best identify the right tool for a given task. Students will use a number of tools to refine their data and create visualizations, including: R and associated visualization libraries, Ruby on Rails visualization tools, ManyEyes, HTML5 & CSS 3, D3.js and related javascript libraries, Google Chart Tools, Google Refine, and image-editing programs. Prerequisite: FE 540

FE 555   2D Data Visualization Programming for Financial Applications   (3 - 3 - 0)

Building effective and efficient tools for next generation integration of data analysis into strategic decision-making requires knowledge of existing software packages as well as the ability to build or extend software when needed. This course will address strategies for representing complex data through coverage of responsive web technologies, programming methods, libraries, and current techniques for transforming local and distributed data sets into meaningful visualizations using data acquisition and machine learning techniques. Prerequisite: FE 540

FE 570   Market Microstructure and Trading Strategies   (3 - 3 - 0)

The course offers an overview of modern financial markets for various securities: equities, FX, and fixed income, different types of traders, orders, and market structures, market microstructure models used for describing price formation in dealer markets (inventory models and information-based models), models of the limit-order markets, optimal order execution: optimal order slicing, and maker-versus-taker strategies. The course introduces several typical trading strategies by introducing technical analysis, including trend, momentum, and oscillator-based strategies, arbitrage trading strategies, including pair trading, implementation and methods of strategies back-testing.

FE 571   Quantitative Hedge Fund Strategies   (3 - 3 - 0)

Hedge funds are among the most influential participants in the financial markets with unique features. They are subject to less regulation and their strategies vary significantly from one another. Examples of common strategies include discretionary investing, quantitative equity investing, global macro, managed futures and exploitation of arbitrage opportunities. This course provides an overview of the hedge fund industry by going into the mechanics of the industry and then follows with detailed descriptions of the different strategies employed. Furthermore, it provides the economic intuition behind each of these strategies as well as the implementation along with practical considerations. It also discusses various examples of how financial engineering toolsets can be utilized to enhance hedge fund performance. In addition, this course emphasizes on the practical techniques of building a quantitative trading system using R programming language. Topics such as the lifecycle of developing a sound trading strategy and strategy validation in the form of back-testing are introduced. Prerequisite: FE 570

FE 575   Introduction to Econophysics   (3 - 3 - 0)

The course will apply certain concepts from statistical physics to the description of real-life financial time series. It will introduce the notion of Random Walk from the physicist stand-point and propose various statistical tests as comparisons of real-life financial time series properties with those of a Random Walk. The course will introduce statistical description of financial data with emphasis on long-memory correlation functions. The course will introduce Levy stochastic processes and their analytical properties and use them to parameterize the real-life financial time series probability density functions. Through homework's and final project, the course will stress phenomenological hands-on work with financial data. The course will culminate with the final project in which students will learn to extract the learned price anomalies through development of basic trading strategies. The dangers of over fitting of financial data will be studied through walk-forward out-of-sample trading simulations, which will teach student to become more prudent practical quantitative analysis.

FE 580   Securitization of Financial Assests   (3 - 3 - 0)

This course provides a theoretical and practical analysis of the asset-backed security market. Topics include: Duration And Convexity of Bond Yields, Price Dynamics of Mortgages and Cash Flows, Default Risk, Interest Rate Volatility, Interest Rate Risk Management of Mortgage-Backed Securities, Securitization, Corporate Debt and The Securitization Markets, Asset-Backed Commercial Paper, Collateralized Loan Obligations, Structuring Synthetic Collateralized Loan Obligations, Securitization of Revolving Credit, Financial Derivatives and Their Use as Hedging Tools. Half of the course is in the Hanlon Financial Systems Lab, where theoretical models are illustrated with real scenarios.

FE 582   Foundations of Financial Data Science   (2 - 2 - 0)

This course will provide an overview of issues and trends in data quality, data storage, data scrubbing, data flows, and data encryption. Topics will include data abstractions and integration, enterprise level data issues, data management issues with collection, warehousing, preprocessing and querying. Furthermore, the Hadoop based programming framework for big data issues will be introduced along with any governance and policy issues. Corequisite: FE 513

FE 590   Statistical Learning   (3 - -)

Introduction to information theory: the thermodynamic approach of Shannon and Brillouin. Data conditioning, model dissection, extrapolation, and other issues in building industrial strength data-driven models. Pattern recognition-based modeling and data mining: theory and algorithmic structure of clustering, classification, feature extraction, Radial Basis Functions, and other data mining techniques. Non-linear data-driven model building through pattern identification and knowledge extraction. Adaptive learning systems and genetic algorithms. Case studies emphasizing financial applications: handling financial, economic, market, and demographic data; and time series analysis and leading indicator identification.

FE 595   Financial Technology   (3 - 3 - 0)

This course deals with financial technology underlying activities of markets, institutions and participants. The overriding purpose is to develop end-to-end business decision making data analytics tools along with enterprise level systems thinking. Statistical learning algorithms will be connected to financial objects identification and authentication along with the appropriate databases to create enterprise level financial services analytics systems.

FE 610   Stochastic Calculus for Financial Engineers   (3 - 3 - 0)

This course provides the mathematical foundation for understanding modern financial theory. It includes topics such as basic probability, random variables, discrete continous distributions, random processes, Brownian motion, and an introduction to Ito's calculus. Applications to financial instruments are discussed throughout the course.

FE 620   Pricing and Hedging   (3 - 0 - 0)

This course deals with basic financial derivatives theory, arbitrage, hedging, and risk. The theory discusses Ito's lemma , the diffusion equation and parabolic partial differential equations, and the Black-Scholes model and formulae. The course includes applications of asset price random walks, the log-normal distribution, and estimating volatility from historic data. Numerical techniques, such as finite difference and binomial methods, are used to value options for practical examples. Financial information and software packages available on the Internet are used for modeling and analysis. Corequisite: FE 610

FE 621   Computational Methods in Finance   (3 - -)

This course provides computational tools used in industry by the modern financial analyst. The current financial models and algorithms are further studied and numerically analyzed using regression and time series analysis, decision methods, and simulation techniques. The results are applied to forecasting involving asset pricing, hedging, portfolio and risk assessment, some portfolio and risk management models, investment strategies, and other relevant financial problems. Emphasis will be placed on using modern software. Prerequisite: FE 543 or FE 610

FE 625   Emerging Markets: Risks and Models   (3 - 3 - 0)

This course covers the basics of Emerging Markets instruments, models, risks, hedging and trading practices. Emerging Markets have seen a dramatic increase in volume, especially since the latest crisis in the developed markets. Geographically the course will be focused on the 4 BRIC countries (Brazil, Russia, India and China) and Mexico. The student should develop a deep understanding of the main differences between Developed Markets and Emerging Markets risk and trading. Many of the unique attributes and models in Emerging Markets have now been adopted by Developed Markets since the 2008 crisis, given students an edge in understanding the latest trends in the markets. Main topics to be covered include: funding in EM; XC basis markets; OIS and local collateralization; Credit Valuation Adjustment (CVA); Extinguishable XC swaps; Inflation indexes and inflation currencies; Capital Constraints, Convertibility and Transferability.

FE 630   Portfolio Theory and Applications   (3 - 0 - 0)

This course introduces the modern portfolio theory and optimal portfolio selection using optimization techniques such as linear programming. Topics include contingent investment decisions, deferral options, combination options and mergers and acquisitions. The course introduces various concepts of financial risk measures.

FE 641   Multivariate Statistics and Advanced Time Series in Finance

The course is an advanced statistics course designed to incorporate the newest areas of statistics research and applications in the Stevens Institute curriculum. Topics include multivariate statistics methods such as principal components, independent components, factor analysis, discriminant analysis, mixture models, and lasso regression. Advanced topics in time series such as Granger causality, vector auto regressive models, co-integration, and error corrected models, VARMA models and multivariate volatility models will be presented.

FE 635   Financial Enterprise Risk Engineering   (3 - 3 - 0)

This course deals with risk assessment and engineering in financial systems. It covers credit risk, market risk, operational risk, liquidity risk, and model risk. Topics include classical measures of risk such as VaR, methods for monitoring volatilities and correlations, copulas, credit derivatives, the calculation of economic capital, and risk-adjusted return on capital (RAROC). The nature of bank regulation and the Basel II capital requirements for banks are examined. Case studies illustrate risk engineering successes and failures in financial enterprises. Prerequisite: FE 535

FE 655   Systemic Risk and Financial Regulation   (3 - 3 - 0)

This course deals with aspects of systemic risk in financial systems. It covers a review of classical risk measures and introduces non-classical risk measures such as Extreme Value Theory. It also covers the study of financial systems as a system of complex adaptive systems, agent-based modeling, history and analysis of bubble formations as a systemic risk, the role of rating agencies, the financial systems ecosystem, risk and regulatory environment, risk and the socio-political environment. It also studies international financial inter-system risk propagation and containment and its impact on international financial systems, the International Monetary Fund assessments and the effect of extreme risk on poverty, international instability and globalization. Prerequisite: FE 535

FE 670   Algorithmic Trading Strategies   (3 - 3 - 0)

This course investigates statistical methods implemented in multiple quantitative trading strategies with emphasis on automated trading and based on combined technical-analytic and fundamental indicators to enhance the trade-decision making mechanism. Topics explore high-frequency finance, markets and data, time series, microscopic operators, and micro-patterns. Methodologies include, but not limited to, Bayesian classifiers, weak classifiers, boosting and general meta-algorithmic emerging methods of machine learning applied to trading strategies. Back-testing and assessment of model risk are explored. Prerequisites: FE 545, FE 570

FE672   Advanced Market Structure and HFT Strategies

This course extends the basic knowledge on market microstructure theory and trading strategies to the most recent advancement in related topics and covers the latest financial market structure theory and practical techniques of the high frequency trading (HFT) paradigm. High frequency trading is a difficult, but profitable, endeavor that can generate stable profits in various market conditions. But solid footing in both the theory and practice of this discipline are essential to success. This course aims to address everything from new portfolio management techniques for high frequency trading and the latest technological developments enabling HFT to updated risk management strategies and how to safeguard information and order flow in both dark and light markets. Topics include: modern microstructure theory, order types, limit-order book, dark pool trading, market-making strategies, arbitrage strategies, directional strategies, performance and risk assessment, as well as related market regulations. Half of the course is in the Hanlon Financial Systems Lab, where theoretical models are illustrated with real scenarios. This course will leverage the market tick data available at the Hanlon Systems Lab and the GPU cluster to allow students to practice high speed trading strategies with advanced programming language.

FE 680   Advanced Derivatives   (3 - -)

This course deals with fixed-income securities and interest-rate sensitive instruments. Topics include term structure of interest rates, treasury securities, strips, swaps, swaptions, one-factor, two-factor interest rate models, Heath-Jarrow-Merton (HJM) models and credit derivatives: credit default swaps (CDS), collateralized debt obligations (CDOs), and Mortgage-backed securities (MGS).

FE 690   Machine Learning in Finance   (3 - 3 - 0)

This course focuses on advanced machine learning models and their applications to finance. Building on fundamental statistical learning theory, the course covers advanced topics in classification, supervised learning, unsupervised learning, latent space models, graphical models, mixture models, online learning, deep learning, and big-data analytics. Learning and building from financial data sets, the lectures will introduce machine learning models in quantitative investing, portfolio management, algorithmic trading, risk management, client-relationship management, and beyond. A final project on related topics is required.

FE 699   Project in Financial Engineering   (3 - -)

A student is given a particular problem in financial engineering to be completed in one semester. The nature of the problem may be computational or theoretical depending on the student's track. It is encouraged that the problems be related and, in some instances, posed by the financial engineering industry.

FE 700   Master's Thesis in Financial Engineering   (3 - -)

This is the thesis option equivalent to one elective and FE 699. The thesis option requires the approval of the advisor and is recommended only for full-time students. The student will produce a Master's thesis in financial engineering.

FE 710   Applied Stochastic Differential Equations   (3 - 3 - 0)

Topics include Ito calculus review, linear stochastic differential equations (SDE's), examples of solvable SDE's, weak and strong solutions, existence and uniqueness of strong solutions, Ito-Taylor expansions, SDE for Markov processes with jumps, Levy processes, forward and backward equtions and the Feynman-Kac representation formula, and introduction to stochastic control. Applications are mostly from fianncial engineering but applications in areas such as population dynamics, energy, climatology and seismology may also be presented. Prerequisites: FE 610, MA 611, MA 623

FE 720   The Volatility Surface: Risk and Models   (3 - 3 - 0)

In this course students will understand the implied volatility, and the empirical static and dynamic behavior of the volatility surface formed using option prices for all strikes and expirations. The students will also examine the volatility risk, stochastic volatility and local volatility models, numerical methods for volatility surface calibration, Monte Carlo simulation of stochastic volatility models, and pricing options through fast Fourier transform. Topics include: the Black-Scholes implied volatility, empirical statics and dynamics of the volatility surface, volatility risk premium, stochastic volatility models (Heston, Hull-White, Stein-Stein, SABR, Bates, Scott, etc), Dupire's local volatility model, Heston-Nandi GARCH model, arbitrage-free properties of the volatility surface, volatility surface parametrization and calibration, simulation of the Heston model, stochastic volatility model with jumps, option pricing based on fast Fourier transforms, and volatility derivatives (Variance swap, CBOE VIX futures and options, etc). Other advanced current research topics will be introduced as well. The students are required to have a solid working knowledge of stochastic calculus, and FE610 is a pre-requisite for this course. The course uses statistical softwares such as Matlab or R throughout. A companion one credit of a relevant lab course is recommended if this knowledge is not acquired before. Prerequisite: FE 610

FE 800   Project in Financial Engineering   (1 - 1 - 0)

Three credits for the degree of Master of Science (Financial Engineering). This course is typically conducted as a one-on-one course between a faculty member and a student. A student may take up to two special problems courses in a master's degree program. A department technical report is required as the final product for this course. Prerequisite: consent of instructor.

FE 810   Selected Topics in Financial Engineering   (3 - 3 - 0)

Selected topics from various areas within Financial Engineering. This course is typically taught to more than one student and often takes the form of a visiting professor's course. Prerequisite: consent of instructor.

FE 900   Master's Thesis in Financial Engineering   (3 - 3 - 0)

For the degree of Master of Science (Financial Engineering). A minimum of six credit hours is required for the thesis. Hours and credits to be arranged.

Information Systems

MIS 201   Fundamentals of Information Systems   (4 - 2 - 2)

This course provides an introduction to systems and development concepts, information technology and application software. It explains how information is used in organizations and the effects IT has on the organization's structure, processes, employees, customers, and suppliers. In addition, the course describes how IT enables improvement in quality, timeliness, and competitive advantage. Structure and functions of computers and telecommunications systems are also examined.

MIS 460   IT Strategy: Strategic Issues in IT Management   (3 - 3 - 0)

This course introduces students to the use of computerized information systems to satisfy strategic business needs. It outlines the concepts of information systems for competitive advantage, data as a resource and IS and IT planning and implementation. It concentrates on developing the students' competency in current/emerging issues in creating and coordinating the key activities necessary to manage the day-to-day IT functions of a company.

MIS 620   Analysis and Development of Information Systems   (3 - 3 - 0)

This course presents and analyzes various approaches to information analysis and development of organizational information systems within a system development life-cycle (SDLC), e.g. the waterfall, concentric, and prototyping approaches. Topics include strategic planning for SDLC, front-end and back-end phases of SDLC, project management, CASE methodologies, and balancing user, organizational, and technical considerations.

MIS 630   Dealing with Data   (3 - 0 - 0)

This course deals with strategic uses of data, data structures, file organizations and hardware as determinants of planning for and implementing a enterprise-wide data management scheme. Major course topics include data as valuable enterprise resource, inherent characteristics of data, modeling the data requirements of an enterprise, data repositories and system development life cycles.

MIS 635   Designing the Knowledge Organization   (3 - 0 - 0)

This course will focus on the design and management of the knowledging organization organizations that generate and apply knowledge. A central theme of this course is the design of knowledge work. We concentrate on both micro- and macro-design and their interrelationships: individual, team, task, process, and organization levels. This courses comprises what is generally termed knowledge management and by extension the learning organization.

MIS 636   Data Warehousing and Business Intelligence   (3 - 3 - 0)

This course focuses on the design and management of data warehouse (DW) and business intelligence (BI) systems. The course is organized around the following general themes: Knowledge Discovery in Databases, Planning and Business Requirements, Architecture, Data Design, Implementation, Business Intelligence, Deployment, Maintenance and Growth, and Emerging Issues. Practical examples and case studies are presented throughout the course.

MIS 637   Data Analytics & Machine Learning   (3 - 0 - 0)

This course will focus on Data Mining & Knowledge Discovery Algorithms and their applications in solving real world business and operation problems. We concentrate on demonstrating how discovering the hidden knowledge in corporate databases will help managers to make near-real time intelligent business and operation decisions. The course will begin with an introduction to Data Mining and Knowledge Discovery in Databases. Methodological and practical aspects of knowledge discovery algorithms including: Data Preprocessing, k-Nearest Neighborhood algorithm, Machine Learning and Decision Trees, Artificial Neural Networks, Clustering, and Algorithm Evaluation Techniques will be covered. Practical examples and case studies will be present throughout the course.

MIS 685   The Healthcare Value Chain   (3 - 0 - 0)

This course has been designed to provide foundational knowledge about the healthcare industry for information technology (IT) professionals working in (or aspiring to work in) the healthcare industry. After an introduction to the U.S. healthcare system from a stakeholder perspective, students learn about the information and communication needs of key interdependent stakeholders: healthcare providers (hospitals, physicians), suppliers of surgical and non-surgical equipment and drugs, third-party insurers and payers (including government), and the healthcare consumer (patients). The course materials include readings by current thought leaders, in-depth case studies, background summaries prepared by the instructor, and public Web-based resources. Students gain up-to-date knowledge about current healthcare IT solutions used by key players in the healthcare valuechain, and also learn about resources for understanding future IT-related trends in this fast-changing industry. This course is also a pre-requisite for three MIS courses that focus on specific types of HIT applications and the process changes and healthcare data needed to support them: MIS 686, MIS 687, and MIS 688

MIS 689   IT Management for the Healthcare Professional   (3 - 0 - 0)

This course has been designed to provide the healthcare professional (physicians, nurses, allied health, and other healthcare professionals) with a foundation in information management. The adoption of clinical systems (electronic medical records, computerized physician ordering, e-prescribing) by healthcare providers, and the growth of evidence-based decision support systems within healthcare providers, suppliers, insurers, and payers in the healthcare value chain, is expected to significantly increase. For the effective utilization of these investments, healthcare professionals who have a mastery of IT management fundamentals are needed to participate in the design, development, and support of all of these types of IT investments. Students will gain an up-to-date knowledge about managing healthcare IT (HIT), and also become familiar with resources for keeping up-to-date with IT terminology and trends in this fast-changing industry.

MIS 690   Supply Chain Management and Strategy   (3 - 3 - 0)

This course serves as the foundation course for studying strategic supply chain management within the Howe School. The course explores the major elements of the supply chain, and exposes students to leading edge thinking on supply chain strategy as well as practical tools and methods for its implementation. Topics covered include: Supply Chain Management Principles and the Customer; Supply Chain Networks and Organizations; Product Lifecycle Implications to Supply Chains; Forecasting and Inventory Management; Supply Chain Processes; Supply Chain Information Systems; Supply Chain Performance and Metrics; Lean Supply Chains; Risk Management; and Legal and Ethical Issues.

MIS 691   Procurement and Supplier Management   (3 - 0 - 0)

The Procurement and Supplier Management course explores the strategic issues in procurement and supply management, including the purchasing process, procurement cycle, purchasing research, relationships with suppliers, negotiation, commodity planning, as well as price and value analysis. The course covers the organizational, strategic, and operational aspects of procurement and supply management, along with an integrated view of how product/service supply networks are being designed and deployed to meet the needs of a highly differentiated customer base.

MIS 692   Distribution and Logistics Management   (3 - 0 - 0)

The Distribution and Logistics Management course explores the strategic issues in order, transportation, and distribution management, including the provisioning of finished goods and services to meet planned or actual demand. The course covers in-depth Distribution and Logistics Principles; Customer Fulfillment; Product Lifecycle Management; Distribution and Logistics Processes; Information Systems; Future Trends; as well as, Regulatory and Import/Export Issues.

MIS 699   Digital Innovation   (3 - 3 - 0)

IT organizations must be able to leverage new technologies. This course focuses on how organizations can effectively and efficiently assess trends and emerging technologies in data and knowledge management, information networks, and analyzing and developing application systems. Students will learn how to help their organizations define, select, and adopt new information technologies.

MIS 710   Process Innovation and Management   (3 - 0 - 0)

This course focuses on the role of Information Technology (IT) in reengineering and enhancing key business processes. The implications for organizational structures and processes, as the result of increased opportunities to deploy information and streamline business systems, are covered. Cross-listed with: NIS 630

MIS 712   Advanced Business Process Management   (3 - 3 - 0)

The course addresses the techniques and concepts required to map, implement, automate, and evaluate business processes. Focusing on the technical and implementation aspects of Business Process Management, the course leads students from technical process design through the implementation and management of workflows to the structure of process-aware information systems. It discusses the distinction between business processes and business rules and outlines how they can be supported by technology. It details the technical structure of process-aware applications and provides an overview of technology standards that affect BPM systems. Modules on the run-time monitoring of processes and post-execution evaluation techniques complete this course. Prerequisites: MIS 501, MIS 620 Corequisite: MIS 710

MIS 714   Service Innovation   (3 - 3 - 0)

This course leads students through the identification, analysis, definition, and deployment of service opportunities within public and private organizations. Each of these phases is analyzed in detail to encompass the principal activities, methods, tools and techniques applied in the respective phase. Students will learn how to identify appropriate supporting techniques and information technologies for the different phases of the service life cycle, assess the role of technology, and gauge the organizational impact of service-focused operations. The objective of the course is to enable students to identify, implement and evaluate innovative service offerings in their organization.

MIS 722   Research Seminar: Business Process Management & Innovation   (3 - 0 - 0)

The course introduces PhD students to research areas surrounding the design, implementation, and improvement of organizational processes. The process-oriented analysis of organizations serves as a focal point for the integration of business requirements (in form of business processes) with technology capabilities (in form of process support systems). Research topics within the area of process innovation range from organization theory and workplace design to control theory and the formal representation of processes. Students will discuss seminal research papers in the individual course modules and develop a research paper of their own on a topic related to process innovation. Prerequisites: MIS 710 or permission of the instructor

MIS 730   Integrating Information System Technologies   (3 - 0 - 0)

This course focuses on the issues surrounding the design of an overall Information Technology architecture. The traditional approach in organizations is to segment the problem into four areas - network, hardware, data, and applications. Instead, this course concentrates on the interdependencies among these architectures. In addition, this course will utilize management research on organizational integration and coordination. The student will learn how to design in the large, make appropriate choices about architecture in relationship to overall organization goals, understand the different mechanisms for coordination available, and create a process for establishing and maintaining an ongoing enterprise architecture. Cross-listed with: NIS 633 Prerequisites: MIS 620, MIS 630 MIS 640

MIS 760   Information Technology Strategy   (3 - 3 - 0)

The objective of this course is to address the important question, "How does one improve the alignment of business and Information Technology strategies?" The course is designed for advanced graduate students. It provides the student with the most current approaches to deriving business and Information Technology strategies, while ensuring harmony among the organizations. Topics include business strategy, business infrastructure, IT strategy, strategic alignment, methods/metrics for building strategies, and achieving alignment. Cross-listed with: NIS 632 Prerequisites: MIS 750

MIS 800   Special Problems in MIS (MS)   (1 to 6 - -)

With permission of the instructor. Limit of six credits for the degree of Master of Science. Cross-listed with: MGT 800

MIS 810   Special Topics in Management of Information Systems   (3 - -)

A participating seminar on topics of current interest and importance in Management of Information Systems.

MIS 900   Thesis in MIS (MS)   (1 to 12 - -)

For the degree of Master of Science. Six to 12 credits with departmental approval.

Management

MGT 103   Introduction to Entrepreneurial Thinking   (2 - 1 - 2)

Entrepreneurial thinking enables engineers to design value-added products and processes that delights the customer and creates a superior business model. This course teaches students a new way of problem solving, finding unique fit between a real-world problem and a new solution. Learning objectives include, teaming and leadership skills, obtaining information through customer discovery, enhancing presentation skills, and techniques for assessing a new idea; including customer and value analysis, competition analysis, and basic financial analysis. The course is taught in an interactive, immersive and experiential format through a hands-on project and computer simulation.   In-class time is focused on active discussions, team activities and project presentations.

MGT 111   Social Psychology and Organizational Behaviour   (3 - 3 - 0)

Using an applied and experiential format, this course exposes students to theory, methods and research in organizational behavior and social psychology. Topics relating to individual differences and group dynamics in organizational settings are stressed. Learning occurs through discussion, group activities, and the completion of assessment instruments. Emphasis is on helping students understand and improve their skills in key areas, including decision-making, leadership, negotiation, and conflict resolution.

MGT 197   Online Writing Tutorial   (0 - 0 - 0)

Students who do not pass the written assessment in MGT198 will be required to take MGT197: Online Writing Tutorial for no cost and zero credit. Completion of all the online quizzes in the tutorial is sufficient to obtain a passing grade.

MGT 198   Writing Assessment   (0 - 0 - 0)

Written and oral communications training and assessment are conduction in conjunction with a required course in the BS in Business program. Students in this course are automatically enrolled in MGT198: Writing and Assessment Program. This online workshop carries zero credits and will not appear on the student's official transcript.

MGT 199   Ethics Quiz   (0 - 0 - 0)

The ethics requirement is incorporated into the course work for a required course in the BS in Business program. Students are automatically enrolled into MGT199 – Ethics Workshop at no cost. This workshop carries zero credit and will not appear on the student's official transcript. Completion of all exercises and the survey associated with the Ethics Workshop is sufficient to satisfy the ethics requirement.

MGT 401   MIS/DBMS/Networks   (3 - 3 - 0)

This sequence develops the use of industry-standard personal productivity packages to develop reports and information in support ofthe key decision-making responsibilities of management. Advanced uses of the spreadsheet are developed, including the creation of aneffective business system using the spreadsheet's macro language. More complicated problems are approached using an industry-standard database management system. A course segment presents the integrated systems approach, including the use of local area networks (such as the campus-wide network) to solve complex business problems.

MGT 414   Entrepreneurship Practicum   (3 - 3 - 0)

This capstone course within the Entrepreneurship minor is designed to develop the content and presentation of the technical and business elements of students entrepreneurial business plans. Starting with the technical aspects of the design project, students are led through the components of a complete business plan, with instruction and practice in the writing and presentation of the plan. As a capstone exercise, students complete the course by presenting their business plans in an Elevator Pitch event at which venture capitalists and other investors rate the quality of student presentations and entrepreneurial business ideas.

MGT 458   Principles of Management   (3 - 3 - 0)

Managerial decision-making and its impact on society are the central theme; emphasis is on the selection and implementation of corporate goals, measures of corporate performance and concepts of industrial regulations.

MGT 472   Assessment and Financing of Technical Business Opportunities   (3 - 3 - 0)

You will be a member of a small learning group in which the dynamics of human behavior are learned through supervised experience. As the group develops, the basic principles of group interaction become apparent to you, as do your own contributions, emotions and motivations. With faculty guidance, and at the group's own initiative, group dynamics and interpersonal interaction on many levels are investigated.

MGT 546   Marketing Strategy   (3 - 3 - 0)

Every firm needs to devise and execute marketing strategies for their offerings to translate into customer value and profits based on an understanding of the consumer and the marketplace. This course is designed to give students an intensive and application-oriented look at how marketing strategy works in the real world. It will include examples and exercises of the role quantitative analysis plays in marketing strategy decisions. The emphasis of this course will be on cases, analysis, real life examples, and presentations.

MGT 548   Consumer Behavior   (3 - 3 - 0)

Marketing begins and ends with the consumer. The purpose of this course is to introduce students to the study of consumer behavior. This is an interdisciplinary course that integrates perspectives from marketing, psychology, sociology, anthropology, and economics in order to examine the elements of the consumer decision-making process and to enable formulation of marketing strategies. Students will take the perspective of a marketing manager who needs knowledge of consumer behavior in order to develop, evaluate and implement effective marketing strategies. The course integrates lectures, case analysis, and discussions to focus on the implications of social science concepts for marketing strategy.

MGT 606   Economics for Managers   (3 - 3 - 0)

This course introduces managers to the essence of business economics – the theories, concepts and ideas that form the economist's tool kit encompassing both the microeconomic and macroeconomic environments. Microeconomic topics include demand and supply, elasticity, consumer choice, production, cost, profit maximization, market structure, and game theory while the Macroeconomic topics will be GDP, inflation, unemployment, aggregate demand, aggregate supply, fiscal and monetary policies. In addition the basic concepts in international trade and finance will be discussed.

MGT 609   Project Management Fundamentals   (3 - 3 - 0)

This course deals with the basic problems of managing a project, defined as a temporary organization built for the purpose of achieving a specific objective. Both operational and conceptual issues will be considered. Operational issues include definition, planning, implementation, control, and evaluation of the project. Conceptual issues include project management vs. hierarchical management, matrix organization, project authority, motivation, and morale. Cases will be used to illustrate problems in project management and how to resolve them. Cross-listed with: PME 609

MGT 610   Strategic Perspectives on Project Management   (3 - 0 - 0)

This course provides a theoretical perspective on project management for a better understanding of project implementation in modern organizations. The course is based on the premise that success in project leadership depends on a proper managerial style and attitude, and not on specific tools for planning and controlling. The course focuses on developing the manager's conceptual thinking and on building "the project manager's mind." The course helps managers see the entire project landscape and the long-term issues that are critical to project success. It will also address the organizational aspects of initiating and running the program. Prerequisites: MGT 609

MGT 611   Project Analytics   (3 - 0 - 0)

Formalized procedures, tools, and techniques used in conceptual and detailed planning of the project. Development of work breakdown structure as the foundation for project cost and project duration. Application of project data in monitoring the project progress and in formulating remedial actions in response to unexpected occurrences. Prerequisites: MGT 609

MGT 612   Leader Development   (3 - 0 - 0)

Project success depends, largely, on the human side.Success in motivating project workers, organizing and leading project teams, communication and sharing information, and conflict resolution, are just a few areas that are critical for project success. However, being primarily technical people, many project managers tend to neglect these "soft" issues, assuming they are less important or that they should be addressed by direct functional managers. The purpose of this course is to increase awareness of project managers to the critical issues of managing people and to present some of the theories and practices of leading project workers and teams.

MGT 613   Program Office and Portfolio Management   (3 - 0 - 0)

A comprehensive, all-inclusive description of the Project Management Office (PMO), highlighting features most appropriate and relevantto specific project situations. Motivations for adopting a PMO, such as project performance, project manager competency or the organizational desire to excel. Short-term and long-term functions are identified and discussed. Project evaluation models and PMO implementation guidelines are presented and discussed in detail. Prerequisite: MGT 614 Corequisite: MGT 611

MGT 614   Advanced Project Management   (3 - 0 - 0)

This course deals with advanced problems in project management that were not addressed in previous courses. It also expands on several previously mentioned topics. The course addresses the critical points in project management for the experienced project manager and looks at projects in their broad sense, as seen by top management and from an organizational global perspective. Prerequisite: MGT 609 Corequisite: MGT 610

MGT 616   Healthcare Leadership and Management   (3 - 3 - 0)

This course provides an overview of critical leadership and management applications and strategies unique to the healthcare industry, such as customer/patient analysis, criterion-based performance evaluation and TimeLine mapping. Current field dynamics of healthcare organizations are explored and instruction in essential management accountabilities directly relevant to the industry is presented comprehensively in both theory and practical application.

MGT 617   Project Quality Management   (3 - 3 - 0)

This course provides project managers with the framework, tools and approaches to meet the quality requirements of their projects and their customers, ensuring project success. Cross-listed with: ME 560

MGT 619   Leading Across Projects   (3 - 3 - 0)

This course focuses on key leadership skills for addressing the complex challenges posed by program management, highly-matrixed environments and cross-national collaborations It's purpose is enhance individuals' abilities to develop others, strategically integrate efforts across groups, and drive change. The concepts presented are theory and research driven so that participants can deepen their conceptual understanding. At the same time, the course calls upon learners to address real-life challenges they face as program and or director level leaders. Each session presents effective techniques and uses experiential exercises or assignments to provide plenty of practice. The course also requires participants to further transfer learning to their workplaces through focused development planning and coaching support. Prerequisites: MGT 609, and MGT 612

MGT 620   Statistical Models   (3 - 3 - 0)

The major portion of the course covers an introduction to the probabilistic and statistical concepts and models used in day-to-day business decision-making. Topics include data analysis, correlational techniques, regression, statistical inference, and forecasting.

MGT 630   Global Business and Markets   (3 - 3 - 0)

There will be a review of probability and statistics as needed and then moves on to regression with a single regressor, multiple regression, the basics of functional form analysis, and the evaluation of regression studies. There will be a focus on using econometrics software in estimating econometrics models learned during the semester and interpreting the results. Cross-listed with: EMT 630 Prerequisites: MGT 699

MGT 635   Managerial Judgment and Decision-Making   (3 - 0 - 0)

Executives make decisions every day in the face of uncertainty. The objective of this course is to help students understand how decisions are made, why they are often less than optimal, and how decision-making can be improved. This course will contrast how managers do make decisions with how they should make decisions, by thinking about how "rational" decision makers should act, by conducting in-class exercises and examining empirical evidence of how individuals do act (often erroneously) in managerial situations. The course will include statistical tools for decision-making, as well as treatment of the psychological factors involved in making decisions. Cross-listed with: EMT 635

MGT 641   Marketing Management   (3 - 3 - 0)

The study of marketing principles from the conceptual, analytical, and managerial points of view. Topics include: strategic planning, market segmentation, product life-cycle, new product development, advertising and selling, pricing, distribution, governmental, and other environmental influences as these factors relate to markets and the business structure.

MGT 650   International Business Management   (3 - 3 - 0)

This course provides students with an exposure to management in the international economic environment: global industries and regional markets, multinational corporations and international economic organizations. Casestudies, business games and presentations illustrate different strategies of firms considering the competitive environment, the national culture, legislation and taxation policy of local governments, and the organizational structure of the firm.

MGT 657   Operations Management   (3 - 3 - 0)

Covers the general area of management of operations, both manufacturing and non-manufacturing. The focus of the course is on productivity and total quality management. Topics include quality control and quality management, systems of inventory control, work and materials scheduling, and process management.

MGT 663   Discovering and Exploiting Entrepreneurial Opportunities   (3 - 3 - 0)

In this course, students will evaluate and create their own prospective business strategies. They will develop an understanding of entrepreneurship and innovation in starting and growing a business venture. Students will be given an opportunity to actually start their own business or create a business in their company by learning how to take advantage of the new order of business opportunities of the information age. This course's main objective is to show students how to identify these opportunities, be able to formulate and evaluate both qualitatively and quantitatively whether the opportunity is worth pursuing, and, of course, how it may be pursued. Actual case studies and experiences will be intertwined with the course content. Cross-listed with: MIS 663

MGT 664   Business Law   (3 - 3 - 0)

The course introduces students to the fundamental concepts and legal principles that they can expect to encounter in various roles as managers/professionals in public and private companies, consultants and/or entrepreneurs, together with the ethical criteria, moral values and social norms in the environments they will face. The course will cover the American judicial system, international law in a global economy, ethics and business decision making, and different forms of business structure, contracts, business torts, products liability, insurance, employment law, criminal law and the recent Dodd-Frank Wall Street Reform & Consumer Protection Act. Cross-listed with: EMT 664

MGT 671   Technology and Innovation Management   (3 - 3 - 0)

This course introduces the student to topics in the management of technology and examines the critical role of technology as a strategic resource to enable management to achieve organizational objectives. Topics include entrepreneurship, developing and managing new ventures, managing innovation, the technology life-cycle and technology forecasting, management of research and development (R&D) personnel and projects, evaluation of R&D projects ,and integrating technology strategy with the organization's overall business strategy. Prerequisites: MGT 699

MGT 672   Realizing Value from Intellectual Property   (3 - 3 - 0)

This course examines the valuation, patenting, and licensing of early-stage technology as a means to exploit innovation. By understanding technology to be a negotiable asset for the firm, we take a fundamentally different approach than venture capital models, which focus on the enterprise, rather than the commercialization of technology itself. Accordingly, we study the economics and theory of intellectual property; valuation of intangible assets; IP agreements and protection regimes; negotiations and trading techniques; and licensing and litigation strategies. Prerequisites: MGT 671

MGT 673   Global Innovation Mangement   (3 - 3 - 0)

This course is focused on the globalization paradigm and its effects on the management of innovation. It is an interdisciplinary course, which analyzes the different managerial areas of strategy, organization, technology, and market as integrated with the innovation process in a global context. The underlying theories and models are explored to understand how the innovation process is affected by local, national, and global influences; what cultural and organizational drivers are at work; and how to manage commercialization of new products on a life-cycle basis, in a diverse and ever-changing global market. Case studies will be used to support the theoretical constructs and reinforce learning. Prerequisites: MGT 671

MGT 675   New Product and Service Innovation   (3 - 0 - 0)

This course provides students with the most current theories of innovation when organizations create new tangible products and intangible services. From team and organizational processes, to the evolving portfolio, the innovating enterprise competes on the basis of change. By building upon material covered in Technology Innovation Management (MGT 671), this course will deepen students' knowledge of the innovation process in the enterprise and will pay special attention to service industries. The course will be taught with lectures and real-world cases. Upon completion, students will have enhanced their knowledge of the innovative enterprise and increased their practical skills for careers in technology management. Prerequisites: MGT 671

MGT 677   Emerging Technologies   (3 - 3 - 0)

This course discusses emerging technologies, how they evolve, how to identify them, and the effect of international, political, social, economic, and cultural factors on them. Topics covered in the course include accuracy of past technology forecasts, how to improve them, international perspectives on emerging technologies, future customer trends, and forecasting methodologies such as monitoring, expert opinion, trend analysis, and scenario construction. Emerging technologies will be examined through student company examples, invited speakers, and videos. Cross-listed with: EMT 677

MGT 681   Pharmaceutical Industry New Drug Development   (3 - 3 - 0)

This course provides an overview of the drug and biologics development process from discovery through regulatory approval. Special attention is given to the roles, functions, and importance of the various disciplines involved in the R&D process, their interactions with each other, and the strategic management of these functions. Attention will also be given to key technologies used throughout the R&D process. The economics of pharmaceutical R&D, as well as trends in licensing, outsourcing, and partnerships will be covered. The student will gain an understanding of R&D strategy and the relationship between R&D and sales, marketing, and manufacturing.

MGT 682   Pharmaceutical Industry Marketing and Sales   (3 - 3 - 0)

This course addresses the business issues, management activities and technologies pertaining to the management of the modern pharmaceutical supply chain. This includes all components of the drug development life cycle starting from the sourcing of materials needed to support pharmaceutical R&D, and ending with the distribution of drugs to retail pharmacies and physicians. The course focuses on the organizational, management and information technology issues and considerations related to the logistics-related activities of the pharmaceutical industry which are comprised of sales, marketing and supply chain management related functions.

MGT 686   Pharmaceutical Industry Trends and Issues   (3 - 3 - 0)

The course will provide an overall look at IT in the pharmaceutical industry, its structure, and trends and issues which have driven it, are affecting it now, and are likely to change it in the future. This course will focus on the business forces shaping the pharmaceutical industry. In addition, this course will use management research on the integration of IT with the business. The student will learn how to evaluate important business trends and how IT can be used to support business success. Topics include a pharmaceutical industry overview, regulatory compliance, new drug development, manufacturing and logistics, product marketing, the role of IT in the pharmaceutical industry, company strategies, e-pharma, and 21st century pharmaceutical-market future trends. Cross-listed with: MIS 671

MGT 687   Pharmaceutical Industry Supply Chain   (3 - 3 - 0)

This course focuses on the issues surrounding supply chain design, planning, and execution for the pharmaceutical and biotech industries from drug discovery to delivery. This course will use research on information systems, optimization, e-business, and decision-support technologies and lessons learned from their effective use in global supply chain management for manufacturing and distribution in the process industries. Students will learn how to evaluate global supply chain issues from the perspectives of various stakeholders in relationship to overall organization and societal goals. They will further understand the different mechanisms for collaboration and create a process for establishing and maintaining an effective global SCM solution architecture. Topics include good manufacturing practice and regulations, advanced planning and scheduling, global competition, mergers and acquisitions, innovation, new tools and partnerships, effective global supply chain management, and qualifying for a global supply chain manager position. Cross-listed with: MIS 673

MGT 689   Organizational Behavior and Design   (3 - 3 - 0)

This course exposes students to the macro and micro aspects of organizational behavior and theory that are essential to technology management. The macro aspects will focus on structural contingency theory as an approach to effective organizational design. The micro aspects will focus on leadership, teams, and individual behavior (e.g., motivation, job attitudes). Specific issues and problems which are covered include: the relationship of the organization with the external environment, the influence of the organization's strategies, culture, size, and production technology on the organization's design, and strategies for managing organizational processes such as teams, conflict, power/politics and organizational change. Current topics, that are key to technology management (e.g., virtual teams), will be stressed.

MGT 695   Leading Creative Collaboration   (3 - 3 - 0)

Innovative organizations are led by people who relentlessly nurture creative collaborations. These leaders stimulate imagination, teach others how to turn imagination into creativity, and build group structures and processes to enable people to turn creative ideas into innovations that drive business results. This course builds individual awareness of creativity and collaboration skills while increasing the student's capacity for both. It teaches the science behind techniques, tools, interpersonal skills, leadership skills, organizational strategies, and environmental designs that increase group effectiveness. The overall goal is to strengthen the student's ability to lead others to address meaningful problems and possibilities wherever they may be found. Cross-listed with: EMT 695

MGT 696   Human-Centered Design Thinking   (3 - 3 - 0)

This course deals with the theory and methods associated with design thinking, a problem-solving protocol that spurs innovation and solves complex problems. Design thinking involves a unique form of inquiry which goes well beyond product and service design. Students will develop an appreciation for design and develop skills for studying design systems. These concepts and methods have wide applicability as they can be used to design organizations of people, information structures, compensation systems as well as the entire consumer experience. Applying these approaches can often create entirely new systems that are more useful and usable. The logic of this approach can sometimes solve "wicked problems" which have defied previous solutions. Cross-listed with: EMT 696

MGT 699   Strategic Management   (3 - 3 - 0)

An interdisciplinary course which examines the elements of, and the framework for, developing and implementing organizational strategy and policy in competitive environments. The course analyzes management problems both from a technical-economic perspective and from a behavioral perspective. Topics treated include: assessment of organizational strengths and weaknesses, threats, and opportunities; sources of competitive advantage; organizational structure and strategic planning; and leadership, organizational development, and total quality management. The case method of instruction is used extensively in this course. Prerequisites: MGT 600

MGT 700   Econometrics   (3 - 0 - 0)

An introduction to the science of designing statistical models of economic processes. Students will be required to build and estimate a number of models during the term. Topics include: regression theory, statistical difficulties in regression analysis, advanced topics in single-equation regression, models of qualitative choice (such as, probit, logit), and simultaneous equation estimation. Prerequisites: MGT 503

MGT 701   MGT Co-Op Education Project   (0 - 0 - 0)

This course is for MGT graduate students who are on Co-Op assignment.

MGT 702   Curricular Practical Training   (1 to 3 - 0 - 0)

This course involves an educationally relevant, practical assignment that augments the academic content of the student's program. Students engage in a project in a company project related to the focus of their academic program. The project is conducted under the supervision of a faculty advisor and an industry mentor. During the semester, the student must submit written progress reports and at the end of the semester, a detailed written report that describes his/her activities and knowledge gained during that semester. This is a one-credit course that may be repeated up to a total of three credits. With approval of the Program Director and faculty supervisor, students may also take this course for three credits in one semester.

MGT 711   PhD Seminar in Entrepreneurship Theory   (3 - 0 - 0)

This course is a Ph.D. seminar course in entrepreneurship. Research on the performance of entrepreneurial new ventures will be analyzed from a theoretical perspective. Relevant studies will be drawn from the economics, management science, and strategic management literatures dealing with entrepreneurship. Emphasis will be placed on the strategic management and competitive environments of new ventures in their early development stages, and topics will be discussed in relation to theoretical concepts in technology and innovation management.

MGT 718   Multivariate Analysis   (3 - 0 - 0)

Experimental design, statistical estimation, and hypothesis testing from multivariate distributions. Topics covered will include regression models, multivariate analysis of variance, canonical correlations, classification procedures, and factor analysis. Computer applications of these techniques will be examined. Cross-listed with: SYS 718

MGT 719   Research Design   (3 - 0 - 0)

Research philosophy, ethics, and methodology will be discussed. Each student will, under the guidance of the instructor, formulate a problem, search the literature, and develop a research design. In addition, the student will examine and criticize research reports with special emphasis on the statement of the problem, the sampling and measuring techniques that are used, and the analyses and interpretation of the data. Emphasis is on applying research methodology to real-world organizational problems.

MGT 721   Qualitative Research Methods   (3 - 3 - 0)

This course is designed to develop the doctoral student's knowledge about a range of qualitative research approaches currently used to conduct management research. Methodological readings authored by social scientists and management researchers on ontological and epistemological assumptions underlying positivist, interpretive, and critical approaches will be examined. Empirical research published in leading journals using case study, action research, ethnography, grounded theory, and other methods will be assessed based on established criteria with the goal of preparing students to conduct and evaluate qualitative research. Students will acquire skills in qualitative research design, data generation, and data analysis techniques through readings, written critiques, and seminar discussions, as well as participation in a qualitative research study. Prerequisites: MGT 719

MGT 730   Design and Analysis of Experiments   (3 - 0 - 0)

This course starts with the design and analysis of one factor analysis of variance. Methods of testing specific questions using planned comparisons are stressed. Models with two or more factors are considered with detailed instruction on the analysis of interactions. Repeated-measures designs are also covered, as well as designs with random and fixed factors. Prerequisites: MGT 620

MGT 734   Design Science Research Seminar   (3 - 3 - 0)

In this graduate Ph.D. seminar, we will actively explore design science. We will read the existing literature and write our own papers. As part of this, we will run simulations and design new mechanisms and interfaces. The end result of the course will be the production of models: simulations that represent social and technical phenomena – and a paper, authored individually or jointly, suitable for publication.

MGT 735   Economic Foundations of Management Research   (3 - 3 - 0)

This course focuses on developing theoretical knowledge and understanding of economic concepts related to decision-making, consumer behavior, and competitive strategy. It introduces the methods and techniques for analyzing economic activities. It aims to improve the understanding of managerial decision-making processes by presenting analytic tools by examining the principal theories of decision-making and strategic behavior.

MGT 753   Theory in Management Research   (3 - 0 - 0)

This course introduces students to the relevant management and organizational theories used in management research, including their origins, substance and significance to the effective conduct of research. In addition, students are expected to develop the capacity to identify and apply theories to the study of specific management phenomena.

MGT 769   Colloquia Series Research Seminar   (3 - 3 - 0)

This course is designed to provide doctoral students with an in-depth knowledge about the research process in technology management and related disciplines. The course content includes assigned readings about conducting academic research in general, as well as assigned readings related to public Howe School research colloquium presentations by different guest speakers during the course of the semester. Students will prepare for the presentation by reading the assigned papers and writing up a set of questions to be posed during the discussion with the presenter, which will take place after the presentation. Each semester there will be six or seven guest speakers who will formally present their research during the first hour of the seminar. After the talk, guest speakers will discuss issues related to conducting research with doctoral students. In the weeks without guest speakers, students discuss assigned readings related to conducting academic research with other class members.

MGT 786   Social Network Analysis Research Seminar   (3 - 3 - 0)

This course addresses concepts and theories of social networks and social network analysis. Core concepts include representations and models of networks, basic descriptive statistics at the individual and network level, and standard models of network formation. The course also covers more advanced topics in network theory, including community detection, processes over networks such as contagion and influence, and models of dynamic networks.

MGT 787   Statistical Learning and Analytics Research Seminar   (3 - 3 - 0)

The significant amount of corporate information available requires a systematic and analytical approach to select the most important information and anticipate major events. Statistical learning algorithms facilitate this process understanding, modeling and forecasting the behavior of major corporate variables.

MGT 798   Integration and Application of Technology Management   (3 - 3 - 0)

This is the capstone course for the program. It is designed to integrate the knowledge developed in the other courses via a business simulation in which teams of students compete in running their companies in a complex simulated environment. The course includes lectures and workshops that demonstrate theory and techniques of cross-functional decision making in the management of technology. Individuals and teams will be observed and assessment feedback will be given. Cross-listed with: EMT 798 Prerequisites: MGT 600, and MGT 623, and MGT 641, and MGT 657, and MGT 699

MGT 800   Special Problems in Management (MS)   (1 to 6 - -)

With permission of the instructor. Limit of six credits for the degree of Master of Science. Cross-listed with: MIS 800

MGT 801   Special Problems in Mangement (PhD)   (1 to 6 - -)

With permission of the instructor. Limit of six credits for the degree of Doctor of Philosophy.

MGT 802   Project Management Examination   (0 - 9 credits)

This will test the project management knowledge of students who have completed approved training programs in project management. Upon successful completion, (graded pass/fail) students will be awarded 12 credits toward the Master of Science in management with a Project Management concentration. The 9 credits cannot be used toward the Project Management Graduate Certificate of Special Study and are not transferable to other institutions.

MGT 803   Project Management Examination   (3 - 0 - 0)

This will test the project management knowledge of students from AT&T, Lucent Technologies and Verizon who have completed company-sponsored project management courses. Upon successful completion, (graded pass/fail) students will be awarded three credits towards a Master of Science degree. The examination is normally given twice each year.

MGT 810   Special Topics in Management   (3 - -)

A participating seminar on topics of current interest andimportance in Management.

MGT 898   Written Communications   (0 - 0 - 0)

Written and oral communications training and assessment are conducted in this online workshop which carries zero credit and will not appear on the student's official transcript. All full-time graduate students are required to take MGT898. To this end, students in certain required graduate courses are automatically enrolled in MGT 898. Students who do not pass the written assessment will be required to take MGT 897: Online Writing Tutorial.

MGT 899   Ethics Quiz   (0 - 0 - 0)

All graduate students in the School of Business must participate in an online ethics workshop in order to graduate. The ethics requirement is part of the course work for MGT 609 - Introduction to Project Management. Students who are enrolled in MGT 609 are automatically enrolled in MGT 899 - Ethics Workshop at no cost. This workshop carries zero credit and will not appear on the student's official transcript. Completion of all exercises associated with the Ethics Workshop is sufficient to satisfy the ethics requirement. This course is required for all students who enrolled in the fall semester 2010 or later.

MGT 900   Thesis in Management (MS)   (1 to 12 - -)

For the degree of Master of Science. Hours and credits to be arranged.

MGT 960   Research in Management (PhD)   (- -)

Original research leading to a doctoral dissertation. Hours and credits to be arranged.

MIS 702   Curricular Practical Training   (1 to 3 - 0 - 0)

This course involves an educationally relevant, practical assignment that augments the academic content of the student's program. Students engage in a project in a company project related to the focus of their academic program. The project is conducted under the supervision of a faculty advisor and an industry mentor. During the semester, the student must submit written progress reports and at the end of the semester, a detailed written report that describes his/her activities and knowledge gained during that semester. This is a one-credit course that may be repeated up to a total of three credits. With approval of the Program Director and faculty supervisor, students may also take this course for three credits in one semester.

Quantitative Finance

QF 101   Quantitative Finance   (3 - 3 - 0)

This is the 1st Spine Course in the Quantitative Finance program. The course objective is to introduce students to the basics of business, finance, and the capital markets as a foundation for subsequent Spine Courses. There is no pre-requisite, and no prior knowledge of business or finance topics is assumed.

QF 102   Basic Financial Tools   (3 - 3 - 1)

This is the 2nd Spine Course in the Quantitative Finance program. The course objective is to familiarize students with the methods of creating and managing investment portfolios. This involves understanding basic concepts of portfolio construction, integrating investment decisions across multiple positions and asset categories. A Secondary objective is to expand the student's familiarity with the sources and formats of the standard financial reports prepared by public companies in the United States, and to allow students to gain experience in accessing and using publicly available financial information. In addition, students will continue to gain experience with the use of real-time market information on traded securities and the application of simple valuation metrics. Third, students will examine the more prominent types of business models in the financial industry, including commercial banks, investment banks, asset managers and other financial service companies. Prerequisites: QF 101

QF 103   Introduction to Financial Tools and Technology   (1 - 0 - 1)

The course will introduce students to the Bloomberg terminal, from technical analysis to fundamental analysis. Students will also learn how to retrieve historical data from Bloomberg and analyze that data in the SAS statistical program. The course arms the students with skill-sets typically learned on the job.

QF 104   Data Management in R   (1 - 1 - 0)

Objective of this course is to provide students with formal training on various advanced skills in R, students will be pre-loaded with these skills prior to entering the workplace. After taking this course, students will be able to understand 1) advanced R, 2) how to read/write financial data to/from SQL and noSQL databases, 3) basic regression techniques, and 4) how to construct and run off-the-shelf machine learning algorithms. This lab session will employ a lecture followed by in-class exercises based on material from the lecture.

QF 112   Statistics   (3 - 3 - 0)

This course provides students with an understanding of the use of statistical methods as applied to business problems, in general, and to marketing research applications in particular. Topics include: descriptive statistics; probability theory, discrete and continuous probability distributions; sampling theory and sampling distributions; interval estimation; hypothesis testing; statistical inference about means, proportions, and variances; tests of goodness-of-fit and independence; analysis of variance and experimental design; simple and multiple regression; correlation analysis.

QF 197   Online Writing Tutorial   (0 - 0 - 0)

Students who do not pass the written assessment in QF198 will be required to take QF197: Online Writing Tutorial for no cost and zero credit. Completion of all the online quizzes in the tutorial is sufficient to obtain a passing grade.

QF 198   Writing Assessment   (0 - 0 - 0)

Written and oral communications training and assessment are conduction in conjunction with a required course in the BS in Business program. Students in this course are automatically enrolled in QF198: Writing and Assessment Program. This online workshop carries zero credits and will not appear on the student's official transcript.

QF 199   Ethics Quiz   (0 - 0 - 0)

The ethics requirement is incorporated into the course work for a required course in the BS in Business program. Students are automatically enrolled into QF199 – Ethics Workshop at no cost. This workshop carries zero credit and will not appear on the student's official transcript. Completion of all exercises and the survey associated with the Ethics Workshop is sufficient to satisfy the ethics requirement.

QF 200   Financial Ecomometrics   (3 - 3 - 0)

Econometrics, literally "economic measurement," is a branch of economics that attempts to quantify theoretical relationships. This course will have both a theoretical and applied econometrics components. There will be a focus on using econometrics software in estimating econometrics models learned during the semester and interpreting the results. There will be a review of probability and statistics as needed and then moves on to regression with a single regressor, multiple regression, the basics of functional form analysis, and the evaluation of regression studies. There will be a focus on using econometrics software in estimating econometrics models learned during the semester and interpreting the results. Prerequisites: BT 221 or MA 221 or QF 112

QF 202   Financial Time Series   (3 - 3 - 0)

Students will study the application of quantitative methods to the field of finance, including investment theory and risk management. Among topics covered will be regression analysis, building asset/business cash flow models of a business, sensitivity analysis, value at risk (VAR) models, probability transition matrices and stochastic difference equations (SDE's). Prerequisite: QF 200

QF 301   Advanced Time Series Analytics and Maching Learning   (3 - 3 - 0)

This course will cover the main topics of the analysis of time series to evaluate risk and return of the main products of capital markets (equity, fixed income, and derivatives). Students will work with historical databases, conduct their own analysis, and test trading strategies based on the techniques reviewed during the class. Prerequisites: QF 202, QF 112, and MA 331 or MGT 620

QF 302   Financial Market Microstructure and Trading   (3 - 3 - 0)

This course will offer students an understanding of the main micro-structural features of financial markets, and the opportunity to test and practice different trading strategies. The course concentrates on the operations of exchanges, trading systems and broker/dealer intermediaries. Students will have a high level view of the trading decision process, market structure design, and market structure regulation. The course is based on computer simulations that recreate a trading environment and the typical challenges faced by professional traders.

QF 401   Senior Design I

Senior Design Project is a two-semester experience beginning with QF401 and progressing to QF 402. The goal of the course is to provide you with basic skills for successfully performing high-quality research in finance and to help you choose a research topic to work on. The course will include both formal training sessions, on various aspects of research in finance, and an actual research project completed by students. This course is designed to better prepare students for their transition into the professional work environment by completing a project, which allows students to put into practice concepts they have learned during their studies at Stevens. In many cases, the project will include doing research on a relevant finance topic.

QF 402   Senior Design II

Senior Design Project is a two-semester experience beginning with QF401 and progressing to QF 402. The goal of the course is to provide you with basic skills for successfully performing high-quality research in finance and to help you choose a research topic to work on. The course will include both formal training sessions, on various aspects of research in finance, and an actual research project completed by students. This course is designed to better prepare students for their transition into the professional work environment by completing a project, which allows students to put into practice concepts they have learned during their studies at Stevens. In many cases, the project will include doing research on a relevant finance topic.

QF 427   Investment Practicum I   (4 - 4 - 0)

The Stevens Investment Practicum is a student managed investment fund (SMIF) staffed by enrolled students and advised by faculty/staff advisory committee. The practicum is intended to be an advanced course for QF and BT and possibly other students considering the pursuit of an investment management career. Prerequisite: BT 321

QF 428   Investment Practicum II   (4 - 4 - 0)

The Stevens Investment Practicum is a student managed investment fund (SMIF) staffed by enrolled students and advised by faculty/staff advisory committee. The practicum is intended to be an advanced course for QF and BT and possibly other students considering the pursuit of an investment management career. Prerequisites: BT 321, and QF 427

QF 430   Introduction to Derivatives   (3 - 3 - 0)

This is a course on the fundamentals of financial derivatives, covering the basic properties and the pricing fundamentals of futures, options and swaps. It also explores trading and hedging strategies involving financial derivatives. Finally, time permitting special topics such as exotic options and credit derivatives are explored. The course provides the foundation of financial derivatives and lays the ground for a rigorous risk management course and other advanced quantitative courses, such as stochastic finance. It also provides students with some of the knowledge required for the CME competition and the CFA examination. Prerequisites: BT 425

QF 465   C++ for Finance   (3 - 3 - 0)

C++ is the main program used in the financial industry because of its efficiency and object oriented structure that facilitates the development of specialized financial libraries. The course will extend the students' knowledge base, learned in QF365, and move them further into C++ object oriented programming through the use of design patterns and expose them how to price out derivative instruments learned throughout the quantitative finance curriculum. Prerequisite: CS385

Network and Communication Management and Services

TM 500   Calculus for Telecommunications Managers   (3 - 0 - 0)

The goal of this course is to provide students with the background in calculus necessary for the telecommunications curriculum. Topics covered include review of algebra, coordinates in the plane and functions, differentiation, series, geometric series and exponential series, elements of counting, illustrations of the material on discrete distributions, z-transform, integration of simple functions, integrals over the entire line and basic probability densities. The eleven topics listed can be expanded or contracted depending on how students react to the material. E.g. the topic of functions of two variables can be changed by emphasizing discrete functions and their relationship to joint distributions. Some topics (e.g. coordinates in the plane and functions) may require two sessions. However, it is planned to cover the entire material in 13 sessions.

TM 550   Introduction to Telecommunications Concepts   (3 - 0 - 0)

This course sets the foundation for courses that are to follow, covering concepts and major technologies of the telecommunications industry. Telecommunications regulations, end-to-end service, and historical events are stressed. This course is open to Telecommunications majors only and is intended for students with a minimal telecommunications background.

TM 584   Wireless Systems Security   (3 - 0 - 0)

Wireless systems and their unique vulnerabilities to attack; system security issues in the context of wireless systems, including satellite, terrestrial microwave, military tactical communications, public safety, cellular, and wireless LAN networks; security topics: confidentiality/privacy, integrity, availability, and control of fraudulent usage of networks. Issues addressed include jamming, interception, and means to avoid them. Case studies and student projects are an important component of the course. Cross-listed with: NIS 584, EE 584

TM 586   Wireless Networking: Architecture, Protocols and Standards   (3 - 0 - 0)

This course addresses the fundamentals of wireless networking, including architectures, protocols, and standards. It describes concepts, technology, and applications of wireless networking as used in current and next-generation wireless networks. It explains the engineering aspects of network functions and designs. Issues such as mobility management, wireless enterprise networks, GSM, network signaling, WAP, mobile IP, and 3G systems are covered. Cross-listed with: EE 586, NIS 586

TM 601   Principles of Applied Telecommunications Technology   (3 - 3 - 0)

This comprehensive course provides an introduction to voice and data networking. The course begins with an overview of sample wide-area and local-area network architectures and provides an introductory discussion on the role and importance of the TCP/IP protocol architecture. The relationship between bandwidth, passband, signaling rate, and data rate is then presented and examined. Different signaling techniques are compared, the operations of selected analog and digital modulation techniques are examined, and PCM and related techniques to digitally encode analog information are studied. We describe the operation of cyclic redundancy codes in error detection and discuss the importance of channel coding rate and coding gain in system operation. The function and service of data link protocols in network architecture is examined. Both frequency and time division multiplexing are described and their operation is compared. The course concludes with an examination of mobile wireless networks. Prerequisite: Knowledge of fundamental algebraic problem solving is a must.

TM 605   Probability for Telecommunications Managers   (3 - 0 - 0)

This course provides a background in probability and stochastic processes necessary for the analysis of telecommunications systems. Topics include: axioms of probability, combinatorial methods, discrete and continuous random variables, expectation, Poisson processes, birth-death processes, and Markov processes. Cross-listed with: NIS 505

TM 610   Business Information Networks   (3 - 0 - 0)

This comprehensive course examines LANs (both Ethernet and Wireless LANs), TCP/IP, routing protocols, congestion control techniques, internetwork operation, and Internet applications (including VoIP). Emphasis is placed on protocol and network architecture, protocol operation, advantages and disadvantages of each approach, and applications. Specific topics include LAN architecture and protocols, IP protocol architecture and addressing, TCP protocol operation, Internet routing, flow and congestion control, multicasting, Mobile IP, DHCP, and an introduction to SDN. Internet applications (email, DNS, http) and VoIP are also studied. This course also includes a virtual (on-line) network simulator which provides valuable and practical examples to support and extend the concepts examined in the lectures. Prerequisite: TM 601

TM 612   Regulation and Policy in the Telecommunication Industry   (3 - 0 - 0)

This course surveys the basic principles underpinning US and international telecommunications policies, regulations and laws. In particular, we will examine the legal and regulatory treatment of a number of related technologies—from telephony to cable to the Internet—whose convergence will continue to challenge established principles. The course will focus most intently on administrative policies as well as statutory and regulatory laws, paying special attention to the design and implementation of the Telecommunications Act of 1996. In addition, the course will address the role played by antitrust, intellectual property and constitutional law in shaping our nation's telecommunications landscape. Finally, the course will consider the important role played by state and federal agencies—antitrust enforcers, state public utility commissions and the Federal Communications Commission—in developing and administering our nation's telecommunications laws, regulations and policies.

TM 615   Wireless Communications and Mobile Computing   (3 - 0 - 0)

This course provides a broad and comprehensive perspective of mobile wireless networks. Topics covered include fundamentals of mobile wireless networking, radio architecture, the multiple access techniques of TDMA, CDMA (with examples provided from UMTS and cdma2000), and OFDMA. The principle 4G standard, LTE, is also studied. The LTE access and core networks are examined and the important functional network elements are identified and distinguished. Key enabling technologies for 5G wireless networks are also identified and discussed. Emphasis is given to the role of Software Defined Networks and Network Function Virtualization in 5G (and 4G) networks. To assist in this discussion, an introduction to both SDN and NFV is provided. 5G mobile wireless networks are introduced and the architecture and challenges of emerging 5G networks are examined. The impact of the Cloud (or Centralized) RAN (C-RAN) in 4G and 5G networks is also studied. Prerequisites: TM601, TM605, and TM610

TM 616   The Global Wireless Industry   (3 - 0 - 0)

This course introduces the student to the global wireless industry focusing on wireless mobility systems. The course will provide the student with an understanding of the various complexities facing management when deploying or operating a wireless mobility system. The course will utilize a combination of traditional text-based material in addition to homework assignments. In addition, there will be a class project that students will each have to work on as a team. The course will focus on four main areas of a wireless mobility system as it relates to the technical management; global wireless mobility market, regulatory requirements, management challenges and decision methods.

TM 617   Next Generation Wireless Systems   (3 - 0 - 0)

This course provides a broad and comprehensive perspective 3.5G, 4G and emerging 5G mobile wireless networks. The architecture of HSPA and Ev-DO are examined and differentiated. Our study of 4G begins with an examination of OFDM and OFDMA. The principle 4G standard, LTE, is studied next. The LTE access and core networks are examined and the important functional network elements are identified and distinguished. Key enabling technologies for 5G wireless networks are also identified and discussed and the network architecture for 5G is examined. Of particular importance is the role of Software Defined Networks and Network Function Virtualization in 5G (both RAN and core networks). The architecture, advantages, and challenges of the Cloud (or Centralized) RAN (C-RAN) is examined along with Network Slicing. Prerequisite: TM615

TM 618   Wireless Network Performance Management   (3 - 0 - 0)

This course develops a fundamental understanding of the performance, management, and life-cycle analysis of emerging mobile wireless networks. The major components of a mobile wireless network, the Radio Access Network (RAN), and the core Back-Bone Network (BBN), are described in terms of their major functional elements. The impact of these functional elements upon the ability of the system to achieve established performance metrics is examined. This course will also examine the trade-offs in system performance and management that each of the elements has on system complexity, planning, and ability to meet the required performance objectives. Life-cycle analysis and, in particular, the migration of mobile wireless systems to third generation networks is discussed with emphasis on the impact of migration on system architecture and cost. The topics of system performance, management, and life-cycle analysis are crucial to wireless managers and professionals in the planning and migration of mobile wireless networks. The course includes a team project where the students will apply the knowledge covered by the course to a practical case study. Prerequisite: TM 615

TM 630   Broadband Networking Services and Technology   (3 - 0 - 0)

This course provides a broad and comprehensive study of the technologies enabling broadband services and networking. High-speed network access technologies, core-network architectures, and the broadband service environment are the focus of this course. The broadband access technologies of Digital Subscriber Line (DSL), cable modem service, optical fiber-based access, and the high-speed wireless technology of LTE and 5G are examined and differentiated. The core-network technologies of MPLS, RSVP, DiffServe, as well as the services-converging IP Multimedia Sub-system (IMS) are discussed and studied as enabling technologies for broadband services. An overview is provided of key broadband services: VoIP, IPTV, streaming video and Video on Demand. The course concludes with a discussion of the opportunities and threats posed to service providers and the communications industry by the emerging disruptive technologies of broadband networking. Prerequisite: TM 610

TM 631   Broadband Service Management   (3 - 3 - 0)

Broadband Service Management is a comprehensive course for those interested in deploying and operating broadband networks from a technical and managerial aspect. A broadband network's success is based on its ability to deliver a desired service with a specific service requirement referred to as a Service Level Agreement (SLA). The Service Level Management whether it is with an operator, infrastructure vendor, Third Party Vendor (3PV) or customer all have specific Key Performance Indicators (KPI) associated with them. The ability to define, identify, and manage those Key Performance Indicators associated with a broadband network Service Level Agreement requires a thorough understanding of the entire broadband ecosystem. Prerequisite: TM 630

TM 650   Software Defined Networks and Network Function Virtualization   (3 - 3 - 0)

This course examines two important new network technologies and architectures; Software-Defined Networking (SDN) and Network Function Virtualization (NFV). These two closely related approaches are a direct response to the changing requirements to support new networking services in an integrated and flexible approach. The reason for each architecture is presented and their ability to meet the changing network requirements is examined. The architecture, standards, and applications for each is presented and studied. Each architecture is differentiated and compared and the potential interworking of each is considered. The course concludes with an introduction and study of the Internet of Things (IoT) and Cloud Computing. The course is guided by both a required textbook and recently published scholarly papers on these topics. Prerequisites: TM610

TM 701   Network and Communication Management and Services Co-Op Education Project   (0 - 0 - 0)

This course is for Network and Communication Management and Services graduate students who are on Co-Op assignment.

TM 702   Curricular Practical Training   (1 to 3 - 0 - 0)

This course involves an educationally relevant, practical assignment that augments the academic content of the student's program. Students engage in a project in a company project related to the focus of their academic program. The project is conducted under the supervision of a faculty advisor and an industry mentor. During the semester, the student must submit written progress reports and at the end of the semester, a detailed written report that describes his/her activities and knowledge gained during that semester. This is a one-credit course that may be repeated up to a total of three credits. With approval of the Program Director and faculty supervisor, students may also take this course for three credits in one semester.

TM 800   Special Problems in Network and Communication Management and Services (MS)   (3 - -)

An investigation of a current research topic under the direction of a faculty member. A written report is required which should have the substance of a publishable article.

TM 810   Special Topics in Network and Communication Management and Services   (3 - -)

A participating seminar on topics of current interest and importance in Network and Communication Management and Services.

TM 900   Thesis in Network and Communication Management and Services (MS)   (1 to 12 - -)

Masters thesis is Network and Communication Management and Services. Hours and Credits to be arranged.

Master of Technology for Experienced Professionals

EMT 606   Economics for Managers   (3 - 3 - 0)

This course introduces managers to the essence of business economics – the theories, concepts and ideas that form the economist's tool kit encompassing both the microeconomic and macroeconomic environments. Microeconomic topics include demand and supply, elasticity, consumer choice, production, cost, profit maximization, market structure, and game theory while the Macroeconomic topics will be GDP, inflation, unemployment, aggregate demand, aggregate supply, fiscal and monetary policies. In addition the basic concepts in international trade and finance will be discussed.

EMT 623   Financial Management   (3 - 3 - 0)

This course covers the fundamental principles of finance. The primary concepts covered include the time value of money, principles of valuation and risk. Specific applications include the valuation of debt and equity securities as well as capital budgeting analysis, financial manager's functions, liquidity vs. profitability, financial planning, capital budgeting, management of long term funds, money and capital markets, debt and equity, management of assets, cash and accounts receivable, inventory and fixed assets. Additional topics include derivative markets.

EMT 624   Financial Analysis for Technical Organizations   (3 - 3 - 0)

This course presents concepts regarding the collection, processing, and reporting of financial information in a technology-based business. Managerial accounting and cost accounting, and their uses and limitations will be discussed. Use of financial statements, budgets, and cost estimates in management decision-making will be emphasized. The impact of the risk and uncertainty associated with financial decisions will be illustrated via case studies.

EMT 630   Global Business and Markets   (3 - 3 - 0)

This is a comprehensive course in global business and markets providing a broad, multidisciplinary understanding of global business. The theoretical context for engaging in international trade is established, with attention to the current economic and political environment. Then the business level rationale and techniques for initiating trade, as well as the functional area decisions that must be made, are discussed. Topics include: cultural differences; international trade; regional economic integration; international monetary system; entry strategies; strategic alliances; exporting and importing; global production and logistics; global marketing. Cross-listed with: MGT 630

EMT 635   Managerial Judgment and Decision-Making   (3 - 3 - 0)

Executives make decisions every day in the face of uncertainty. The objective of this course is to help students understand how decisions are made, why they are often less than optimal, and how decision-making can be improved. This course will contrast how managers do make decisions with how they should make decisions, by thinking about how "rational" decision makers should act, by conducting in-class exercises and examining empirical evidence of how individuals do act (often erroneously) in managerial situations. The course will include statistical tools for decision-making, as well as treatment of the psychological factors involved in making decisions. Cross-listed with: MGT 635

EMT 638   Corporate Finance   (3 - 3 - 0)

This course serves as a second semester sequence in corporate finance. Students enrolling should have a mastery of the topics of covered in Managerial Finance I (EMT 623), including time value of money, capital budgeting, risk adjusted hurdle rates, managerial accounting, and ratio analysis. Among the topics covered in EMT 638 are: leverage on the balance sheet and weighted average cost of capital; bankruptcy, turnarounds, and recapitalizations; international currency hedging; stock options; private equity valuation; mergers and acquisitions; and the issuance of public and private securities. Cross-listed with: MGT 638 Prerequisites: EMT 623

EMT 642   Marketing Strategy   (3 - 3 - 0)

This course focuses on the methodology involved in developing and writing an effective marketing plan. It covers how to obtain the information that is needed and how to write a rigorous marketing plan for a product or service. The course details the steps needed to perform a market opportunity analysis (MOA) and explores how to develop market-based strategies and tactics to capitalize on the identified opportunities.

EMT 675   New Product and Service Innovation   (3 - 3 - 0)

This course provides students with the most current theories and tools to function effectively in the corporate environment when there is constant change. By building upon material covered in Technology Innovation Management (MGT 671), this course will deepen students' knowledge of the innovation process in the enterprise and will pay special attention to service industries. The course will be taught with lectures and real world cases. Upon completion, students will have enhanced their knowledge of the innovative enterprise and increased their practical skills for careers in technology management. Prerequisites: MGT 671

EMT 677   Emerging Technologies   (3 - 3 - 0)

This course discusses emerging technologies, how they evolve, how to identify them, and the effect of international, political, social, economic, and cultural factors on them. Topics covered in the course include accuracy of past technology forecasts, how to improve them, international perspective on emerging technologies, future customer trends, and forecasting methodologies such as monitoring, expert opinion, trend analysis, and scenario construction. Emerging technologies will be examined through student company examples, invited speakers, and videos. Cross-listed with: MGT 677

EMT 695   Leading Creative Collaboration   (3 - 3 - 0)

Innovative organizations are led by people who relentlessly nurture creative collaborations. These leaders stimulate imagination, teach others how to turn imagination into creativity, and build group structures and processes to enable people to turn creative ideas into innovations that drive business results. This course builds individual awareness of creativity and collaboration skills while increasing the student's capacity for both. It teaches the science behind techniques, tools, interpersonal skills, leadership skills, organizational strategies, and environmental designs that increase group effectiveness. The overall goal is to strengthen the student's ability to lead others to address meaningful problems and possibilities wherever they may be found. Cross-listed with: MGT 695

EMT 696   Human-Centered Design Thinking   (3 - 3 - 0)

This course deals with the theory and methods associated with design thinking, a problem-solving protocol that spurs innovation and solves complex problems. Design thinking involves a unique form of inquiry which goes well beyond product and service design. Students will develop an appreciation for design and develop skills for studying design systems. These concepts and methods have wide applicability as they can be used to design organizations of people, information structures, compensation systems as well as the entire consumer experience. Applying these approaches can often create entirely new systems that are more useful and usable. The logic of this approach can sometimes solve "wicked problems" which have defied previous solutions. Cross-listed with: MGT 696

EMT 714   Technology Strategy   (3 - 3 - 0)

This course discusses the technology strategy process and develops skills, methodologies, and critical thinking in order to achieve technological competitive advantage. Subjects covered include technology life-cycles, type and characteristics of RD&E project portfolio selection, and an overview of successful development strategies. Case studies will be used to build competence and confidence in the concepts.

EMT 715   Strategic Business Management   (3 - 3 - 0)

This course focuses on the major elements of the strategic management model, including mission, external and global environment, company profile, strategic analysis and choice, long- and short-term objectives; action plans/tactics, policies, restructuring, reengineering, strategic control, and continuous process improvement (CPI). Student teams analyze and formulate strategies for companies they select.

EMT 740   Team Leadership Development in Technical Organizations   (3 - 3 - 0)

This course focuses on understanding the interplay of group, inter-group, and organizational factors on the performance of multifunctional teams in technology-based organizations. The course integrates theory and research on multifunctional teams with the skills necessary for effectively managing them. Topics covered include managing decision-making and conflict in multifunctional teams, managing the team's boundary and inter-group relations, organizational designs that support working cross-functionally, and measuring and rewarding team performance. Cases are used to illustrate the problems of working cross-functionally. Individuals are given feedback on their team management skills.

EMT 751   Project Management and Leadership   (3 - 3 - 0)

This course provides a theoretical and practical perspective on modern project management and leadership in technology-based organizations and forms the conceptual basis to develop "a project leader mindset." The course will focus on strategic project success, as well as project cultures, project organization, and project processes as they are employed in different project types and for different levels of project uncertainty, complexity, and pace. The leadership part of the course is based on the premise that people are the real engine behind project results, and they must be led and motivated in a very unique way. Different leadership styles will be discussed, together with motivation and career issues, in different project and organizational settings.

EMT 752   Corporate Entrepreneuring   (3 - 3 - 0)

This course focuses on corporate venturing and entrepreneurship. Business and financial issues associated with starting and buying an entrepreneurial, high-technology business are addressed. Subjects covered include a discussion of previous corporate ventures, critical success factors, and an international perspective on corporate venturing. Lessons learned from new technology start-ups will be discussed, along with an evaluation of the decision processes used by venture capitalists. The final project is the development of a venture plan for the student's company. Over half of the business plans receive funding. Startup funding on previous projects has ranged from $50,000 to $1,000,000,000.

EMT 758   Practicum - Oral & Written Communication Competency   (3 - 3 - 0)

In this workshop/lab, students will learn several skills to help them present and write more effectively. Specific topics include components of effective writing, ten steps for effective presentations, using advanced computer technologies in oral presentations, and portraying the correct image. Students will be graded on several team and individual oral presentations and written reports throughout the program to demonstrate their competency in both oral and written communications. Each student will have an oral/written report card. Cross-listed with: MIS 758

EMT 798   Integration and Application of Technology Management   (3 - 3 - 0)

This is the capstone course for the program. It is designed to integrate the knowledge developed in the other courses via a business simulation in which teams of students compete in running their companies in a complex simulated environment. The course includes lectures and workshops that demonstrate theory and techniques of cross-functional decision-making in the management of technology. Individuals and teams will be observed and assessment feedback will be given. (5.0 credits) Cross-listed with: MGT 798

EMT 800   Special Problem: EMTM   (3 - 3 - 0)

One to six credits. Limit of 6 credits for the degree of Master of Technology Management (EMTM).

EMT 810   Special Topics in Management of Technology   (3 - 3 - 0)

A participating seminar on topics of current interest and importance in Management of Technology.

COLLEGE OF ARTS AND LETTERS

COLLEGE OF ARTS AND LETTERS

The College of Arts & Letters (CAL) provides curricula in the Arts, Humanities, and Social Sciences for all Stevens students. As befits the history and mission of Stevens, CAL delivers liberal arts courses that empower students to engage the world analytically, creatively, ethically, and critically. Such preparation requires historical literacy, knowledge and appreciation of the rich intellectual and artistic heritage of diverse cultures, the ability to reason clearly, and strong writing and communication skills.

CAL offers interdisciplinary undergraduate degree programs with strong technological emphasis, including Science, Technology, and Society; Science Communication; Social Sciences; Music & Technology; and Visual Arts & Technology. CAL also offers undergraduate degree programs in Literature, History, and Philosophy.

The Freshman Experience

The College of Arts and Letters administers the Freshman Experience program for all incoming freshmen and transfer students.

Incoming domestic freshmen take CAL 103 Writing and Communications Colloquium in the fall of their freshman year, followed by CAL 105 Knowledge, Nature, Culture in the spring of their freshman year. International students who are not English Language Learners (ELL) will follow the same path. Transfer students may be required to take one or both of these courses, to be determined at the time of their matriculation.

Incoming international students who are ELL will be placed in CAL 101 English Skills for the fall semester of their freshman year, before going on to the Freshman Experience sequence. They can attempt to place out of this course and go directly into the 103/105 sequence by taking a diagnostic test with both a written and an oral component, administered during Freshman Orientation. Students who remain in CAL 101 for the fall semester will take CAL 103 in the spring of their freshman year and CAL 105 in the following fall.

While Advanced Placement (AP) credit cannot be applied to CAL 103 or CAL 105, transfer credit may be accepted for CAL 103, for a writing course taken at another university if equivalency can be established. No transfer credit is available for CAL 105, except in exceptional cases, as determined by CAL. CAL 101 is a three-credit course that can be used to fulfill general elective credits (not humanities credits).

Writing and Communications

The Writing & Communications Center (WCC), in the College of Arts & Letters, empowers students by helping them develop the written and oral communication skills essential to their success in academic coursework and beyond. To the end, the WCC offers feedback on any essay, research project, dissertation, or presentation in a safe and supportive learning space. In one-on-one conferences, our staff of highly-trained consultants help create stronger writers rather than "correcting" or "fixing" student writing.

FACULTY

Carlos Alomar
Distinguished Artist in Residence

Andrew Brick
Teaching Professor, Music & Techology

Diana Bush, Ph.D.
Teaching Associate Professor, Art History

Fatma Betul Cihan Artun, Ph.D.
Teaching Assistant Professor, Writing & Humanities

Lindsey Cormack, Ph.D.
Assistant Professor, Social Sciences/Political Science

Aysegul Durakoglu, Ph.D.
Teaching Associate Professor, Music & Technology

Karina Everett, Ph.D.
Teaching Assistant Professor, Writing & Humanities

David Farber, Ph.D.
Distinguished Career Professor of Science
and Technology Studies

Lainie Fefferman, Ph.D.
Assistant Professor, Music & Technology

Bradley Fidler, Ph.D.
Assistant Professor, Science and Technology Studies

Michael Geselowitz, Ph.D.
Faculty Affiliate, History

Robin Hammerman, Ph.D.
Teaching Associate Professor, Writing & Humanities

Robert Harari, M.S.
Teaching Associate Professor, Music & Technology

Mary Ann Hellrigel, Ph.D.
Faculty Affiliate, History

John Horgan, M.S.
Director, Center for Science Writings

Kristyn Karl, Ph.D.
Assistant Professor, Social Sciences/Political Science

Michael Kowal, Ph.D.
Assistant Professor, Social Sciences/Political Science

Susan Levin, Ph.D.
Professor, Literature

Ashley Lytle, Ph.D.
Assistant Professor, Social Sciences/Psychology

Theresa MacPhail, Ph.D.
Assistant Professor, Director, Science and Technology Studies

Alexander Magoun, Ph.D.
Faculty Affiliate, History

Christopher Manzione, M.F.A.
Assistant Professor, Visual Arts & Technology

Jennifer McBryan, Ph.D.
Teaching Assistant Professor, Writing & Humanities
Director, Freshman Experience

Billy Middleton, Ph.D.
Teaching Associate Professor, Writing & Humanities
Director of Assessment

Gregory Morgan, Ph.D.
Associate Professor, Philosophy

Joyce Mullan, Ph.D.
Teaching Assistant Professor, Philosophy
Pre-Law Advisor

Samantha Muka, Ph.D.
Assistant Professor, Science & Technology Studies

Lisa Nocks, Ph.D.
Teaching Affiliate, History

Nancy Nowacek, M.F.A.
Assistant Professor, Visual Arts & Technology

Nicholas O'Brien, M.F.A.
Assistant Professor, Visual Arts & Technology

Benjamin Ogden, Ph.D.
Teaching Assistant Professor, Writing & Humanities

Anthony Pennino, Ph.D.
Associate Professor, Literature

Donya Quick, Ph.D.
Research Assistant Professor, Music & Technology

Andrew Rubenfeld, Ph.D.
Teaching Professor, Literature

Deborah Sinnreich-Levi, Ph.D.
Associate Professor, Literature

Michael Steinmann, Ph.D.
Professor, Philosophy
Director, Program in Humanities and Social Sciences

Lindsey Swindall, Ph.D.
Teaching Assistant Professor, Writing & Humanities

Yu Tao, Ph.D.
Associate Professor, Social Sciences/ Sociology

Kelland Thomas, D.M.A.
Dean, College of Arts & Letters
Professor, Music & Technology

Jeff Thompson, M.F.A.
Assistant Professor, Director, Visual Arts & Technology

Jason Vredenburg, Ph.D.
Teaching Assistant Professor, Writing & Humanities

Alex Wellerstein, Ph.D.
Assistant Professor, Science and Technology Studies

Mary Robin Whitney, Ph.D.
Teaching Assistant Professor, Writing & Humanities

Undergraduate Programs

B.A. AND B.S. DEGREE PROGRAMS

The College of Arts and Letters at Stevens offers distinctive B.A. degree programs in the arts, humanities, and social sciences. CAL's comprehensive and rigorous curricula provide the foundations and expertise necessary for a variety of careers, graduate work in the chosen field of study, or for professional programs in law, medicine, or management.

Students can earn a degree majoring in one of the following fields of study:

Bachelor of Arts (B.A.) degrees:

‣ Literature

‣ Music & Technology

‣ Philosophy

‣ Science Communication

‣ Social Science

‣ Visual Arts & Technology

Bachelor of Science (B.S.) degree:

‣ Science, Technology & Society (STS)

Core Humanities Courses

In their first year of study, all CAL majors take a two-course sequence, the Freshman Experience, which offers an introduction to academic writing and communication (CAL 103) and an introduction to the humanities and social sciences (CAL 105).

Majors in the humanities, social sciences, and STS must take a sequence of four core courses which cover the humanistic disciplines as they pertain to topics in science and technology:

‣ History of Science and Technology (HHS 130)

‣ Introduction to Science and Technology Studies (HST 120)

‣ Images of Science in Literature (HLI 220)

‣ Science and Metaphysics (HPL 112)

Visual Arts & Technology majors must take any four courses for humanities credit, with at least one course 300-level or higher.

Music & Technology majors must take a total of four (4) humanities courses outside of their major field (i.e. non-HMU courses). At least one of these four humanities courses must be at the 300/400 level.

Major Concentration Area

CAL Majors all take courses in their major discipline, as follows:

BA in Literature:

‣ HLI 113 Classical Literature

‣ HLI 114 Western Literature: Middle Ages to the Present

- One Course on a Major Author (e.g. Shakespeare)

- One Course in American Literature (e.g. Colonial & Romantic American Literature)

- One Survey Course from Classical to Renaissance or Elizabethan to Modern (e.g. 19th Century English Literature: Victorians)

- One Course in Modern Literature (e.g. Realist & Modern American Literature)

- One Course in Non-European Literature (e.g. Caribbean Literature & Culture)

Additional Major Courses:

- Five major-area courses (HLI)

Upper Division CAL Courses:

- Two courses of CAL 300- or 400-level courses outside your major (i.e. non-HLI)

General Elective Requirements:

- Eight additional elective courses chosen by the student. May be used to satisfy minor, double major, or dual degree requirements.

BA in Music & Technology:

- HMU 101 Music History I

- HMU 102 Music History II

- HMU 201 Music Theory I

- HMU 202 Music Theory II

- HMU 303 Music Theory III

- HMU 304 Music Theory IV

- HMU 231 Sound Recording I

- HMU 232 Sound Recording II

- HMU 333 Sound Recording III

- HMU 334 Sound Recording IV

- HMU 220 Keyboard Studies I

- HMU 221 Keyboard Studies II

- HMU 211 MIDI & Electronic Music

- HMU 397 Orchestration I

- HMU 310 Music Composition

- HMU 407 Sound Design

- HMU 405 Electronic Music

- Two Semesters of Music Ensemble - HMU 498

- Four Semesters of Private Instrumental Lessons - HMU 496

- One Semester of Music Recital - HMU 497

General Elective Requirements:

▸ Four additional elective courses chosen by the student. May be used to satisfy minor, double major, or dual degree requirements.

BA in Philosophy:

▸ HPL 111 Theories of Human Nature

One course selected from each of the following groups:

▸ Group 1: HPL 339 (Ethics) or HPL 340 (Social & Political Philosophy) or HPL 348 (Aesthetics)

▸ Group 2: HPL 368 (Philosophy of Science) or HPL 442 (Logic)

▸ Group 3: HPL 347 (Theories of Knowledge and Reality) or HPL 443 (Philosophy of Language) or HPL 444 (Philosophy of Mind)

Major Courses:

▸ 8 major-area courses (HPL)

Upper Division CAL Courses:

▸ Two courses of CAL 300- or 400-level courses outside your major (i.e. non-HPL)

General Elective Requirements:

▸ Eight additional elective courses chosen by the student. May be used to satisfy minor, double major, or dual degree requirements.

BA in Science Communication:

▸ HST 160 Introduction to Science Communication

Major Courses:

▸ 10 major-area courses (HST or consult your advisor regarding non-HST courses that count towards this degree)

Upper Division CAL Courses:

▸ Two courses of CAL 300- or 400-level courses outside your major

General Elective Requirements:

▸ Eight additional elective courses chosen by the student. May be used to satisfy minor, double major, or dual degree requirements.

BA in Social Science:

Two courses selected from:

▸ HSS 127 (Political Science I: National Government)

▸ HSS 141 (Introduction to Sociology)

▸ HSS 175 (Fundamentals of Psychology)

Major Concentration:

▸ Five courses in psychology, sociology, or political science

Major Courses:

▸ Five major-area courses (HSS or HST)

Upper Division CAL Courses:

▸ Two courses of CAL 300- or 400-level courses outside your major (i.e. non-HSS or HST)

General Elective Requirements:

▸ Eight additional elective courses chosen by the student. May be used to satisfy minor, double major, or dual degree requirements.

BA in Visual Arts & Technology:

▸ HAR 110 Foundation 2D: Color & Composition

▸ HAR 111 Foundation 3D: Form & Space

▸ HAR 112 Observational Drawing

▸ HAR 113 Figure Drawing

▸ HAR 114 Introduction to Photography

▸ HAR 180 History of Art: Prehistory to Modern

▸ HAR 225 Moving Image: On Screen

▸ HAR 226 Moving Image: In Space

▸ HAR 241 Design I

▸ HAR 280 Modern Art History & Theory

▸ HAR 385 Contemporary Art

▸ Plus one upper-level art history course (300/400 level)

Major Concentration - One of the following sequences:

▸ Animation: HAR 330 (Animation II) and HAR 430 (Animation III)

▸ Design: HAR 340 (Design II) and HAR 440 (Design III)

▸ Game Design: HAR 360 (Game Design II) and HAR 460 (Game Design III)

▸ Creative Programming: HAR 371 (Creative Programming II) and HAR 471 (Creative Programming III)

▸ Video: HAR 320 (Video II) and HAR 430 (Video III)

General Elective Requirements:

▸ Eight additional elective courses chosen by the student. May be used to satisfy minor, double major, or dual degree requirements.

BS in Science, Technology & Society:

▸ HST 160 Introduction to Science Communication

▸ HST 401 Seminar in Science Writing

Major Courses:

▸ 10 major-area courses (HST or consult your advisor regarding non-HST courses that count towards this degree)

Upper Division CAL Courses:

▸ Two courses of CAL 300- or 400-level courses outside your major

General Elective Requirements:

▸ Six additional elective courses chosen by the student. May be used to satisfy minor, double major, or dual degree requirements.

Secondary Concentration Area

Successful completion of a degree requires a secondary concentration area. This entails taking a set of five (5) courses in one or more disciplines outside of the major program of study, including (but not limited to) engineering, management, physics, chemistry, computer science, or another discipline in CAL. This additional breadth of experience provides students with an opportunity to achieve significant competence in a scientific, technological, or professional field and prepares them for a variety of careers. Secondary concentration areas may draw from any disciplinary area offered across Stevens. Students may use the secondary concentration area to complete requirements towards a minor in a second field. Although a limited number of courses are needed to complete the secondary concentration requirement, open electives in the student's study plan may be used to gain greater expertise and depth in the chosen area.

Writing and Research Methods / Professional Practices

All CAL majors are required to take a class in Writing and Research Methods or Professional Practices, to be taken during the junior year. The course prepares students for academic and professional work in their chosen major area while developing the senior thesis or capstone project as the culmination of major study. Courses that fulfill this requirement for various majors in CAL include:

▸ BA in Literature, Philosophy, Science Communication: CAL 301, Writing and Research Methods

▸ BS in STS: CAL 301, Writing and Research Methods or HST 301, Research Design and Methods

▸ BA in Music & Technology: CAL 301, Writing and Research Methods (Special Section for Music & Technology majors ONLY)

▸ BA in Social Science: HSS 301, Research Design and Methods

▸ BA in Visual Arts & Technology: HAR 301, Professional Practices

Senior Thesis / Capstone

All CAL students, with the exception of Visual Arts & Technology majors, take the following classes:

▸ CAL 498, Thesis Research (first semester of senior year)

▸ CAL 499, Senior Thesis (second semester of senior year, 4 credits)

Visual Arts & Technology majors take the following equivalent courses:

▸ HAR 498, Capstone I (first semester of senior year)

▸ HAR 499, Capstone II (second semester of senior year)

These classes all require formal registration. Midterm and final grades will be given. Students must pass CAL / HAR 498 in order to register for CAL / HAR 499. If CAL / HAR 498 has to be retaken, the completion of the thesis will be postponed for at least one semester. The sequence of classes is necessary to ensure adequate preparation for thesis writing or capstone project implementation. All graduating CAL majors participate in the Stevens Innovation Expo.

Courses in Computing, Mathematics, and Sciences

CAL majors must also take courses in computing, math, and science. CAL major students have specific requirements in these areas. Four mandatory courses for all majors are distributed as follows:

▸ Computing - 3 credits

▸ Mathematics - 6 credits

▸ Science - 3 credits

In addition to the courses listed above, majors in the B.S. degree in Science, Technology, and Society (STS) must take two (2) additional science courses.

The following courses fulfill the computer science requirement for CAL students:

▸ CS 105 Introduction to Scientific Computing

▸ CS 115 Introduction to Computer Science

▸ HAR 271 Creative Programming I

The following courses can be combined to fulfill the 6-credit math requirement for CAL students:

▸ MA 117 Calculus for Business & Liberal Arts (3 credits)

▸ MA 119 Multivariable Calculus & Finite Math for Business & Liberal Arts (3 credits)

▸ MA 120 Introduction to Calculus (2 credits)

▸ MA 121 Differential Calculus (2 credits)

▸ MA 122 Integral Calculus (2 credits)

▸ MA 123 Series, Vectors, Functions & Surfaces (2 credits)

▸ MA 124 Calculus of Two Variables (2 credits)

▸ BT 221 Statistics

The following courses fulfill the science requirement for CAL students:

▸ PEP 151 Introduction to Astronomy

▸ PEP 123 Physics I for Business & Technology

▸ PEP 124 Physics II for Business & Technology

▸ BIO 281 Biology & Biotechnology

▸ EN 250 Quantitative Biology

- NANO 200 Intro to Nanotechnology

- CE 240 Introduction to Geoscience

- CH 115 Chemistry I

- CH 116 Chemistry II

- PEP 111 Mechanics

- PEP 112 Electricity & Magnetism

Additional computer science, math and science courses may also satisfy requirements. Please consult your academic advisor for the specific requirements of your program.

Minors

Students can obtain a minor at the College of Arts and Letters by submitting a study plan to the appropriate CAL minor advisor. Those completing the minor receive a certificate upon graduation. Students have to achieve a C or better in each course of the minor.

- History

- Literature

- Philosophy

- Social Science

- Science, Technology, and Society

- Science Communication

- Medical Humanities

- Visual Arts & Technology

- Music & Technology

- Theater and Technology

- Film Studies

- Gender and Culture Studies

- Pre-law and Public Policy

In general, a CAL minor requires a total of 9 humanities courses including the Freshman Experience (CAL 103 and CAL 105). Beyond these courses, a minimum of six courses in the minor discipline must be taken. Depending on the discipline and with the approval of the advisor, these can be:

- one 100/200-level course and five upper-division (300/400-level) courses

Or

- two 100/200-level courses and four upper-division (300/400-level) courses

Students must also take one upper-division course (which qualifies for humanities credit) in a CAL discipline outside the minor field.

For specific requirements for any CAL minor, please contact the minor advisor.

Bachelor of Arts in Literature

The Literature program at Stevens provides students with the opportunity to study great books of world literature in their entirety to understand what and how these texts signify. A number of courses involve literary and cultural events in New York City. Literature courses cover a wide range from Shakespeare to science fiction and also include the study of classical mythology, cinema, and creative writing.

Literature Curriculum

Term I

Course #	Course Name	Lecture	Lab	Study	Credit
CAL 103	Writing & Communications Colloquium	3	0	6	3
HHS 130	History of Science and Technology	3	0	6	3
HST 120	Introduction to Science and Technology Studies	3	0	6	3
	Computer Science	3	0	6	3
	Major Specific Course	3	0	6	3
	Total	**15**	**0**	**30**	**15**

Term II

Course #	Course Name	Lecture	Lab	Study	Credit
CAL 105	CAL Colloquium: Knowledge, Nature, Culture	3	0	6	3
HLI 220	Images of Science in Literature	3	0	6	3
HPL 112	Science and Metaphysics	3	0	6	3
	Mathematics	3	0	6	3
	Major Specific Course	3	0	6	3
	Total	**15**	**0**	**30**	**15**

Term III

Course #	Course Name	Lecture	Lab	Study	Credit
	Major Specific Course	3	0	6	3
	Major Specific Course	3	0	6	3
	Mathematics	3	0	6	3
	Secondary Concentration	3	0	6	3
	General Elective	3	0	6	3
	Total	**15**	**0**	**30**	**15**

Term IV

Course #	Course Name	Lecture	Lab	Study	Credit
	Major Specific Course	3	0	6	3
	Major Specific Course	3	0	6	3
	Science	3	0	6	3
	General Elective	3	0	6	3
	General Elective	3	0	6	3
	Total	**15**	**0**	**30**	**15**

Term V

Course #	Course Name	Lecture	Lab	Study	Credit
	Major Specific Course	3	0	6	3
	Major Specific Course	3	0	6	3
	Non-Major Humanities Requirement	3	0	6	3
	Secondary Concentration	3	0	6	3
	General Elective	3	0	6	3
	Total	**15**	**0**	**30**	**15**

Term VI

Course #	Course Name	Lecture	Lab	Study	Credit
	Major Specific Course	3	0	6	3
	Major Specific Course	3	0	6	3
CAL 301*	Seminar in Writing and Research Methods	3	0	6	3
	Secondary Concentration	3	0	6	3
	General Elective	3	0	6	3
	Total	**15**	**0**	**30**	**15**

*Other research method classes determined with your advisor.

Term VII

Course #	Course Name	Lecture	Lab	Study	Credit
	Major Specific Course	3	0	6	3
	Major Specific Course	3	0	6	3
CAL 498	Thesis Preparation	3	0	6	3
	Secondary Concentration	3	0	6	3
	General Elective	3	0	6	3
	Total	**15**	**0**	**30**	**15**

Term VIII

Course #	Course Name	Lecture	Lab	Study	Credit
CAL 499	Senior Thesis	4	0	8	4
	Non-Major Humanities Requirement	3	0	6	3
	Secondary Concentration	3	0	6	3
	General Elective	3	0	6	3
	General Elective	3	0	6	3
	Total	**16**	**0**	**32**	**16**

Bachelor of Arts in Philosophy

The bachelor's degree in Philosophy at Stevens provides the opportunity to explore all the traditional fields of philosophy with the unique advantage of doing so at an institution renowned for advances in science and engineering. The program is focused on the philosophy of science, the history of philosophy, and applied ethics. Students acquire foundational skills in analytical and conceptual thinking and apply philosophical analysis to practical and societal issues.

Philosophy Curriculum

Term I

Course #	Course Name	Lecture	Lab	Study	Credit
CAL 103	Writing & Communications Colloquium	3	0	6	3
HHS 130	History of Science and Technology	3	0	6	3
HST 120	Introduction to Science and Technology Studies	3	0	6	3
	Computer Science	3	0	6	3
	Major Specific Course	3	0	6	3
	Total	**15**	**0**	**30**	**15**

Term II

Course #	Course Name	Lecture	Lab	Study	Credit
CAL 105	CAL Colloquium: Knowledge, Nature, Culture	3	0	6	3
HLI 220	Images of Science in Literature	3	0	6	3
HPL 112	Science and Metaphysics	3	0	6	3
	Mathematics	3	0	6	3
	Major Specific Course	3	0	6	3
	Total	**15**	**0**	**30**	**15**

Term III

Course #	Course Name	Lecture	Lab	Study	Credit
	Major Specific Course	3	0	6	3
	Major Specific Course	3	0	6	3
	Mathematics	3	0	6	3
	Secondary Concentration	3	0	6	3
	General Elective	3	0	6	3
	Total	**15**	**0**	**30**	**15**

Term IV

Course #	Course Name	Lecture	Lab	Study	Credit
	Major Specific Course	3	0	6	3
	Major Specific Course	3	0	6	3
	Science	3	0	6	3
	General Elective	3	0	6	3
	General Elective	3	0	6	3
	Total	**15**	**0**	**30**	**15**

Term V

Course #	Course Name	Lecture	Lab	Study	Credit
	Major Specific Course	3	0	6	3
	Major Specific Course	3	0	6	3
	Non-Major Humanities Requirement	3	0	6	3
	Secondary Concentration	3	0	6	3
	General Elective	3	0	6	3
	Total	**15**	**0**	**30**	**15**

Term VI

Course #	Course Name	Lecture	Lab	Study	Credit
	Major Specific Course	3	0	6	3
	Major Specific Course	3	0	6	3
CAL 301*	Seminar in Writing and Research Methods	3	0	6	3
	Secondary Concentration	3	0	6	3
	General Elective	3	0	6	3
	Total	**15**	**0**	**30**	**15**

*Other research method classes determined with your advisor.

Term VII

Course #	Course Name	Lecture	Lab	Study	Credit
	Major Specific Course	3	0	6	3
	Major Specific Course	3	0	6	3
CAL 498	Thesis Preparation	3	0	6	3
	Secondary Concentration	3	0	6	3
	General Elective	3	0	6	3
	Total	**15**	**0**	**30**	**15**

Term VIII

Course #	Course Name	Lecture	Lab	Study	Credit
CAL 499	Senior Thesis	4	0	8	4
	Non-Major Humanities Requirement	3	0	6	3
	Secondary Concentration	3	0	6	3
	General Elective	3	0	6	3
	General Elective	3	0	6	3
	Total	**16**	**0**	**32**	**16**

Bachelor of Arts in Social Sciences

The Social Sciences program at Stevens allows students to study human behavior and society through a variety of approaches and methodologies. Students acquire foundational skills from disciplines such as Political Science, Sociology, and Psychology. After choosing a concentration in one of these fields, they are involved in individual research projects.

Social Sciences Curriculum

Term I

Course #	Course Name	Lecture	Lab	Study	Credit
CAL 103	Writing & Communications Colloquium	3	0	6	3
HHS 130	History of Science and Technology	3	0	6	3
HST 120	Introduction to Science and Technology Studies	3	0	6	3
	Computer Science	3	0	6	3
	Major Specific Course	3	0	6	3
	Total	**15**	**0**	**30**	**15**

Term II

Course #	Course Name	Lecture	Lab	Study	Credit
CAL 105	CAL Colloquium: Knowledge, Nature, Culture	3	0	6	3
HLI 220	Images of Science in Literature	3	0	6	3
HPL 112	Science and Metaphysics	3	0	6	3
	Mathematics	3	0	6	3
	Major Specific Course	3	0	6	3
	Total	**15**	**0**	**30**	**15**

Term III

Course #	Course Name	Lecture	Lab	Study	Credit
	Major Specific Course	3	0	6	3
	Major Specific Course	3	0	6	3
	Mathematics	3	0	6	3
	Secondary Concentration	3	0	6	3
	General Elective	3	0	6	3
	Total	**15**	**0**	**30**	**15**

Term IV

Course #	Course Name	Lecture	Lab	Study	Credit
	Major Specific Course	3	0	6	3
	Major Specific Course	3	0	6	3
	Science	3	0	6	3
	General Elective	3	0	6	3
	General Elective	3	0	6	3
	Total	**15**	**0**	**30**	**15**

Term V

Course #	Course Name	Lecture	Lab	Study	Credit
	Major Specific Course	3	0	6	3
	Major Specific Course	3	0	6	3
	Non-Major Humanities Requirement	3	0	6	3
	Secondary Concentration	3	0	6	3
	General Elective	3	0	6	3
	Total	**15**	**0**	**30**	**15**

Term VI

Course #	Course Name	Lecture	Lab	Study	Credit
	Major Specific Course	3	0	6	3
	Major Specific Course	3	0	6	3
HSS 301	Research Design and Methods	3	0	6	3
	Secondary Concentration	3	0	6	3
	General Elective	3	0	6	3
	Total	**15**	**0**	**30**	**15**

Term VII

Course #	Course Name	Lecture	Lab	Study	Credit
	Major Specific Course	3	0	6	3
	Major Specific Course	3	0	6	3
CAL 498	Thesis Preparation	3	0	6	3
	Secondary Concentration	3	0	6	3
	General Elective	3	0	6	3
	Total	**15**	**0**	**30**	**15**

Term VIII

Course #	Course Name	Lecture	Lab	Study	Credit
CAL 499	Senior Thesis	4	0	8	4
	Non-Major Humanities Requirement	3	0	6	3
	Secondary Concentration	3	0	6	3
	General Elective	3	0	6	3
	General Elective	3	0	6	3
	Total	**16**	**0**	**32**	**16**

Bachelor of Arts in Music & Technology

Music and Technology students will gain not only the skills and technological aptitude necessary for any actively engaged musician, but cultivate an insight into the mutually dependent nature of music and technology. With such insight, our students actively engage the critical thinking necessary to implement creative and technical innovation in music.

All Music and Technology students will complete a rigorous curriculum that will include courses in music theory, history, composition, production, sound design, electronic music, instrumental proficiency and technological innovation. The curriculum will prepare the student for a future within a field in which creative innovation and technological implementation is a critical requisite. The Music and Technology major at Stevens is focused on providing a well-balanced course of study that will prepare the student for the ever-increasing demands of today's musicians.

Music & Technology Curriculum

Term I

Course #	Course Name	Lecture	Lab	Study	Credit
CAL 103	Writing & Communications Colloquium	3	0	6	3
HMU 201	Music Theory I	3	0	6	3
HMU 220	Keyboard Studies I[1]	3	0	6	3
HMU 211	MIDI & Electronic Music	2	2	4	3
HMU 496	Music Performance: Private Lessons	0	1	1	.5
	Computer Science Requirement	2	2	4	3
	Total	**13**	**5**	**27**	**15.5**

Term II

Course #	Course Name	Lecture	Lab	Study	Credit
CAL 105	CAL Colloquium: Knowledge, Nature, Culture	3	0	6	3
HMU 202	Music Theory II	3	0	6	3
HMU 221	Keyboard Studies II[1]	3	0	6	3
HMU 496	Music Performance: Private Lessons	0	1	1	.5
	Non-Major Humanities	3	0	6	3
	Science Requirement	3	0	6	3
	Total	**15**	**1**	**31**	**15.5**

Term III

Course #	Course Name	Lecture	Lab	Study	Credit
HMU 101	Music History I	3	0	6	3
HMU 231	Sound Recording I	2	2	4	3
HMU 303	Music Theory III	3	0	6	3
HMU 397	Orchestration I	3	0	6	3
HMU 496	Music Performance: Private Lessons	0	1	1	.5
	Non-Major Humanities	3	0	6	3
	Mathematics	3	0	6	3
	Total	**17**	**3**	**35**	**18.5**

Term IV

Course #	Course Name	Lecture	Lab	Study	Credit
HMU 102	Music History II	3	0	6	3
HMU 232	Sound Recording II	2	2	4	3
HMU 304	Music Theory IV	3	0	6	3
HMU 496	Music Performance: Private Lessons	0	1	1	.5
HMU 497	Recital	0	1	1	.5
	Non-Major Humanities	3	0	6	3
	Mathematics	3	0	6	3
	Total	**14**	**4**	**30**	**16**

Term V

Course #	Course Name	Lecture	Lab	Study	Credit
HMU 310	Music Composition	3	0	6	3
HMU 333	Sound Recording III	2	2	4	3
HMU 498	Ensemble	0	2	2	1
	Non-Major Humanities	3	0	6	3
	Secondary Concentration	3	0	6	3
	Secondary Concentration	3	0	6	3
	Total	**14**	**4**	**30**	**16**

Term VI

Course #	Course Name	Lecture	Lab	Study	Credit
HMU 334	Sound Recording IV	2	2	4	3
HMU 498	Ensemble	0	2	2	1
	Secondary Concentration	3	0	6	3
	Secondary Concentration	3	0	6	3
	Secondary Concentration	3	0	6	3
CAL 301	Seminar in Writing and Research Methods	3	0	6	3
	Total	**14**	**4**	**30**	**16**

Term VII

Course #	Course Name	Lecture	Lab	Study	Credit
HMU 407	Sound Design	3	0	6	3
CAL 498	Thesis Preparation	3	0	6	3
	General Elective	3	0	6	3
	General Elective	3	0	6	3
	Total	**12**	**0**	**24**	**12**

Term VIII

Course #	Course Name	Lecture	Lab	Study	Credit
HMU 405	Electronic Music	3	0	6	3
CAL 499	Senior Thesis	4	0	8	4
	General Elective	3	0	6	3
	General Elective	3	0	6	3
	Total	**13**	**0**	**26**	**13**

(1) Students have the option to take HMU 220, HMU 221, HMU 322.

Bachelor of Arts in Science Communication

The B.A. in Science Communication from Stevens Institute of Technology teaches students to convey information about science, technology and medicine to experts and non-experts in the public, private and non-profit sectors, using a wide variety of media from newspapers and blogs to radio and television. Students will learn processes for data gathering, interviewing, reporting, storytelling and clear presentation of complex information. Science communication majors and minors will benefit from learning their craft at Stevens, one of the world's leading research institutions.

Science Communication Curriculum

Term I

Course #	Course Name	Lecture	Lab	Study	Credit
	Computer Science	3	0	6	3
CAL 103	Writing & Communications Colloquium	3	0	6	3
HST 120	Introduction to Science and Technology Studies	3	0	6	3
HHS 130	History of Science and Technology	3	0	6	3
	Major Specific Course	3	0	6	3
	Total	**15**	**0**	**30**	**15**

Term II

Course #	Course Name	Lecture	Lab	Study	Credit
CAL 105	CAL Colloquium: Knowledge, Nature, Culture	3	0	6	3
HPL 112	Science and Metaphysics	3	0	6	3
HLI 220	Images of Science in Literature	3	0	6	3
	Mathematics	3	0	6	3
HST 160	Intro to Science Communication	3	0	6	3
	Total	**15**	**0**	**30**	**15**

Term III

Course #	Course Name	Lecture	Lab	Study	Credit
	Major Specific Course	3	0	6	3
	Major Specific Course	3	0	6	3
	Science	3	0	6	3
	Mathematics	3	0	6	3
	General Elective	3	0	6	3
	Total	**15**	**0**	**30**	**15**

Term IV

Course #	Course Name	Lecture	Lab	Study	Credit
	Major Specific Course	3	0	6	3
	Major Specific Course	3	0	6	3
	Secondary Concentration	3	0	6	3
	General Elective	3	0	6	3
	General Elective	3	0	6	3
	Total	**15**	**0**	**30**	**15**

Term V

Course #	Course Name	Lecture	Lab	Study	Credit
	Major Specific Course	3	0	6	3
	Secondary Concentration	3	0	6	3
	General Elective	3	0	6	3
	Non-Major Humanities	3	0	6	3
	General Elective	3	0	6	3
	Total	**15**	**0**	**30**	**15**

Term VI

Course #	Course Name	Lecture	Lab	Study	Credit
	Secondary Concentration	3	0	6	3
	Major Specific Course	3	0	6	3
	Major Specific Course	3	0	6	3
CAL 301	Seminar in Writing and Research Methods	3	0	6	3
	General Elective	3	0	6	3
	Total	**15**	**0**	**30**	**15**

Term VII

Course #	Course Name	Lecture	Lab	Study	Credit
	Major Specific Course	3	0	6	3
	Secondary Concentration	3	0	6	3
CAL 498	Thesis Preparation	3	0	6	3
	Major Specific Course	3	0	6	3
	General Elective	3	0	6	3
	Total	**15**	**0**	**30**	**15**

Term VIII

Course #	Course Name	Lecture	Lab	Study	Credit
	Secondary Concentration	3	0	6	3
CAL 499	Senior Thesis	4	0	8	4
	Non-Major Humanities	3	0	6	3
	Major Specific Course	3	0	6	3
	General Elective	3	0	6	3
	Total	**16**	**0**	**32**	**16**

Bachelor of Science in Science, Technology, and Society

Students pursuing the B.S. in STS will be at the forefront of developing solutions to the most pressing issues of the 21st century, such as global climate change, sustainable economic growth, the alleviation of poverty and disease, and the uses of artificial intelligence. The curriculum includes several core courses, in which students analyze science and technology in broad historical, social, and political contexts; foundational courses in science, mathematics, and engineering; and finally, a wide field of advanced topics that allow students to explore case studies and create their own research projects that combine the theoretical and the practical.

Science, Technology, and Society Curriculum

Term I

Course #	Course Name	Lecture	Lab	Study	Credit
CAL 103	Writing & Communications Colloquium	3	0	6	3
	Computer Science	3	0	6	3
MA 117	Calculus I	3	0	6	3
HST 120	Introduction to Science and Technology Studies	3	0	6	3
HHS 130	History of Science and Technology	3	0	6	3
	Total	**15**	**0**	**30**	**15**

Term II

Course #	Course Name	Lecture	Lab	Study	Credit
CAL 105	CAL Colloquium: Knowledge, Nature, Culture	3	0	6	3
HPL 112	Science and Metaphysics	3	0	6	3
MA 236 Or MA 134	Intro to Mathematical Reasoning Or Discrete Mathematics	3	0	6	3
HST 160	Intro to Science Communication	3	0	6	3
HLI 220	Images of Science in Literature	3	0	6	3
	Total	**15**	**0**	**30**	**15**

Term III

Course #	Course Name	Lecture	Lab	Study	Credit
	Major Specific Course	3	0	6	3
	Major Specific Course	3	0	6	3
	Science	3	0	6	3
	Secondary Concentration	3	0	6	3
	General Elective	3	0	6	3
	Total	**15**	**0**	**30**	**15**

Term IV

Course #	Course Name	Lecture	Lab	Study	Credit
	Major Specific Course	3	0	6	3
	Major Specific Course	3	0	6	3
	Science	3	0	6	3
	General Elective	3	0	6	3
	Non-Major Humanities	3	0	6	3
	Total	**15**	**0**	**30**	**15**

Term V

Course #	Course Name	Lecture	Lab	Study	Credit
	Major Specific Course	3	0	6	3
	Secondary Concentration	3	0	6	3
	Major Specific Course	3	0	6	3
	Science	3	0	6	3
	General Elective	3	0	6	3
	Total	**15**	**0**	**30**	**15**

Term VI

Course #	Course Name	Lecture	Lab	Study	Credit
CAL 301 Or HST 301	Seminar in Writing and Research Methods Or Research Design and Methods	3	0	6	3
	Secondary Concentration	3	0	6	3
	Major Specific Course	3	0	6	3
	Major Specific Course	3	0	6	3
	General Elective	3	0	6	3
	Total	**15**	**0**	**30**	**15**

Term VII

Course #	Course Name	Lecture	Lab	Study	Credit
	Major Specific Course	3	0	6	3
	Major Specific Course	3	0	6	3
	Secondary Concentration	3	0	6	3
CAL 498	Thesis Prep	3	0	6	3
	General Elective	3	0	6	3
	Total	**15**	**0**	**30**	**15**

Term VIII

Course #	Course Name	Lecture	Lab	Study	Credit
	Secondary Concentration	3	0	6	3
CAL 499	Senior Thesis	4	0	8	4
	Non-Major Humanities	3	0	6	3
	Major Specific Course	3	0	6	3
	General Elective	3	0	6	3
	Total	**16**	**0**	**32**	**16**

Bachelor of Arts in Visual Arts & Technology

Led by an accomplished faculty, students contemplate the theories and inquiries that have defined art through the ages, all the while forging the expertise needed to land industry jobs. Creativity, critique and collaboration define the classroom, and students are encouraged to explore the intersections of their imaginations and the latest technologies. After a rigorous first-year foundations curriculum, Visual Arts and Technology students complete a concentration in design, creative computation, game design, or moving image as well as a range of electives including virtual reality, physical computing, and art history. Graduates often go on to work in a range of creative fields, including media, production, design, game design, advertising and marketing.

Visual Arts & Technology Curriculum

Term I

Course #	Course Name	Lecture	Lab	Study	Credit
CAL 103	Writing & Communications Colloquium	3	0	6	3
HAR 110	Foundation 2D: Color and Composition	2	2	4	3
HAR 112	Observational Drawing	2	2	4	3
HAR 180	History of Art: Prehistory to Modern	3	0	6	3
	Science	3	0	6	3
	Total	**13**	**4**	**26**	**15**

Term II

Course #	Course Name	Lecture	Lab	Study	Credit
CAL 105	CAL Colloquium: Knowledge, Nature, Culture	3	0	6	3
HAR 111	Foundation 3D: Form and Space	2	2	4	3
HAR 113	Figure Drawing	2	2	4	3
HAR114	Introduction to Photography	2	2	4	3
	Mathematics	3	0	6	3
	Total	**12**	**6**	**24**	**15**

Term III

Course #	Course Name	Lecture	Lab	Study	Credit
HAR 225	Moving Image: On Screen	2	2	4	3
HAR 241	Design I	2	2	4	3
HAR 226	Moving Image: In Space	2	2	4	3
	Humanities Elective	3	0	6	3
	Computer Science	3	0	6	3
	Total	**12**	**6**	**24**	**15**

Term IV

Course #	Course Name	Lecture	Lab	Study	Credit
	300-Level Major Concentration	2	2	4	3
	Mathematics	3	0	6	3
HAR 280	Modern Art History and Theory	3	0	6	3
	Secondary Concentration	3	0	6	3
	Humanities Elective	3	0	6	3
	Total	**14**	**2**	**28**	**15**

Term V

Course #	Course Name	Lecture	Lab	Study	Credit
HAR 385	Contemporary Art	3	0	6	3
	Secondary Concentration	3	0	6	3
	General Elective	3	0	6	3
	General Elective	3	0	6	3
	Humanities Elective	3	0	6	3
	Total	**15**	**0**	**30**	**15**

Term VI

Course #	Course Name	Lecture	Lab	Study	Credit
HAR 301	Professional Practices	3	0	6	3
	400-level Major Concentration	2	2	4	3
	General Elective	3	0	6	3
	General Elective	3	0	6	3
	Secondary Concentration	3	0	6	3
	Total	**14**	**2**	**28**	**15**

Term VII

Course #	Course Name	Lecture	Lab	Study	Credit
HAR 498	Capstone I	4	0	8	4
	Secondary Concentration	3	0	6	3
	General Elective	3	0	6	3
	General Elective	3	0	6	3
	Humanities Elective	3	0	6	3
	Total	**16**	**0**	**32**	**16**

Term VIII

Course #	Course Name	Lecture	Lab	Study	Credit
HAR 499	Capstone II	3	0	6	3
	Secondary Concentration	3	0	6	3
	Upper-level Art History	3	0	6	3
	General Elective	3	0	6	3
	General Elective	3	0	6	3
	Total	**15**	**0**	**30**	**15**

Humanities Requirements

All undergraduate students are required to complete CAL 103, Writing and Communications, and CAL 105, Knowledge, Nature, Culture. Please refer to page 573 for a more detailed explanation of this requirement.

Following the completion of CAL 103 and CAL 105, students must meet the humanities requirements below:

▸ Engineering students: Four additional humanities classes. At least one must be at the 100 or 200 level, at least one must be at the 300 or 400 level, and courses must cover at least two different disciplines within CAL.

▸ Science and Math students: Six additional humanities classes. At least one must be at the 100 or 200 level, at least one must be at the 300 or 400 level, and courses must cover at least two different disciplines within CAL.

▸ Computer Science, Cybersecurity, and Information Systems (for 2011 & 2012 incoming classes) students: Six additional humanities classes. At least one must be at the 100 or 200 level, at least one must be at the 300 or 400 level, and courses must cover at least two different disciplines within CAL. One of the six additional classes must be either HSS 371 or HPL 455.

▸ Cybersecurity (for 2014 incoming class and LATER): Four additional humanities classes. At least one must be at the 100 or 200 level, at least one must be at the 300 or 400 level, and courses must cover at least two different disciplines within CAL. One of the four additional classes must be either HSS 371 or HPL 455.

▸ Business & Technology (Marketing, Finance, Economics, & Information Systems) and Quantitative Finance students: Two additional humanities classes. One must be at the 100 or 200 level, one must be at the 300 or 400 level, and courses must cover at least two different disciplines within CAL.

BT 243, Macroeconomics, and BT 244, Microeconomics, may be counted as upper-level humanities courses, provided they are not required courses in the student's major.

Please note the following about Stevens Humanities Requirements:

Not all courses offered by the College of Arts & Letters satisfy the general humanities requirement for undergraduate programs at Stevens. All courses with the prefixes HHS, HLI, HPL, HSS, and HST offer humanities credit. Courses with the prefixes LFR or LSP do not offer humanities credit. The HTH, HAR and HMU courses listed below offer humanities credit. If you are not sure about a course, please contact the program director, your academic advisor or the CAL office for confirmation.

The only theater, music, and visual arts classes that fulfill humanities requirements are:

Theater

▸ HTH 201 Introduction to Theater

▸ HTH 221 Introduction to Cinema

Music

▸ HMU 101 Music History I

▸ HMU 102 Music History II

▸ HMU 192 Music Appreciation I

▸ HMU 193 Music Appreciation II

▸ HMU 195 History of Electronic and Experimental Music

▸ HMU 350 Music of the Eastern Mediterranean

▸ HMU 494 Seminar in Music and Technology

Other classes in Music & Technology can qualify. Please contact the program director for details.

Students may complete 6 semesters of HMU 490, Music Performance: Concert Band or HMU 491, Music Performance: Jazz Ensemble or HMU 492, Music Performance: Stevens Choir as a general elective.

Visual Arts

- ▶ HAR 180 History of Art: Prehistory to the Modern Era
- ▶ HAR 280 Modern Art History and Theory
- ▶ HAR 281 History of Photography
- ▶ HAR 282 History of Middle Eastern Art
- ▶ HAR 372 Technology and the Landscape
- ▶ HAR 380 Media Culture and Theory
- ▶ HAR 385 Contemporary Art
- ▶ HAR 494 Seminar in Visual Arts and Technology

Graduate Programs

MASTER OF ARTS IN POLICY AND INNOVATION

The Master of Arts in Policy and Innovation educates leaders who can address the challenges in an everchanging global environment. The interdisciplinary program draws on the humanities, the social sciences and management to tackle the most challenging problems faced by our world today. By exposing students to topics related to the ethics, leadership, management and decision-making aspects of technological innovation, the program aims to cultivate ethical leadership in science and technology intensive organizations such as for-profit corporations, non-governmental organizations and the public sector. Graduates of the program find careers as corporate social responsibility officers, project leaders in technological organizations, policymakers in public sector organizations and managers of non-profit entities, among others. This program can help experienced professionals in advancing their careers in their respective organizations by enhancing their knowledge and skills in tackling challenging problems related to technology, policy and ethics.

The program consists of 30 credits (either 10 courses or eight courses and a thesis). After taking three core courses and an applied ethics course, students can earn a Graduate Certificate in Policy and Innovation on the way to their Master's.

COURSE OFFERINGS

General Humanities

CAL 101　　　English Skills　　　　　　　　　　　　　　　　　　　　(3 - 4 - 0)

Open to International Students Only. Cannot be used for Humanities Credit.

CAL 103　　　Writing And Communications Colloquium　　　　　(3 - 3 - 0)

Part of the Freshman Experience at Stevens, this course empowers students with the written and oral communications skills they need for university-level academic discourse and thoughtful global citizenship. The mission of the course is to help students develop their skills in the following essential areas: connective and innovative thinking about complex global issues; composition, structure and argumentation; grammatical and stylistic sophistication; critical reading and textual analysis; research and investigation; group work and mutual evaluation; and polished public speaking using visual aids. Students in this course will be exposed to a wide variety of texts by influential writers who tackle themes of global importance. In addition to learning the conventions of academic communication, they will be encouraged to synthesize complex ideas and develop their own critical perspectives, so that they can become active and ethical members of the global community.

CAL 105　　　CAL Colloquium: Knowledge, Nature, Culture　　　(3 - 3 - 0)

This course introduces students to enduring questions and methods of inquiry that drive research and creative endeavors in the College of Arts and Letters. Drawing on multiple ethical, cultural, and disciplinary perspectives, each faculty member will select a theme designed to help students deepen their understanding of a social-cultural phenomenon by examining it from different points of view. The completion of a research essay is required.

CAL 301　　　Seminar in Writing and Research Methods　　　　(3 - 3 - 0)

A working seminar in which students will become acquainted with the various research methods and resources in the Humanities disciplines, and with the modes of presentation characteristic of each discipline. Special attention will be paid to clarity of expression and logical structure of essays and research papers.

CAL 495　　　Independent Study I　　　　　　　　　　　　　　(3 - 3 - 0)

Independent study allows the student to participate in research, explore a topic not covered by existing courses, or continue to study in greater depth a topic introduced by a course. Independent study courses must be conducted under the guidance of a full time faculty member, whose approval is required prior to enrollment. The student and faculty member must agree on the scope and details of participation in advance.

CAL 496　　　Independent Study II　　　　　　　　　　　　　(3 - 3 - 0)

Independent study allows the student to participate in research, explore a topic not covered by existing courses, or continue to study in greater depth a topic introduced by a course. Independent study courses must be conducted under the guidance of a full time faculty member, whose approval is required prior to enrollment. The student and faculty member must agree on the scope and details of participation in advance.

CAL 498　　　Thesis Preparation　　　　　　　　　　　　　　(3 - 3 - 0)

The student will complete a major research thesis in the area of concentration under the guidance of a faculty advisor. Open to Bachelor of Arts students only.

CAL 499　　　Senior Thesis　　　　　　　　　　　　　　　　(4 - 4 - 0)

An individual program of study arranged between student and instructor. A tutorial plan must be prepared (and presented to the Tutorial Committee of the Department of the Humanities) outlining the program and indicating the nature and scope of the project (generally a written paper). Upon completion of the program, the student will receive a grade and credit for a humanities elective.

CAL 800　　　Special Topics in Policy and Innovation　　　　　(3 - - -)

A participating seminar on topics of current interest and importance in Policy and Innovation.

Visual Arts & Technology

HAR 110   Foundation 2D: Color and Composition   (3 - 2 - 2)

This course traverses through the elemental study of two-dimensional art and design--structural elements, organizational principles, psychological effects, and communicative functions--focusing on both the technical and the imaginative. Problem-solving studio assignments and critiques combined with visits to museums and galleries enable students to develop criteria for the analysis and evaluation of images created both by themselves and by others.

HAR 111   Foundation 3D: Form and Space   (3 - 2 - 2)

This studio course explores the concepts of form and space, focusing on hands-on experiences using different types of materials to create three-dimensional sculptural works. Students are encouraged to be experimental with their combination and use of materials. This course will address formal elements of design and construction in relation to contemporary art works through video documentation, slides and books. Readings that accompany class discussions and a visit to Manhattan will be assigned throughout the semester.

HAR 112   Observational Drawing   (3 - 2 - 2)

This course will approach the basics of drawing as an integrative tool where ideas and processes are explored and expanded through the drawing medium. Skills will be rendered through observation, manipulation, and coordinating and understanding these practices. Through problem solving within a range of projects, each student will begin to develop a visual language and the drawing skills that can be applied to conceptual, visual, and technical disciplines.

HAR 113   Figure Drawing   (3 - 2 - 2)

Students will focus and expand their visual and conceptual knowledge and technical skills by drawing from the nude model, as well as explore new issues, dialogues, and skills surrounding the medium of drawing. The class will include studio course work and independent projects, as well as group field trips to see current drawing exhibitions in New York City. A class presentation of a chosen artist, as well as a supporting written paper, will be required of each student. The final project will be an interdisciplinary independent project designed and created by each student.

HAR 114   Introduction To Photography   (3 - 2 - 2)

This course provides an introduction to the techniques, processes, history, and language of photography. Students will gain a technical understanding of cameras, production techniques, and post-production/presentation in order to develop their abilities to communicate creatively through studio exercises, discussion, and homework projects.

HAR 180   History of Art: Prehistory to the Modern Era   (3 - 3 - 0)

This course will introduce the formal vocabularies specific to works of art and familiarize the student with the complex interaction between form, meaning, and historical context. Course readings will consist of historical documents, as well as recent critical and historical writing. Western and non-Western objects and architecture dating from pre-history to the mid-nineteenth century will be discussed at length in the classroom and at museums. Cross-listed with: HHS 180

HAR 225   Moving Image: On Screen   (3 - 2 - 2)

In this course students will learn foundational creative skills using software to appropriate, manipulate, and create time-based digital images. Concepts such as sequencing, editing, collage, and motion will be discussed through readings, and practiced by generating creative projects. By looking at significant historical and contemporary examples of moving image works, students will formulate how to place their projects within emerging creative practices. Over the course of the semester students will share their work with each other and engage in peer-based critiques. By the end of the semester students will have an introductory understanding of video editing, animation principles, media formatting and output, as well as a starting place to further develop a creative moving image practice using images.

HAR 226   Moving Image: In Space   (3 - 2 - 2)

In this course students will learn foundational creative skills using software to appropriate, manipulate, and create 3D objects and spaces. Concepts such as topology, scale, rendering, and simulating physics will be discussed through readings, and practiced by generating creative projects. By looking at significant historical and contemporary examples of moving image works, students will formulate how to place their projects within emerging creative practice. Over the course of the semester students will share their work with each other and engage in peer-based critiques. By the end of the semester students will have an introductory understanding of 3D modeling and animation, projection, translating digital space into physical space, as well as a starting place to further develop a creative moving image practice using space.

HAR 241   Design I   (3 - 2 - 2)

Almost everything we see and touch has been designed: someone made the decision to use Helvetica on that box of cereal, to make the stop sign a certain shape and color. Design lets us communicate, create relationships between a person and an object or ideas, improve accessibility, and shape our experience of the world. In this class, students will learn the fundamentals of graphic design with a focus on process and tools. Our goal will be developing visual language that communicates ideas while being aesthetically satisfying. By the end of the semester students will know how to use layout, typography, and images to tell stories and communicate ideas.

HAR 250   Data Visualization I   (3 - 2 - 2)

This course addresses how increasingly complex information is represented in novel visual forms in order to address problems in understanding and interpreting information. Fundamental topics on information visualization will be addressed through reading and lectures, tools and techniques for representation, and relevant current research in information visualization methods. Students will gain hands-on experience using appropriate programming tools and software.

HAR 260   Game Design I   (3 - 2 - 2)

An introduction to the mechanics of games as well as a technical introduction to building videogames with industry-standard game engines. Students will create several short, experimental board/analog- and video-games, followed by a large-scale final project. Additionally, students will be introduced to critical writing about games and play.

HAR 271   Creative Programming I   (3 - 2 - 2)

In this interdisciplinary course, students will explore the computer as a tool of powerful creative possibility, not via pre-built software but instead by writing code. Students will learn about the structures and affordances of code, including iteration, recursion, randomness, interactivity, and object-oriented programming as an inspiration for making artworks. Social and political issues around code, such as open source software, will also be discussed. Students will be introduced to historical and contemporary artists and designers who use programming as their medium.

HAR 280   Modern Art History and Theory   (3 - 3 - 0)

This course introduces students to key moments in the history of modern art in the newly industrial societies of America, Europe, and the Soviet Union. Painting, culpture, and photography from the 1850s to the 1980s will be examined. Focusing on a wide range of methodological questions, this course will also consider the relationship between avant-garde culture and mass culture, the implications of emergent technologies for cultural production, and the development of radical avant-gardism in the context of authoritarian political formations and advancing global capitalism. Cross-listed with: HHS 280

HAR 281   History of Photography   (3 - 3 - 0)

This course introduces students to the history of photography from its beginnings in the 1830s to the recent practices of artists working with photographic technologies in the context of postmodernity. The primary task of the course will be to develop visual literacy and familiarity with the complex and contradictory genres and social functions of photographic image production. At the same time, this course will introduce the difficulty of writing the history of photography as a separate discipline that operates both inside and outside histories of modern art. Cross-listed with: HHS 281

HAR 282   History of Middle Eastern Art   (3 - 3 - 0)

This course is a survey of the myriad art and architectural forms of the Middle East. From earliest origins in Mesopotamia and Egypt, the course examines Byzantine and Sassanid influences on the development of Islamic Art under the Umayyids and Abbassids, as well as the Ottomans and Persians. It follows these influences through the nineteenth and twentieth centuries, examining the current state of art, including film, in the Middle East.

HAR 301   Professional Practices   (3 - 3 - 0)

This course covers the essentials of being a professional artist or designer: professional writing, portfolio preparation, finding exhibition and job opportunities, and finances for creatives. By the end of the semester, students will have crafted a portfolio of their work, as well as a professional packet for seeking internships, jobs, and exhibition opportunities. Additionally, the course marks the beginning of the Visual Art & Technology thesis process. Students will conduct research and write an artist statement outlining other artists and creatives whose work is an influence.

HAR 321   Virtual and Augmented Reality   (3 - 2 - 2)

Virtual and augmented realties combine our real-world environments with dynamic computer-generated sensory inputs such as 3D models, sound, video, and graphics to create immersive artworks. In this course students will learn a range of current tools and processes within this field to develop creative artworks, and discuss historical, contemporary and theoretical issues of virtual and augmented reality.

HAR 340   Design II   (3 - 2 - 2)

The foundation of design is built on typography and shape and process, but today design is much more than just solutions to visual problems. Design is about problem-making, responding to the world, offering up new visual ideas, thinking through materials, social responsibility, and communicating ideas between people. This semester, we'll build on the fundamentals you learned in Design I, but will be focusing on processes that cross the analog/digital divide, on designing experiences with multiple pages and screens, and ways to connect how you work with what you make. Prerequisite: HAR 241

HAR 342   Motion Graphics   (3 - 2 - 2)

This is an introductory studio-based class designed to teach students the methods and applications for creating graphic- and text-based animation for digital video, film and the Internet, and introduces students to the aesthetics and creative philosophies in the field. Through lectures, in-class tutorials, readings, discussions, and weekly projects, students learn professional techniques to develop creative projects and practical approaches to visual problem solving. The class covers techniques ranging from simple animations to complex special effects, and students are required to create all resources for animation purposes including digital image and recorded content. Does not fulfill general humanities requirements; may be taken as a free elective.

HAR 343   3D Modeling   (3 - 2 - 2)

This course is an in-depth studio for creating and manipulating 3D models for artistic production. Focusing on advanced techniques for designing custom topology, this course will build upon beginner skills established in the prerequisite course. Topics include mesh optimization, UV mapping, texturing, baking materials and lights onto models, and rendering. By the end of the course, students will be able to create production-ready 3D models for animation, game design, and portfolio-ready display. Additionally, this class is intended to hone students' aesthetic and personal style through group critique and peer feedback.

HAR 351   Data Visualization II   (3 - 2 - 2)

Having a foundation in the principles and tools of data visualization, this intermediate course will present larger, more complex, and varied projects transforming data into meaningful and beautiful visual forms. Students will be introduced to advanced data parsing, database storage, web-based output, and other topics.

HAR 360   Game Design II   (3 - 2 - 2)

Building upon game design foundations in the introductory prerequisite, this class delves deeper into designing, building, and critically thinking about games. With a focus on 3D, collaborative design team building, and alternative practices, this class will give students the tools to building unique game experiences. Prerequisites: HAR 260

HAR 371   Creative Programming II   (3 - 2 - 2)

This interdisciplinary course introduces students to programming languages created for artists and designers for making practical and experimental interactive artworks. Leveraging the power of custom-written software, this project-based class focuses on interactivity through the lens of videogames. Students will design a series of games, as well as learn about artists/designers using code for creative projects, and the mechanics and history of popular and art games.

HAR 372   Technology and the Landscape   (3 - 2 - 2)

This hybrid studio/seminar course examines how technology has shaped our experience of the landscape, from stone tools to the invention of perspective to algorithmic and virtual worlds. Through creative projects, readings, writing, and field visits, students will explore how technology has shaped the landscape, ways of recording it, and our cultural relationship with the natural and built world. Not for humanities credit.

HAR 380　　　Media Culture and Theory　　　　　　　　　　　　　　　　(3 - 3 - 0)

This course will survey key benchmarks and documents in the history of media technologies, while also introducing critical readings of 20th- and 21st-Century media culture, both from the theoretical field of media studies and the creative works of artists, filmmakers, and writers. We will explore how media technologies from print and photography through film, radio, television, video, the Internet, games, and social software have been successively introduced, disseminated, and commodified, and how their mediations have profoundly affected the way we experience and interpret our contemporary society and culture. Students will be required to complete readings every week, to contribute to a class Web project including blogs and wiki, and to produce short papers and presentations that respond to and analyze the readings, in-class screenings, and other material we discuss.

HAR 385　　　Contemporary Art　　　　　　　　　　　　　　　　　　(3 - 3 - 0)

This course is an overview of a broad range of topics about contemporary fine art. We examine theoretical issues, modern and post-modern styles, and the industry and practice of visual art through bi-weekly visits to galleries and museums in Manhattan. Readings, papers, and presentations are required. This course approaches its subject matter from the artists' standpoint and is taught by a professional artist. Prerequisites: HAR 280

HAR 425　　　Moving Image: Advanced Projects　　　　　　　　　　　　(3 - 2 - 2)

In this course students will develop and produce moving image projects based on independent research. Based on previous skills obtained in the course prerequisites, students will produce focused and advanced projects for their professional portfolio. This class builds the foundations of a studio practice through intensive critiques, class discussion, and maintaining a rigorous production schedule. Students will also undertake the task of presenting these projects in professional contexts outside of Stevens and learn the process of applying for opportunities to jump-start their careers.

HAR 440　　　Design III　　　　　　　　　　　　　　　　　　　　　(3 - 2 - 2)

This course is the culmination of the Design sequence in the Visual Arts program, and as such it is mostly about long-form, self-directed design research. The goal is for you to continue to hone your voice and interests as a designer, to take on a large project requiring considerable creative investigation, and to make work that aligns with your goals as a professional. Prerequisite HAR 340.

HAR 460　　　Game Design III　　　　　　　　　　　　　　　　　　(3 - 2 - 2)

As the highest level course offered in the Game Design concentration for Visual Art and Technology, this course is structured to give advanced students the opportunity to develop from the ground up a complete, well-polished, ready-to-market game. Furthermore, this class will focus on the later stages of development, prototyping, testing, and distribution for students finalizing large-scale or ambitious game projects. Prerequisites: HAR 360

HAR 461　　　Net Art and Design　　　　　　　　　　　　　　　　　(3 - 2 - 2)

An introduction to the principles and strategies of net art through readings, encounters with artwork, projects, and practical instruction in graphic, multimedia, and interaction design for the Web. Techniques and design problems will be studied through historical and current examples of networked artistic practices. This is a studio course, focused on creative production and peer critique, which meets for four hours, once a week, and also requires students to put in weekly lab time outside of class to complete their assignments. Students will be expected to produce and present three net art projects over the course of the semester, including one final project that must be launched online. Students are not expected to have previous programming experience but should already be familiar with the digital imaging, audio, and/or video tools necessary to produce media that they wish to include in their projects. While this course will introduce students to some of the technologies used by net artists, it should not be taken as a programming class, and cannot be used as an equivalent to technical courses offered by other departments.

HAR 470　　　Interactive Installations　　　　　　　　　　　　　　　　(3 - 2 - 2)

In this project-based course, students will produce three site-specific interactive installations which successfully integrate image and sound through audience interaction within a predetermined space and time, using video cameras, microphones, midi, radio waves, live video software, and analog mixers. We will focus on collaboration, process, and contextualizing work within the history of interactive media art, and include research projects, writing/presentations, sketches, critiques, and technical workshops. Prerequisite: CS 105 or CS 115 or CS 181 or HAR 271

HAR 471   Creative Programming III   (3 - 2 - 2)

As the culminating course of the Creative Computation sequence in the Visual Arts & Technology program, this class is structured as long-form, self-directed creative work at the intersection of art, design, and code. Students will hone their voice and interests in the field, take on a semester-long project requiring considerable creative investigation, and make work that aligns with their professional goals.

HAR 490   Internship in Art and Technology   (3 - 0 - 0)

An internship is a short-term work experience that emphasizes learning. It is an essential way to try out a career, develop new skills, combine academic theory with "hands-on" experience, and build up a resume. This is an independent and individually-initiated program of work arranged between the student and an institution, organization, or business. Internship requires a plan (prepared with the job supervisor) to be presented to the Internship faculty sponsor, per approval, in the Program in Art & Technology, outlining the scope of work before starting the internship. It is expected that Internship will run approximately 8 to 12 hours per week for 14 weeks (or 112 to 168 hours per academic session) per 3 credits. A scheduled bi-weekly meeting with a group to discuss internships and career interests is expected. The student's internship performance will be evaluated by the following: a) a weekly journal describing the student's involvement in various activities and projects; b) an approximately five-page reflective essay in which the student integrates prior coursework with the internship experience (a theory and practice exercise); c) a basic report indicating the extent to which scope of work was accomplished; d) attendance and participation in group meetings; e) a written evaluation from the student's supervisor; f) a portfolio of work accomplished during the internship, if appropriate. Does not fulfill general humanities requirements; may be taken as a free elective.

HAR 494   Seminar in Art and Technology   (3 - 3 - 0)

This course provides students with the opportunity to pursue in-depth study of a particular topic within Visual Art and Technology. Topics, prerequisites and assessment criterion may vary at the discretion of the instructor. Registration by permission of the instructor or Visual Arts and Technology director only. Humanities credit is given for this course.

HAR 495   Special Topics in Art and Technology   (3 - 2 - 2)

This course has a different topic or theme each semester, and can be taken twice, subject to advisor approval. Visiting artists who have been invited to work at Stevens will design this course, which will be studio-based or in a seminar format. Teaching methods and evaluation will vary with the instructor. Registration by permission of the instructor or ARTC director only. Topics might include: "The Artist's Book," "The Body and New Physicality," "Database Art," "Negotiating the Everyday," "Transmedia."

HAR 498   Capstone I   (4 - 4 - 0)

Art & Technology students are required to produce a significant body of work or major project in the last semester of their senior year in which the ideas, methods of investigation, and execution are determined by the student under the guidance and direction of a faculty advisor. HAR 498, in combination with the prerequisite (HUM 499) is the culmination of their undergraduate experience. Students are responsible for finding faculty advisors in their area of choice, which may be one person for both HUM 499 and HAR 498, or two faculty members working together during the yearlong process. During the seventh semester, students work in HUM 499 tutorial to begin their research and create a model for their senior projects. Their final semester at Stevens is spent in production. Plans and a schedule are developed with their advisor(s), and they meet every week or two to discuss and evaluate student progress. Group meetings with other seniors and advisors are encouraged. At the end of the semester, the project and substantial analytical paper situating the project are juried by a committee of three, and the project is publicly exhibited. The paper with accompanying visual documentation of the project is submitted to the library. Prerequisite: HAR 301

HAR 499   Capstone II   (3 - 3 - 0)

This course is intended as the capstone experience for Visual Art & Technology students, a focused time to prepare your thesis project and paper. During this semester, we will have a series of group and individual critiques of thesis work in progress, as well as work together to plan, promote, install, and host a reception for the thesis exhibitions, and organize participation in Innovation Expo through posters or other presentations. Prerequisite: HAR 498

History

HHS 119   The Ancient World   (3 - 3 - 0)

This course surveys world history of the ancient era.

HHS 120   Origins of Western Culture   (3 - 3 - 0)

This course examines the foundations of Western Culture.

HHS 123   History of European Society and Culture to 1800   (3 - 3 - 0)

This course investigates the social, economic, intellectual, political and cultural trends in Europe from the Middle Ages to 1900.

HHS 124   History of European Society and Culture Since 1800   (3 - 3 - 0)

This course investigates the social, economic, intellectual, political and cultural trends in Europe from 1800 to the present.

HHS 125   United States History to 1865   (3 - 3 - 0)

This course is a survey of important themes, people, and events in American history from the colonial era to 1865. During the semester we will approach American history from several different vantage points, including the history of racism, political history, cultural history, biographical history, and the history of technology.

HHS 126   United States History Since 1865   (3 - 3 - 0)

This course is a survey of important themes, people, and events in American history since 1865. During the semester we will consider changes in American race relations, civil liberties, corporate capitalism, technology, and American power in a global context.

HHS 130   History of Science and Technology   (3 - 3 - 0)

A historical survey of science and technology. Principal topics include science and technology in prehistory, Egyptian and Babylonian science and culture, Greek science, Medieval technology and science, the Scientific Revolution, the making of the modern physical science, Darwin, and the Darwinian Revolution.

HHS 135   Survey of the Islamic World   (3 - 3 - 0)

This course provides a survey of the origin and development of the modern Islamic World. Beginning in sixth-century Arabia, the course follows the theological and political development of the Muslim community. It explores the reasons for the great appeal Islam has had and the reasons for its spread throughout the Middle East, North Africa, and Southern Asia as well as other regions of the world.

HHS 301   Introduction to Historical Methods   (3 - 3 - 0)

This is an intensive writing and research seminar designed to introduce students to the world of historical research and the historian's craft. History majors are required to take this course during the spring semester of their junior year.

HHS 310   Social History of Science   (3 - 3 - 0)

This course analyzes science as a social entity. The connections between science and society are studied in the first instance through a historical survey of the externals of science: the non-cognitive social, institutional, and professional dimensions of the scientific enterprise. On a case-study basis, the course proceeds to investigate more theoretical problems concerning relations between scientific knowledge and social structure, particularly as interpreted in the Strong Program of the Sociology of Knowledge. Students complete individual projects arising out of themes developed in class.

HHS 311   Science and Society in the 20th Century   (3 - 3 - 0)

An examination of the historical process whereby the scientific enterprise became a central concern of the state in modern industrial societies.

HHS 321   Gay Studies   (3 - 3 - 0)

The course draws on such diverse areas as media studies, literature, art, and psychology, an interdisciplinary approach focusing on the production, distribution, and consumption of cultural artifacts that reflect and/or promote identities and stereotypes based on sexual orientation. Socially normative conditions, in particular compulsive heterosexuality, are examined in an effort to understand the underlying reasons for the narrow range of sexual behaviors and identities traditionally expected in Western societies. By sampling a wide array of works, notably films and literary texts, the course aims to destabilize normative sexual expectations while considering the consequences of social constructions to which individuals are conventionally subjected. Although the course focuses primarily on gay history, parallels to, and intersections with, issues of importance elsewhere in the GLBTQ community are indicated in lectures.

HHS 322   American Cultural History   (3 - 3 - 0)

"America Cultural History" provides an introduction to ways of analyzing conflicts between dominant and minority groups in American life.

HHS 323   Women and Gender in American History   (3 - 3 - 0)

This course focuses on the history of the United States from the perspective of women's experiences and the role gender plays in shaping and defining American history from the colonial era to the present. It examines women's social, political, and economic lives; their roles in society, their familial roles, their struggle to achieve civil rights; changes in their legal status; and the rise of feminism.

HHS 324   Women and Gender in European History   (3 - 3 - 0)

This course focuses on the history of Europe from the perspective of womens' experiences and the role gender plays in shaping and defining European history from the Medieval period to the present. It examines a woman's social, political, and economic life in Europe; their roles in society, their familial roles, their struggle to achieve civil rights; changes in their legal status; and the rise of feminism.

HHS 325   African-American Studies   (3 - 3 - 0)

An exploration of the African-American experience in the United States from the time of the Atlantic Slave Trade to the present. Topics include social and political dynamics shaping African-American history with particular attention focused on Reconstruction, the Great Migration, and the Civil Rights Movement. Numerous African-American leaders and their concepts for an African-American identity are also emphasized, including the W. E. B. Du Bois and Booker T. Washington debates, as well as speeches from Malcolm X and Martin Luther King, Jr.

HHS 355   U.S. Foreign Relations   (3 - 3 - 0)

Selected topics in American diplomatic history are studied, including nationalism, imperialism, economic diplomacy, missionary diplomacy, isolationism, world war, cold war, and detente. Readings include diplomatic correspondence, documents, interpretive articles, and monographs.

HHS 356   The Golden Age of Athens   (3 - 3 - 0)

A study of Ancient Athens in the High Classical period, from the Persian wars to the end of the fifth century BC. Topics will include the rise of democracy under Pericles, as well as achievements in art and architecture, philosophy, and drama.

HHS 357   Latin American History   (3 - 3 - 0)

A survey of the history of the different Latin-American nations from pre-colonial times to the present.

HHS 363   Darwin and the Darwinian Revolution   (3 - 3 - 0)

This course examines the transformation in human thought occasioned by the work of Charles Darwin. It covers the pre-history to Darwin and evolutionary thought. It explores the work of Charles Darwin himself, notably his Origin of Species (1859), and it surveys the further history and impact of Darwin and evolutionary thought in science and society down to today.

HHS 367   Twentieth-Century History   (3 - 3 - 0)

A survey of 20th century Middle Eastern history and politics. This course will explore the issues of nationalism, secularism and social transformations set within the predominantly Islamic Middle East. The different paths adopted by Turkey, Iran and Egypt will be among the major topics to be explored.

HHS 368   History of Astronomy   (3 - 3 - 0)

This course surveys the trajectory of human thought and technological mastery that leads from prehistory down to astronomy and cosmology today. The West was not the only civilization possessed of sophisticated astronomical systems, and the course pauses to examine the cases of astronomy in non-Western cultures. The Scientific Revolution and the acceptance of heliocentrism are historical turning points that receive particular attention in looking at astronomy and physics from Copernicus through Newton. The many normal science advances in astronomy in the 18th and 19th centuries receive treatment before the course turns to the 20th century and revolutionary work that led to modern astrophysics and Big Bang cosmology. The course also treats the state of the current research in astronomy and astronomy as a social institution and profession.

HHS 369   Studies in the Scientific Revolution   (3 - 3 - 0)

An analysis of the intellectual and methodological transformations of sixteenth- and seventeenth-century science and the development of the modern world view. This course focuses on the major scientific figures of the age (Galileo, Descartes, Newton), with particular attention to the study of original texts. The social and institutional transformations of science in this period are also considered.

HHS 370   US Constitutional Law I: Early Foundations and Federalism   (3 - 3 - 0)

An historical and theorectical analysis of the Constitutional Convention, the US Constitution, its foundations, conceptual and idealistic basis for the national government. The decision-making and policymaking roles of the US Supreme Court through case law is closely examined as it relates to governmental powers and federalism.

HHS 371   Modern US Presidency and the Legislative Process   (3 - 3 - 0)

An exploration of the modern American political experience from the turn of the twentieth century to the present. This course examines the historical significance of the American policymaking process. Discussions center on presidential administrations, Congress and political parties addressing domestic agendas and policies. Highlighted eras promoting government activism include Progressivism, New Dealism, Great Society measures and recent political proposals.

HHS 373   US Constitutional Law II: Civil Liberties and Civil Rights   (3 - 3 - 0)

An historical and political analysis of the US Constitution as it relates to civil liberties and civil rights. The decision-making and policymaking roles of the US Supreme Court through case law in these areas are closely examined.

HHS 378   Modern European History   (3 - 3 - 0)

Selected contemporary persepctives on European history since the French Revolution up to the creation of the European Union.

HHS 386   Ancient Civilizations: The Roman Empire   (3 - 3 - 0)

Analyses of the foundation, expansion, and decline of the Roman Empire with an evaluation of its place in history.

HHS 387   The History of American Films   (3 - 3 - 0)

This course examines American fiction films in terms of their historical development through the studio system and in terms of current narrative theory. The course is concerned with ways in which narratives are constructed and ways in which they provide the appearance of "meaning". Particular attention is given to film noir. Various European films that strongly influenced, or parallel, American works, are also examined.

HHS 395   Images of American Life   (3 - 3 - 0)

This course is an advanced elective concerned with cultural aspects of American arts from the nineteenth century to the present. The course centers on the ways in which images in literature, painting, photography, films, and other arts reflect, reinforce, and stimulate cultural norms. Trends in European arts are studied in relation to their influence on American art.

HHS 397   Historical Materialism   (3 - 3 - 0)

An analysis of history taking material factors into account. Course probes this theme from the point of view of historical change over time, case studies of material factors shaping history, and historiographically, that is, how the historical and theoretical literature has treated the exigencies of the material world and parameters governing human interaction with the material world.

HHS 414   Industrial America   (3 - 3 - 0)

In the late nineteenth and early twentieth centuries the United States was fundamentally transformed. This course examines the nation's genesis as an industrial and economic power and society's adaptation to the industrial age. It also considers the impact of industrialism on such historical problems as technological change, economic development, race and gender relations, political participation, reform movements, urbanization, immigration, imperialism, and globalization.

HHS 415   Religion in America   (3 - 3 - 0)

"Religion in America" maps various routes pursued by religious groups in the United States—a culture in which there has been no "established" religion and in which symbiotic relations between the secular world and religious practices/beliefs continually evolve. The course will look principally at religion as a business, religion as a force in politics, and religion in conflict with science and technology.

HHS 420   Modern East Asian Studies   (3 - 3 - 0)

This course explores the modern economic and political development of China, Korea, and Japan from the late nineteenth century to the present and responses to Western imperialism. The rise of Chinese and Korean communism and Japanese fascism during the twentieth century are especially emphasized. There is also a close examination and comparison of development in additional Asian countries such as the Philippines and Vietnam.

HHS 463   The Sixties: A Decade of Protest   (3 - 3 - 0)

The period of the 1960's has been called America's second revolution, or second civil war, because of the radical changes occurring in many parts of society—from politics of inequality to cultural revolutions. The course examines the various movements and shows how individuals and groups have shaped America culturally and socially.

HHS 465   From Caves to Cathedrals: Engineering and Technology Until 1500   (3 - 3 - 0)

This course is a social and cultural history of engineering prehistoric times through the 14th century CE. It examines the nature and the role of the engineer and engineering in a global context in the pre-modern period. Through a series of case studies involving lecture, reading, discussion, and technical demonstrations, the course will examine the technical, economic, political, ideological, and cultural factors that can influence the contents, direction, location, and rhythm of engineering innovation. Particular attention will be paid to the variety of engineering approaches in the pre-modern world, and to non-western attitudes towards technology. This course complements HHS 466, from "Water, Wind & Steam: Engineering from 1400 – 1700" and "Engineering Empire from 1700 to the Present," but none of these courses is a prerequisite for any of the others.

HHS 466   Water, Wind & Steam: Engineering From 1400-1750   (3 - 3 - 0)

This course is a social and cultural history of engineering in the early modern era, the 15th, 16th, 17th, and early 18th centuries. Through a series of case studies involving lecture, reading, and discussion, the course will examine the technical, economic, political, ideological, and cultural factors that can influence the contents, direction, location, and rhythm of engineering innovation. Particular attention will be paid to the emergence of science-based engineering in early modern Europe, and the conditions that were going to lead to its spread throughout the world during the modern period. This course complements HHS 465, from "Caves to Cathedrals: Engineering Until 1500" and "Engineering Empire from 1700 to the Present," but none of these courses is a prerequisite for any of the others.

HHS 467   Engineering Empire From 1700 to 2000   (3 - 3 - 0)

This course highlights selected engineers in the 18th, 19th, and 20th centuries who both contributed to and were influenced by their country's politics, economy, society, or culture. Through readings, discussions, lectures, and assignments we shall see, in countries from France to the U.S. to China, how engineers helped modern nations shape the world inside and beyond their borders. This course complements HHS 465, from "Caves to Cathedrals: Engineering Until 1500" and "Wind, Water & Steam: Engineering from 1400 – 1750,"but none of these courses is a prerequisite for any of the others.

HHS 468   The Electronic Century: Engineering The Last 100 Years   (3 - 3 - 0)

This course surveys the history of electronic and computing technologies from the invention of the electron tube in 1904, through the invention of the transistor, to the internet and the smart phone of today. Most of the semester will be devoted to the trajectories of applications of electricity and electronics to three broad areas of American society—communications, electric power and light, and computing; the social, cultural, political, and economic significance of these technological areas in global history; and the interplay between these technologies and others. Historians of technology have written much on these subjects, and their work will form the basis for the readings, discussions, and writing in this course.

HHS 469   History of England: 1066 - Present   (3 - 3 - 0)

The impact of the Norman Conquest on kingship, government, and social structure; the reign of the Tudors on church and state; the Puritan and Lockean revolutions on the development of Parliament and Common Law; the two party system on reform; the industrial revolution on economic power and Empire; and Britain's role in world wars and the twentieth century. Particular attention is paid to the development of individual rights.

HHS 473   Renaissance Studies   (3 - 3 - 0)

The life and times of the Renaissance artist-engineer, the institutions and influences which created his imagination, inventiveness, and great works of art. The course also covers what he was not, exploding popular myths about his achievements, and investigates his life on a personal, more human level.

HHS 475   Environmental Sustainability in Historical Perspective   (3 - 3 - 0)

The course examines the genealogy of the construct of "sustainability" and the efforts to address its inherent challenges in a variety of places and times. The course is chronological and thematic, with each unit reflecting the mood of the times regarding the conceptual framework of sustainability and reaction/responses, such as the Romantic response to industrialization in Europe and the rise of the Ecology movement in the United States in the late 1960s. It will also provide students with substantive grounding in historical case studies of environmental issues, and develop intellectual tools for understanding and solving contemporary sustainability challenges globally.

HHS 476   History of Medicine   (3 - 3 - 0)

Examination of the history of medical science in the Western World from Greek antiquity to the present.

HHS 479   Studies in the History of Technology   (3 - 3 - 0)

This course takes a thematic approach to the history of technology in the modern era. Topics may include the study of invention, innovation, and standardization; industrial research and development; technological systems; transnational exchanges: histories of gender, labor, and race: and the emergence of a global 'Network Society.'

HHS 495   Seminar in History   (3 - 3 - 0)

Research topics in history and methods of historical scholarship.

Literature

HLI 105   Special Topics in Literature   (3 - 3 - 0)

The subject of this course changes, but recent topics have been an in-depth study of Shakespeare'sHamlet, consideration of three of his comedies, and a study of literary New York.

HLI 113   Western Literature: Classical Literature   (3 - 3 - 0)

Readings in core texts of western literature produced by civilizations of the ancient world. Representative texts include works by: Homer, Sophocles and Virgil, and readings in the Hebrew and Christian Bibles. Sections of this course may takes up great books of science such as Vitruvius' Ten Books on Architecture read in conjunction with Virgil's Aeneid. Instruction in basic elements of rhetoric and composition is also emphasized.

HLI 114   Western Literature: Middle Ages to the Present   (3 - 3 - 0)

Readings in core texts of western literature from medieval times to the present. Representative authors include Chretien, Dante, Racine, Shakespeare, de Lafayette, and Kafka. Instruction in basic elements of rhetoric and composition is also emphasized. Group A, 100-level course.

HLI 115   The English Language: Language of Ideas   (3 - 3 - 0)

Examination of the philosophical use of language as it deals with concepts and value judgments.

HLI 116   Analysis of Literary Forms   (3 - 3 - 0)

Uses of language to convey thought and feeling in a variety of fictional and nonfictional forms. A study of various literary genres with particular attention to what and how texts signify. To survey the structure and development of literary forms, the course will include such works as: Poems by Homer, Dante, and Wadsworth; Plays by Sophocles, Racine, and Anouilh; Novels by Defoe, Austen, and Lessing.

HLI 117   Colonial and Romantic American Literature   (3 - 3 - 0)

A survey of European culture as the foundation of American culture. Course emphasizes literary evelopments and also provides a brief introduction to major developments in western architecture, music, and art.

HLI 118   Realist and Modern American Literature   (3 - 3 - 0)

A study of American literature with reference to parallel developments in architecture, art, music and film. American literature seen as a response to European culture and to problems unique to life in the New World.

HLI 220   Images of Science in Literature   (3 - 3 - 0)

This course introduces students to the discipline of literature by examining literary works of different genres that focus on science and scientific inquiry. Special attention is given to the ways that scientific advances have challenged conventional beliefs about the structure of the world and humanity's place in it. The course will examine how, throughout the centuries, science has been considered as a source for liberation and innovation on the one hand or oppression and even possible transgression on the other. Readings may include works by Aeschylus (Prometheus Bound), Marlowe (Doctor Faustus), Blake, Brecht, Stoppard, Vonnegut, and others.

HLI 312   Modern Literature   (3 - 3 - 0)

A survey of Modernism in European Literature. The authors to be considered include Rimbaud, Mallarme, Rilke, and Mann. Developments in architecture, music, and art are provided, as well.

HLI 313   Wordsworth and English Romanticism   (3 - 3 - 0)

Community, set, group, garden, orchard, parish, vale, poetry, ecology, friendship, food, nature, walking, talking, writing describe the life of the Wordsworth circle. Creating a community of writers who help bring about the Romantic revolution in literature, the Wordsworth circle also addresses perennial concerns about the politics and morality of environmental sustainability, about the health and well-being of people and of their ecological environment. In this context, we study poems such as William Wordsworth's Prelude, Samuel Taylor Coleridge's Rime of the Ancient Mariner, and prose such as Dorothy Wordsworth's Grasmere and Alfoxden journals and Thomas De Quincey's Confessions of an English Opium-Eater.

HLI 314   19th Century English Literature: Victorians   (3 - 3 - 0)

A survey of poets and prose writers such as Thomas Carlyle, Alfred Lord Tennyson, Elizabeth Barrett Browning, John Stuart Mill, Charles Dickens, Oscar Wilde, and Christina Rossetti who in the days of Queen Victoria created texts that reflect our own concerns with religion and science, spirituality and materialism, labor and capital, gender and space, Christmas and goblins.

HLI 316   Science Fiction   (3 - 3 - 0)

A study of the fiction of science and the science of fiction through the reading of authors from Mary Shelley (Frankenstein) to William Gibson (Neuromancer), the viewing of films such as Metropolis and Dune, and the writing of a piece of science fiction.

HLI 318   Caribbean Literature & Culture   (3 - 3 - 0)

Course examines the interrelationship of literary works and the ethnic heritage of their authors and/or the texts themselves.

HLI 319   Ethnicity and Literature   (3 - 3 - 0)

Course examines the interrelationship of literary works and the ethnic heritage of their authors and/or the texts themselves.

HLI 321   Literature, Science and Technology   (3 - 3 - 0)

This course investigates the views man has expressed about the advent impact of technology and science across recorded history. Questions that might be addressed include: What is the relationship between religion and technology? Has man always viewed technological innovations as positive? What relationship is there between man's vision of utopian society and technology? Readings may include, but are not limited to, novels, philosophical treatises, and the literature of various societies.

HLI 330   Classical Mythology   (3 - 3 - 0)

Myths are much more than entertaining stories; they teach much about their cultures. Myths pervade our lives and represent a discrete way of thinking, different from rational logic. In this course, students will see how Western civilization was enriched by Greek and Roman myths. Myths from the ancient Near East also reached the West through the Judeo-Christian tradition. This course provides an introduction to ancient civilizations and their literary, religious, and artistic legacies.

HLI 331   Shakespeare   (3 - 3 - 0)

Selected plays by Shakespeare will be read and analyzed both as literary and performance texts. Students are required to attend a professional production of a Shakespearean play in New York City.

HLI 334   Chaucer: The Journey and the Dreams   (3 - 3 - 0)

This course includes Geoffrey Chaucer's major works The Canterbury Tales and the dream vision poems. The latter are based on accepted contemporary psychological theory that dreams teach solutions to real life problems. In The Canterbury Tales, pilgrims who meet at a roadside tavern tell each other stories about contemporary morals, love, religion, and war as they journey to Canterbury Cathedral. Students will encounter a range of medieval literary genres (e.g., romance, epic, fabliau, and saint's life) while studying the mores and customs of the fourteenth century. Topics include medieval ideas on fate and religion, marriage, magic, science, and technology.

HLI 335   Shakespeare in the City   (3 - 3 - 0)

During the summer, Shakespeare is presented in parks and parking lots throughout New York City. In this course, we read and discuss plays and then go to see them. We view both traditional and experimental productions. Sometimes we see more than one production of a play, if a number of companies decide to do it.

HLI 336   The Short Story   (3 - 3 - 0)

The study of prose fiction in short story form. Texts consist of representative selections of the short story genre that offer a wide variety of techniques and themes. All students will participate in classroom critical analysis.

HLI 337   History of the English Language   (3 - 3 - 0)

A study of the Indo-European origins and development of English from Old English Anglo-Saxon, to Chaucer's Middle English and the Modern English Period.

HLI 338   Thoreau and Environment   (3 - 3 - 0)

This course examines the beginnings of the environmental movement in America by focusing on the writings of Henry David Thoreau and his contemporaries. Primary readings include works by Meriwether Lewis and William Clark, John James Audubon, James Fenimore Cooper, William Cullen Bryant, Ralph Waldo Emerson, Emily Dickinson, John Muir, Sarah Orne Jewett, and Jack London. Contextual material includes works by Hector St. Jean de Crevecoeur, Thomas Jefferson, William Bartram, Philip Freneau, Louis Agassiz, Susan Fenimore Cooper, George Perkins Marsh, Gifford Pinchot, and Theodore Roosevelt.

HLI 341   19th Century English Literature: Romanticism   (3 - 3 - 0)

Consideration of texts by writers of the romantic movement in England: Blake, Coleridge, William and Dorothy Wordsworth, Percy Bysshe and Mary Shelley, Keats, and Byron.

HLI 342   Modern Drama   (3 - 3 - 0)

A survey of theatrical innovation in modern and contemporary Europe and the United States. Students will analyze dramatic literature and attend performances in New York City. Elements of theatrical production such as acting, scenic design and production are emphasized.

HLI 344   British Fiction   (3 - 3 - 0)

Readings from the novel's beginnings in England up to contemporary works. Selections include works such as Defoe's Robinson Crusoe, Richardson's Pamela, Austen's Pride and Prejudice, Bronte's Wuthering Heights, Dickens' Hard Times, and Woolf's To the Lighthouse.

HLI 345   A Survey of Dramatic Literature   (3 - 3 - 0)

Readings of plays from the dramatic productions of Aeschylus to modern works of theatre. Students attend professional productions in New York City and often have an opportunity to interact with those involved in bringing them to the stage.

HLI 348   James Baldwin   (3 - 3 - 0)

Novelist, playwright, poet, essayist, critics, and activist, James Baldwin was one of the most significant and prolific contributors to American letters in the late 20th century. In this class, students will thoroughly explore his canon and consider his work within the frame of race, class, and gender-orientation. The class will also introduce students will learn how to utilize his critical tools in their own writing

HLI 349   American Poetry to 1900   (3 - 3 - 0)

Readings in authors such as Bradstreet, Bryant, Longfellow, Poe, Whitman, and Dickinson.

HLI 351   Romanticism: Painting, Literature, Music   (3 - 3 - 0)

A study of works produced during the British and European romantic movements by. PAINTERS such as David, Turner, Delacroix, Gericault; WRITERS such as Hugo, Goethe, Byron, Sand; COMPOSERS such as Berlioz, Wagner, Chopin. Students attend a professional concert or opera in New York City.

HLI 352   The American Renaissance in Literature   (3 - 3 - 0)

An introduction to works by such writers as Emerson, Thoreau Whitman, Poe, Hawthorne, Melville, and Dickinson. An examination of 19th-century race relations in America from a literary perspective is emphasized.

HLI 354   American Culture   (3 - 3 - 0)

An interpretation of American civilization through its literature and cultural forms. The course involves close reading of a few works of American literature written since World War II.

HLI 357   American Films-American Fiction   (3 - 3 - 0)

An interpretation of American civilization through its literature and cultural forms. The course this semester will involve close reading of a few works by some of the giants of American literature since the Second World War.

HLI 358   American Poetry: 20th Century   (3 - 3 - 0)

A study of works of major American poets of the twentieth century including Pound, Eliot, Williams, Moore, Stevens, Lowell, Ashbery, and Ginsberg.

HLI 363   Modern Irish Literature   (3 - 3 - 0)

This course examines the journey Ireland has taken from British colony to what Fintan O'Toole describes as an island unmoored. Students will explore the complex nature of political, religious, and cultural forces found in the assigned works. Historically, literature is particularly important in the context of Irish nationalism as it served as a means for crafting an identity independent of a British one. Irish authors also contributed greatly to both the Modernist and Post-Modernist movements, and the course will provide a strong foundation in those practices.

HLI 370   Introduction to Journalism   (3 - 3 - 0)

An introduction to the basic methods of journalism, including gathering and verifying facts, finding and interviewing sources, and constructing compelling narratives.

HLI 380   Survey of Latin American Literature: Motorcyclists, Writers, and Revolutionaries   (3 - 3 - 0)

Utilizing Che Guevara's journeys from The Motorcycle Diaries and from later in his life as its spine, this course surveys post-1945 Latin American literature. The emphasis will be placed on works that explore issues of poverty, oppression, and disenfranchisement. The course will further explore specific genres of fiction such as magical realism and examine how they came to evolve in Latin America. The course could include such writers as Gabriel Garcia Marquez, Pablo Neruda, and Guillermo Cabrera Infante.

HLI 390   Modern Culture: Literature and Film (1870s-1948)   (3 - 3 - 0)

Modern Culture provides an introduction to modernism in literature and film. Students read and view a range of works that illustrate aesthetic and cultural aspects of modernism, including political, social, and religious matters, and the influence of technology on works by Hart Crane, Fernand Léger, George Antheil, and others. The course is not intended as a survey of the principal modernist texts and films but rather as an introduction to certain key notions and modes that are characteristic of modernism.

HLI 408   Creative Writing   (3 - 3 - 0)

Creative Writing is a beginner's workshop in the creation of poetry and fiction. Students examine issues such as narrative structure, stanza forms, free verse, and so on. The course explores distinctions between writing as a craft and writing as a process more closely allied with prophecy and gnosis. The impact of the computer on writing is examined. Students read works on poetics and theories of fiction, in particular mimetic and expressionistic theories developed in the West, and learn to shape their own work accordingly. Brief writing assignments are assigned weekly with a longer writing project developed over the part of the course and due the final day of class.

HLI 409   Rhetoric and Technical Writing   (3 - 3 - 0)

An introduction to classical and modern expository and argumentative writing and speech, as well as an introduction to contemporary technical and science writing.

HLI 410   Wanderers, Warriors, Sinners and Saints: Medieval Literature   (3 - 3 - 0)

This course surveys the work of the medieval period in Europe and includes such works as *Beowulf, The Song of Roland,* and selections from the works of Dante, Boccaccio, Chaucer, Marie de France, and other poets.

HLI 412   Medieval Romances: Rise of the Individual   (3 - 3 - 0)

This course focuses on the developing interest in the individual in society in medieval romance. Works and authors studied include: Sir Gawain and the Green Knight, Chretien de Troyes and Gottfried von Strassburg. The course follows the adventuring knight on his quests.

HLI 413   Literature by Women: The Tradition in English   (3 - 3 - 0)

A survey of women authors writing in English from the fourteenth century to the present.

HLI 414   Literature and Empire   (3 - 3 - 0)

This course examines the role of empire building and its influence on the novel, prose, and poetry of the late nineteenth century. Readings present an overview of both colonial and post-colonial literature against the historical background. This course also examines relevant films to explore how the twentieth and twenty-first centuries portray imperialism.

HLI 415   The Bible as Literature   (3 - 3 - 0)

Analysis of selections from the Hebrew and Christian Bibles as literary texts.

HLI 416   The Legend of King Arthur   (3 - 3 - 0)

The course covers a variety of texts beginning with the earliest chronicle reports of a great battle leader—Arthur, king of Britain—and ending with high medieval romances such as The Death of King Arthur. The course explores the birth of the Arthurian legend. Was there ever a historical Arthur? Did he arise to save his people? Will he come again as legend has promised? How has his story developed in literature and popular culture? Delving into the mythic past of Europe, the readings include folk-tales and historical chronicles, and students will immerse themselves in some of earliest sword and sorcery literature, and observe along the way how developing technologies enhanced warrior cultures.

HLI 417   English Literature from Beowulf to the Restoration (1660)   (3 - 3 - 0)

A study of major works and authors including Beowulf, Chaucer, Spenser, Milton, Shakespeare, Wordsworth and Wolf.

HLI 418   Literature and Critical Theory   (3 - 3 - 0)

The application of contemporary literary theory derived from Heidegger and modern linguistics to the study of postmodern American literature. Students are introduced to various literary theories developed by Barthes, Kristeva, Lacan, Derrida, and Foucault, and then asked to apply these theories in considerations of works by such postmodern American writers as Pynchon, Bronk, Gass, Spicer, and Ashbery.

HLI 421   Power and Politics, Kinship and Kings I: Ancient to Renaissance   (3 - 3 - 0)

From the ancient times to the present, literature has engaged political issues. This course traces the intrigues of civil and familial power as captured in significant literary works which offer profound statements, creatively wrought, about vital moral, social and political principles concentrating on works up to the Renaissance. Questions such as whether civilizations can expect their leaders to be ethical in addition to powerful or what happens to society when leaders confront evolving social conditions such as wars, civil unrest or new legal systems or what interplay there may be among the leader (often a man), his family, and the led will be examined in a variety of genres, such as tragedy and epic, and can be explored by invoking the moral imagination. By considering these questions through the vehicle of fiction, literature elicits not only the audience or readers' intellect, but their emotions as well – in both cases, by means of reader-response. One pressing question we will tackle is whether fiction that engages issues of power and politics does – or can function to – change the world.

HLI 446   English Literature: Restoration (1660) to the Present   (3 - 3 - 0)

A survey of English literature from the restoration of the monarchy to the present.

HLI 447   Survey of British Literature   (3 - 3 - 0)

A study of major works and authors, including Beowulf, Chaucer, Spenser, Milton, Shakespeare, Wordsworth, and Wolf.

HLI 471   Literature and the Arts   (3 - 3 - 0)

This course offers consideration of literary texts and their relationships to other art forms. Students will study works of literature and attend related cultural events in New York City. A typical semester may include attendance of "Hamlet" at the Metropolitan Opera, "Hard Times" at the Pearl Theater Company,or an exhibit on El Greco, Iconography, and the "Book of John" at the Alexander S. Onassis Public Benefit Foundation.

HLI 474   The Novel in America   (3 - 3 - 0)

A survey of the development of the novel in America from the late eighteenth century to the present. Included are works by authors such as: Nathaniel Hawthorne, Harriet Beecher Stowe, William Faulkner, Henry James, Edith Wharton, and Philip Roth.

HLI 476   Contemporary Culture: Literature and Film, 1950-the present   (3 - 3 - 0)

Contemporary Culture provides an introduction to work in literature and film from 1950 to the present. Students read and view a range of works that illustrate aesthetic and cultural aspects of contemporary literature and film, including political, social, and religious matters, and the influence of technology on works by Ginsberg, Seybald, Godard, and others. The course is not intended as a survey of the principal contemporary texts and films but rather as an introduction to various key notions and modes that are characteristic of our time.

HLI 495   Seminar in Literature   (3 - 3 - 0)

This course will provide more advanced students with an opportunity to pursue in-depth study of a particular author and/or topic within the field of Literature.

Music & Technology

HMU 101   Music History I   (3 - 3 - 0)

During this course, we will review Western Medieval and Renaissance art music from the 2nd century B.C. to 1600 A.D. from several perspectives: as individual masterworks, as representatives of various composers, as examples of particular styles and forms, as analytic "problems," and as artworks derived from changing social circumstances. We will emphasize the development of skills in talking and writing "about" monophonic, liturgical and polyphonic music. The course will include lectures and class discussions, assigned readings, written assignments, and periodic examinations.

HMU 102   Music History II   (3 - 3 - 0)

In this course, student will review western Baroque to Classic music from 1600 to 1780, from several perspectives: as individual expressions of various composers, as examples of particular styles and forms, as analytic problems, and as artworks derived from changing social circumstances. This course emphasizes the development of skills in talking and writing about piano, pipe organ, orchestral and early opera music. Some composers include Bach, Vivaldi, Purcell, Pachebel, and Handel. The course will consist of discussions, assigned readings, oral presentations, and periodic examinations. Goals: To learn by reading notation and listening to samples of the earliest forms of music; To acquire verbal skills which are needed to explain music styles; To learn about the culture of the time which inspired the compositions.

HMU 192   Music Appreciation I   (3 - 3 - 0)

The course aims to guide and strengthen students in developing the skills of active listening in order to increase their enjoyment of classical music. To this end, the course strengthens the students' ability to identify and respond to the basic musical building blocks - melody, harmony, rhythm, tempo, tone color and form - and to the ways individual composers combine these elements to express and communicate substantive musical ideas. The course is not intended as a historical survey of the Western musical canon. Rather, it focuses on important core works in the genres of symphonic, chamber, and choral and solo vocal music, primarily from the common practice period extending from the late Renaissance to the late Romantic period, without excluding important trends and developments in earlier (medieval) and later (modern, post-modern) periods. The aim throughout is to focus on works that an interested music lover is liable to hear in live performance, and that form a basis for further musical exploration. At the same time, the course provides, without losing this central focus, at least brief exposure and consideration of selected examples of both world music and commercial pop music in some of its various forms. Finally, and unique to the Music and Technology program at Stevens, the course draws special attention, wherever appropriate, to important milestones in the development of music technology and their impact on the development of musical style.

HMU 193   Music Appreciation II   (3 - 3 - 0)

The course aims to guide and strengthen students in developing the skills of active listening in order to increase their enjoyment of ballet music, film music, music theater and opera. To this end, the course strengthens the students' ability to identify and respond to the basic conventions of ballet, film, music theater and opera and the way that the basic musical building blocks—melody, harmony, rhythm, tempo, tone color and form—take creative advantage of these conventions for expressive purposes, including the creation of mood, characterization, narration and storytelling. The course is not intended as a historical survey of the genres of ballet, film music, music theater or opera. Rather, it focuses on important core works from these genres, placed in their historical and stylistic context for purposes of comparison and appreciation. The aim throughout is to focus on works that an interested music lover is liable to hear in the normal course of their musical experience and that form a basis for further in-depth exploration of these genres. At the same time, the course provides, without losing this central focus, at least brief exposure and consideration of selected examples of contemporary pop and commercial music in these and related genres, including hip-hop and music video, that will build on the students' pre-existing interest and enthusiasm. Finally, and unique to the Music and Technology program at Stevens, the course draws special attention, wherever appropriate, to important milestones in the development of music technology and their impact on the development of music in the genres of ballet, film music, music theater and opera as well as related contemporary genres. Prerequisites: HMU 192

HMU 195   History of Electronic and Experimental Music   (3 - 3 - 0)

This course will provide an extensive overview of the development of electronic music, from early experiments and innovations in the late 19th century through to modern-day electronic music. This course will also provide an extensive overview of salient technical and artistic methodologies cultivated throughout the development of electronic music. This course will also explore the correlation between technological change and societal change.

HMU 201   Music Theory I   (3 - 3 - 0)

With the presumption of no previous formal study, Music Theory I presents the fundamental materials and procedures of tonal music. The students are introduced to elements of music theory, including scales, key signatures, intervals, triads, seventh chords, Roman numeral and figured bass analysis, 4-part writing, and first species counterpoint. Aural skills are developed with the introduction to "fixed-do" solfege.

HMU 202   Music Theory II   (3 - 3 - 0)

Music Theory II continues the presentation of the material and procedures of tonal music with the study of harmonic syntax as it pertains to tonal cadences, intermediary harmonies modulation and tonicization in major and minor, and fundamental concepts of diatonic sequences. Students continue their mastery of 4-part writing with Roman numeral and figured bass analysis and undertake writing assignments in second and third species counterpoint in two voices. Aural skills are developed with alto clef "fixed-do" solfege primarily in minor. Prerequisites: HMU 201

HMU 205   Introduction to Digital Media   (3 - 3 - 0)

This course introduces students to theoretical and practical experiences in interdisciplinary production technologies, with an emphasis on visual and aural design principles. Projects may include creating and editing digital images, music, sound, video, text, and motion graphics. Students will work in teams to create projects.

HMU 210   Introduction to Music Technology   (3 - 3 - 0)

This course will introduce music technology as a compositional platform to construct non-traditional musical structures that do not strictly adhere to typical western musical conventions of melody, harmony, rhythm and meter. Instead, students will focus on the creation of envelopes, frames and forms of sonic structure; the use of sound as a primary compositional resource. Students will interrogate recent music production environments and emerging approaches to multi-channel (surround sound) loudspeaker systems in order to create original electroacoustic works for 8.1 surround sound. This course will incorporate current research trends within the sonic arts community, specifically focusing on emerging spatial audio methodologies and the perceptual implications of acousmatic structures.

HMU 211   Introduction to Electronic Music   (3 - 3 - 0)

This is a required tutorial-based course for all music and technology freshman, providing necessary technical and practical foundation for their major. Students will engage all current hardware and software packages required by the Music and Technology Program

HMU 220   Keyboard Studies I   (3 - 3 - 0)

Keyboard Studies I develops basic keyboard skills based on five-finger exercises and the execution of major scales The course provides an understanding and application of basic music theory including the ability to read treble and bass clefs, the construction of triads and their inversions. In addition, students will play a basic solo repertoire piece by the end of the semester. Group practices and rehearsals are encouraged. Beginning students

HMU 221   Keyboard Studies II   (3 - 3 - 0)

Keyboard Studies II Develops the students ability to harmonize and improvisation at the keyboard. Students acquire intermediate sight-reading and technical skills technical skills by playing minor scales and arpeggios and seventh chords and inversions. Students are assigned intermediate repertoire from various genre including classical, jazz, and at least one other of their choice. Students are encouraged to form groups to work on ensemble repertoire. Intermediate students. Prerequisites: HMU 220

HMU 231   Sound Recording I   (3 - 2 - 2)

Fundamentals of sound recording technology with focus on composer-operated tools to generate the art. Presents an understanding of the terms and basic skills needed to make quality recordings of the art on the "ProTools" non-linear based system. Microphone, Monitor, Mixer, Digital Signal Processing "Plug-Ins," Dynamics, and basic studio acoustics will be explored. Students will experience the producing and recording of a multi-track song project at the completion of the course.

HMU 232   Sound Recording II   (3 - 2 - 2)

Mixing consoles in project studios will be explored and more advanced techniques in dynamics, equalization, reverberation, and signal processing. Students will meet in small groups for at least four hours a week to execute organized studio "hands on" lab exercises. Students will experience the producing and recording of a more advanced multi-track song project at the completion of the course. Does not fulfill general humanities requirements; may be taken as a free elective. Prerequisites: HMU 231

HMU 260   Software Instrument Design   (3 - 3 - 0)

This course will provide students with the fundamental understanding of the role and construction of software-based musical instruments. The course will focus on the development of skill-sets in commercial and open-source platforms. Students will also be introduced to low-level coding logic, providing the opportunity to develop and contribute original externals for prominent music production environments.

HMU 303   Music Theory III   (3 - 3 - 0)

Music Theory III continues the presentation of the material and procedures of tonal music with the study of elements of melodic and rhythmic figuration, dissonance and chromaticism, modal mixture, and an advanced examination of applied chords and diatonic modulation. Students undertake writing assignments in 4th and 5th species counterpoint in two voices. Species counterpoint is incorporated into 4 part-writing exercises. Aural skills are developed with and chromatic alterations. Prerequisites: HMU 202

HMU 304   Music Theory IV   (3 - 3 - 0)

Music Theory IV continues the presentation of the material and procedures of tonal music with a continued study of dissonance and chromaticism including 7th, 9th, 11th and 13th chords, Neapolitan II, Augmented Sixth chords, and chromatic voice leading techniques. Students undertake writing assignments in species counterpoint in three voices. Aural skills are developed with more complex "fixed-do" solfege primarily in mixed modes with chromatic alterations. Does not fulfill general humanities requirements; may be taken as a free elective. Prerequisites: HMU 303

HMU 310   Music Composition   (3 - 3 - 0)

Music Composition is a one semester course that presents a detailed analysis of the techniques of music composition. The course will focus on Form and Structure, Stylistic Movements, and Compositional Techniques. Students will be expected to demonstrate their understanding of all concepts presented in class via a series of quizzes and two significant works they will compose during the course of the semester. Music Composition will deepen the students understanding and implementation of the various techniques of musical composition.

HMU 314   Electroacoustic Composition   (3 - 3 - 0)

This course will explore the historical context, methods and current research trends surrounding the composition of electroacoustic music. Students will record and shape environmental sound recordings using digital audio platforms to explore the soundscape (sonic environment) as compositional form. Through this creative process, students will explore the integration and segregation of both traditional music and environmental sound events into different musical streams based on comparative analyses of their sonic structures. The final course assignment will require students to apply new knowledge and music production skill-sets to produce their own original electroacoustic composition.

HMU 322   Keyboard Studies III   (3 - 3 - 0)

Keyboard Studies III is designed for intermediate students who already have basic keyboard skills and sight-reading abilities. This course is focused on creative projects, ensemble playing, music analysis at the keyboard, execution of figured bass, score reading with multiple clefs, and the integration and implementation of technology to their choice of repertoire. This course facilitates the formation of traditional and virtual ensembles on the keyboard. Intermediate-advance students. Highly recommended for composition students. Prerequisites: HMU 221 or permission of the instructor.

HMU 324   Piano Class IV   (3 - 3 - 0)

Piano Class IV is the fourth class in a four semester sequence of group piano classes offered by the Music and Technology Program. The class concentrates on advanced piano skills including the development of a contemporary repertoire, advanced piano technique, advanced concepts in keyboard improvisation, score reading and accompaniment techniques. Prerequisite: HMU 322

HMU 333   Sound Recording III   (3 - 2 - 2)

Lecture will be based around advanced implementation of recording techniques and procedures in the professional studio environment. Students will end the semester with; a thorough understanding of large frame in-line audio mixing consoles, additional advanced microphone placement techniques, and understanding of transducer experimentation. Synchronization between analog machines and digital audio workstations and MIDI interfaces will be explored. The student will gain the ability to troubleshoot and avoid externally generated noise in an audio system. Students will experience the entire engineering process that goes into integrating tracks from a live recording session with songs, from running the original recording session to producing the final mix. Does not fulfill general humanities requirements; may be taken as a free elective. Prerequisites: HMU 232

HMU 334   Sound Recording IV   (3 - 2 - 2)

As the final semester of Sound Recording Arts, students are expected to fully understand the basic principles of audio engineering and the studio environment as a workplace. This class is designed to specifically address digital audio production. Although many of the topics have been mentioned in previous classes, course work will require in depth analysis of the many elements of this production format. Additionally, we will be studying in depth, advanced audio techniques. Students will be required to bring an audio example every class to be evaluated and attempt to recreate using the studio as lab. By the end of the semester, students will understand advanced principals of digital recording and the practical application thereof. Additionally, students will have in depth experiential knowledge of recording practices and advanced production techniques. Does not fulfill general humanities requirements; may be taken as a free elective. Prerequisites: HMU 333

HMU 350   Music of the Eastern Mediterranean   (3 - 3 - 0)

This course is an introductory survey of the music of the Eastern Mediterranean as explored by Traditional and Modern Turkish music. It explores the Balkan, Greek, and Persian influences from earliest times as well as Western composition and idioms. Modern jazz, rock, dance, and video influences will be examined, as well. Cross-listed with: HHS 350

HMU 351   Musical Acoustics   (3 - 3 - 0)

This course deals with the basic principals of physics as it relates to sound. Sound wave transmission, musical instrument sound vibration, transducer theory, room acoustic design and isolation design are discussed and explored. Recording Studio design will be explored and the mysteries of the room "appearance" will be explained. The more informed an individual is about the topic of acoustics; the art of music production becomes more efficiently achieved. The student will complete the course with a thorough understanding of acoustical design techniques. This knowledge will not only prepare the student for professional studio design and construction (music, audio/video for post production), it is also applicable in understanding the environments in which they might create productions. Prerequisites: MA 115 or MA 117, MA 122

HMU 394   History of Jazz   (3 - 3 - 0)

Techniques in how to listen and what to listen for. History of the idiom. Analysis of outstanding performances and their styles. Satisfies Humanities Upper Level requirements.

HMU 397   Orchestration I   (3 - 3 - 0)

This course is an in depth exploration of acoustic and orchestral instruments. Students will learn the idiomatic and mechanical characteristics of these instruments through classroom examples of masterpieces in the classical, jazz and popular repertoire, as well as by experiencing either live demonstrations or sampled demonstrations by the instructor.

HMU 398   Orchestration II   (3 - 3 - 0)

This is part two of a two-semester sequence. Whereas Orchestration I explored the mechanical aspects of acoustic instruments and presented the physical and technical boundaries of each instrument contained therein, Orchestration II explores the aesthetic principals engaged when writing for various instrumental ensembles. Prerequisite: HMU 397

HMU 404   Techno Music Composition   (3 - 3 - 0)

The exciting art of techno music has dynamically transformed over the years, incorporating elements of classical electronic music and cutting edge high tech innovations. This course will explore the techniques and enable the student to have a greater understanding of the tools of the trade. Each class will preview examples of the most well known works over the years, and demonstrate the technique since sounds often recycle years later: sample loops in current compositions, for example. The students will participate in weekly lab exercises by creating music in the Media Arts Center with state-of-the-art software and will apply advanced music theory skills. The final project shall be a 3-song student composition professional "demo". Guest producers will be invited to join us in class. Basic keyboard or iGuitar skills are required.

HMU 405   Advanced Topics in Electronic Music   (3 - 3 - 0)

An introduction and survey of the art of sound synthesis, Electronic Music will focus on synthesizer programming utilizing subtractive synthesis, filter manipulation, voltage control amplifiers and ADSR generators. As well, a historical presentation will expose the student to the evolution of non-acoustic sounds. Weekly labs and assignments will allow the student to implement those synthesis techniques presented in class. Does not fulfill general humanities requirements; may be taken as a free elective. Prerequisite: HMU 211

HMU 406   Audio Post Production   (3 - 3 - 0)

HMU 406 explores the integration of audio production for such visual mediums as television, film and interactive games. Through an analysis of various commercial visual media The course introduces 1) the techniques and terminology representing the technical parameters common to both audio and visual producers 2) the psychological impact of sound association 3) the implementation of audio tools in the creation of . ADR (automatic dialog replacement), Music Editing, Sound effects and/or Foley. 4) An understanding of the commercial marketing impact of sound. Prerequisites: HMU 211, HMU 232

HMU 407   Sound Design   (3 - 3 - 0)

Sound Design calls upon major technical elements from HMU 410-413 from psychoacoustics to sound wave manipulation within the digital to create soundscapes that enhance the art of story telling. The student will learn to create original sound effects, use and manipulate existing sound effect libraries, and identify the audio needs of a visual image. They will use the Digital Audio Workstation (DAW), as instructed in the Sound Recording course series, to integrate audio and visual elements. They will also be able to create a stand-alone soundscape for radio or audio only internet applications. Via lab assignments, students will complete the course with the foundation for an audio portfolio - demo CD. Prerequisites: HMU 232, HMU 231

HMU 415   Contemporary Music Theory   (3 - 3 - 0)

Contemporary Music Theory is a one semester presentation of the materials and procedures of music emanating from the evolution of Romanticism through Impressionism and arriving at the dismantling of tonality in the 20th century. In this class, melodic, rhythmic and harmonic analysis will transcend the triadic structures of the common period as presented in Music Theory I-IV. Students will be expected to demonstrate their understanding of all concepts presented in class via a series of quizzes and two significant works they will compose during the course of the semester. Prerequisites: HMU 304

HMU 420   Spatial Music Applications   (3 - 3 - 0)

Spatial Music Applications will explore the intersection between the spatial features of traditional music structures and the environmental soundscape. The course will present a perspective on aesthetics through the creation of original spatial audio works. Students will engage with spatial music applications, composing large-scale sonic works for multi-channel loudspeaker arrays. Students will develop their own spatialization tools in order create dynamic spatial works; interrogating the notion of dynamic spatial gesture as a means to develop compositional narrative and to function as a temporal sonic signature.

HMU 450   Music Business   (3 - 3 - 0)

This course is an overview of the vast music business world and what a real and successful producer must know to compete in today's commercial music environment. Topics include: discovering an act, training, development, music union memberships, performance, music attorney expectations, management contracts, booking agents, promoters, publishing deals, performance rights organizations, production deals, recording studio management, record deals and labels, interactive media and Web promotion, and distribution.

HMU 489   Internship   (3 - 0 - 0)

HMU 489 Internship is a program of independent work arranged between the student and a professional organization. The student will receive academic credit for his or her participation in the internship and the satisfactory completion of various academic components including: (1) the submission of a detailed journal of activities that demonstrates substantive experiences and training; (2) the submission of a ten-page research paper, the topic of which shall be determined in consult with the student's faculty advisor; and (3) an assessment from the student's internship mentor or supervisor. These components will be reviewed by the student's faculty advisor and evaluated for a grade for this course.

HMU 490   Music Performance: Concert Band   (0.5 - 0 - 0)

The study and performance of popular Concert Band repositories.

HMU 491   Music Performance: Jazz Ensemble   (0.5 - 0 - 1)

The study and performance of modern music.

HMU 492   Music Performance: Stevens Choir   (0.5 - 0.5 - 1)

The study and performance of choral masterworks.

HMU 494   Seminar in Music and Technology   (3 - 3 - 0)

This course provides students with the opportunity to pursue in-depth study of a particular topic within Music and Technology. Topics, prerequisites and assessment criterion may vary at the discretion of the instructor. Registration by permission of the instructor or Music and Technology director only.

HMU 495   Special Topics in Music and Technology   (3 - 2 - 2)

This course provides students with the opportunity to pursue in-depth study of a particular topic within Music and Music Technology. Topics, prerequisites and assessment criterion may vary at the discretion of the instructor. Registration by permission of the instructor or Music and Technology director only.

HMU 496   Music Performance: Private Lessons   (0.5 - 3 - 0)

All Music and Technology majors are required to take four semesters of musical instrument instruction. After choosing an instrument (subject to availability), the student will be assigned an instructor with whom weekly lessons are arranged. Lessons are 1 hour/week with grade evaluations based on a combination of homework and in-class performance. The first two semesters of lessons are taken under HMU 496, while the second two are under HMU 497 and require a recital/performance.

HMU 497   Music Performance: Recital   (0.5 - 1-0)

Concurrent to the 4th term of music instruction, HMU 496, all students are required to perform a public recital or recital by jury. The recital should consist of a repertoire determined by the instructor. Co-requisite: HMU 496 (4th term)

HMU 498   Ensemble   (1 - 0 - 0)

Upon completion of the Recital requirement (HMU 497), Music and Technology majors must enroll in two additional semesters of Ensemble. They may complete this requirement in one of two ways: 1) By becoming an active member of a Stevens sanctioned (student life) ensemble, or 2) by participating in a private Ensemble (consisting of at least three members, 66% of whom must be Music & Technology students). In both cases, there must be faculty supervision and approval. Prerequisites: HMU 497

HMU 506   Broadcasting Practices for Audio Post Production   (3 - 3 - 0)

This production-centered course provides a comprehensive overview of broadcast practice and Internet media streaming, balancing theory and hand-on applications. Audio production work flows; team integration, scheduling, and synchronization will be addressed with a focus on successful comprehension and content delivery. Exploring the technical foundations and technical infrastructure necessary to achieve professional audio for mass-distribution, this course foregrounds the important role played by sound in the contemporary media landscape benchmarked against best practices in the industry.

HMU 510   Audio Programming   (3 - 3 - 0)

This course provides a comprehensive grounding in the design of modules for prominent computer music software environments. Topics include modulation synthesis objects, sample-accurate sequencers, and spectral processing modules, as well as an overview of how these digital audio applications can be applied in musical practice. Prerequisites: HMU 260

HMU 520   Spatial Music Composition   (3 - 3 - 0)

Spatial music intentionally foregrounds spatial location and proximity cues within a musical work. This course explores the spatial features of traditional and electroacoustic music through the development of spatial audio applications and multichannel music compositions. Topics include perspectives on soundscape design, directional hearing, and the role of emerging spatial audio practices in the composition and performance of electroacoustic music. Prerequisites: HMU 314

HMU 534   Advanced Audio Recording & Processing   (3 - 3 - 0)

This production-centered course provides a comprehensive overview of digital audio production as it relates to audio capture and reproduction for music as well as broadcast transmission. The course will advance basic theory through to in-depth, advanced audio techniques such as signal flow, digital sampling systems, dynamic processing, and transducer technology for broadcast studio environments. This course extends the undergraduate course HMU 334 by adding additional individually accomplished projects requiring full comprehension of techniques and best practices in the industry.

HMU 550   Advanced Digital Video Post Production   (3 - 3 - 0)

This course provides an in-depth analysis of moving image / sound ingest and post production techniques as employed in a professional production environment. Students perform practical exercises using professional applications illustrating native video resolutions, and applied compression strategies. By identifying the parameters of file-based media, consequences of compression, practical delivery-driven workflows and specifications, the student will develop a practical foundation in professional media production tools, standards and practices. Site visits will illustrate the scale of implementation in an enterprise (Network Broadcast) environment.

HMU 560   Broadcast Studio Design   (3 - 3 - 0)

This course will focus on the design of broadcast environments in the studio and control areas for audio and video. Typical camera systems, media storage devices, monitoring systems for on-set and control rooms, component video infrastructure, set, lighting, intercom and cooling systems are explored through site visits and vendor literature. Complex signal flow is detailed by specifying component interconnects, gear racks, A/V patch-bay and wiring documentation. The student will observe working teams in professional broadcast facilities.

Philosophy

HPL 111   Theories of Human Nature   (3 - 3 - 0)

This course is intended as a general introduction to the discipline of philosophy through an examination of various attempts throughout history to answer the very fundamental question, "What does it mean to be human?" Topics discussed include happiness, the soul, virtue, good and evil, and the like. Readings from classical sources include Plato, Aristotle, Augustine, Hume, Mill, Nietzsche, Sartre and others.

HPL 112   Science and Metaphysics   (3 - 3 - 0)

This course provides an examination of philosophical concepts and ideas that address questions regarding the problem of knowledge (epistemology), methods of reasoning and the nature of reality (metaphysics). Special attention will be given to applying these topics to an introduction to the philosophy of natural science. Readings include classical sources such as Plato, Aristotle, Descartes, Hume, Kant, and Hegel, as well as contemporary works.

HPL 339   Ethics   (3 - 3 - 0)

A discussion and critical analysis of leading contemporary ethical theories, including utilitarianism, intuitionism, and virtue theories, among others. In addition, some consideration of criticisms by feminist philosophers of these traditional approaches to ethics will be given.

HPL 340   Social and Political Philosophy   (3 - 3 - 0)

A study of the relation of the individual to society and the state. Major issues to be examined include the nature of freedom, justice and equality, alienation, and political authority. Also includes an analysis of political models such as liberalism, socialism, conservatism, and anarchism, as well as alternative conceptions of democracy.

HPL 341   Philosophies of Good and Evil   (3 - 3 - 0)

This class concerns problems related to the ideas of good and evil. In the history of philosophy, no consensus has been reached as to how these ideas can be defined or explained. This is especially so for the idea of evil. It is unclear whether evil is a phenomenon in its own right or a mere reduction of the good. Also, it is unclear how the reality of evil can be reconciled with the idea of the supreme goodness of God. The problem of good and evil raises the questions of human nature, the existence of free will, and humans' basic attitude toward suffering. In modernity, the problem of evil was given further emphasis through the advent of nihilism, for which no moral obligations exist, and the mass extinction carried out by totalitarian regimes. The class will discuss classical and modern texts.

HPL 346   Modern Philosophy   (3 - 3 - 0)

The philosophy of Immanuel Kant and other prominent philosophers of the 17th and 18th century.

HPL 347   Theories of Knowledge and Reality   (3 - 3 - 0)

A comprehensive examination of the disciplines of Epistemology and Metaphysic; topics addressed include being and reality, logic and language, the concept of truth, skepticism, causality, and knowledge. Readings are both historical and contemporary in nature.

HPL 348   Aesthetics   (3 - 3 - 0)

An exploration of theories of art and of aesthetic experience. Questions addressed include the following: Are judgments of taste objective? What are the roles of form, expression, and representation in the arts? How is art related to society? What is the nature of creativity in art and science? What is the relationship between creativity and madness? Examples are drawn from the various art forms, including painting, literature, music, dance, and film.

HPL 350   Ancient and Medieval Philosophy   (3 - 3 - 0)

A comprehensive study of Ancient and Medieval philosophers beginning with the Greek Pre-Socratics, through Plato and Aristotle, the post-Aristotelian schools of Epicureanism, Stoicism and Skepticism, through Plotinus, Augustine, and major Medieval thinkers such as Anselm, Avicenna, Averroes, and Thomas Aquinas.

HPL 367   Philosophy of Biology   (3 - 3 - 0)

This class is an introduction to the philosophy of biology and structured around a number of the central issues of the field. Students will consider some of the following questions: Is the history of life a series of accidents or a drama scripted by selfish genes? Is there an "essential" human nature, determined our biology either at birth or in a distant evolutionary past? What parts of our behavior are most shaped by natural selection? Can evolutionary theory give us any insight into the nature of human consciousness? What does it mean for an evolutionary biologist to say that our heart is supposed to pump blood? What defines a biological species? Are human races biologically real? How does evolutionary theory, and contemporary human biology more generally, impact classical ethical theory?

HPL 368   Philosophy of Science   (3 - 3 - 0)

A critical analysis of the aims and methods of science, and its principles, practices, and achievements.

HPL 369   Science and Religion   (3 - 3 - 0)

This course investigates the history of the opposition of science and religion, beginning with the emergence of philosophy as an alternative to mythology, through the scholastic dominance of the Aristotelian world-view, to the Scientific Revolution, the emergence and acceptance of evolution, and beyond. Special attention will be given to current attempts at reconciling and/ or harmonizing these traditionally antithetical disciplines.

HPL 370   Philosophy of Technology   (3 - 3 - 0)

An introduction to the theoretical problems involved in the study of technology. Topics include the nature of technology as tool and system, the question of technological determinism, political implications of technology, and the impact on human nature.

HPL 371   Philosophy of Time   (3 - 3 - 0)

Time is one of the fundamental problems in philosophy. It poses specific challenges for any analysis or definition. Many philosophers have even denied the existence of time. Others have pointed at the difference between the linear time of nature and the non-linear time of human experience. The class will discuss classical and modern texts. It will raise questions such as: why is there only one direction of time? Does time have a beginning? Is time travel possible? Is time real or a product of our understanding? Is a timeless existence possible?

HPL 380   Environmental Ethics   (3 - 3 - 0)

An examination of basic positions in the field of environmental ethics with emphasis on principles of sustainability, whether there are legal and moral rights for nature, human treatment of animals, and environmental policy and decision-making.

HPL 442   Logic   (3 - 3 - 0)

An examination of the methods and techniques of formal logic, including the history of the discipline from Aristotle through Leibniz, Frege, Russell, Quine, and others.

HPL 443   The Philosophy of Language   (3 - 3 - 0)

Problems of meaning and reference in Frege, Russell, Wittgenstein, and others.

HPL 444   Philosophy of Mind   (3 - 3 - 0)

A philosophical examination of the mind and mental functioning. Some questions addressed include the following: Can we know what it is like to be a bat? Could it be that everyone (other than oneself) is a robot? What is the relationship between mind and brain? Can computers think? Readings include the work of Nagel, Wittgenstein, and Freud, among others.

HPL 445   The History of Philosophy   (3 - 3 - 0)

A consideration of the historical development of the western philosophical tradition, beginning with the pre-Socratics, up and through contemporary thinkers. The course will examine the recurrence of perennial problems in the history of intellectual thought.

HPL 447   Marx, Nietzsche, Freud: the Modern Individual and Society   (3 - 3 - 0)

A study of major thinkers and movements in the nineteenth century including Kant, Hegel, Marx, Kierkegaard, Nietzsche, Mill, James, and Freud. Issues discussed will include the nature of scientific knowledge, political and moral right, and the emergence of psychological theory.

HPL 448   Contemporary Philosophy   (3 - 3 - 0)

Studies of current trends in analytic and Continental philosophy.

HPL 449   Philosophy of Law   (3 - 3 - 0)

What is the basis for the authority of the law? What are the competing theories of crime and punishment? What are the grounds of legal rights and duties? What are the relations among justice, liberty, and equality in the law? We will also consider such current legal issues as the insanity defense, the death penalty, the rights of unborn children, regulation of the internet, and affirmative action.

HPL 450   Global and International Ethics   (3 - 3 - 0)

This course will focus on some of the new ethical issues that face social and political actors in the current period of globalization. We will examine the value questions that arise in relations among nation-states in such contexts as human rights, distributive justice, economic development, and the preservation of the environment. Among the topics to be discussed are just war theory and the analysis and response to terrorism; hunger, welfare, and global distributive justice; immigration and refugees; international business ethics; racism and sexism in national and international contexts; and democracy and the Internet. To illuminate these issues, we will consider alternative contemporary perspectives in political philosophy, including liberal, communitarian, and feminist approaches, and will examine their implications for politics in the context of emerging global frameworks.

HPL 455   Ethical Issues in Science and Technology   (3 - 3 - 0)

Consideration of such issues as the ethical responsibility of scientists and technologists for the uses of their knowledge, the ethics of scientific research, and truth and fraud in science and engineering. We will study such contemporary moral questions as those concerning the uses and abuses of nuclear energy, environmental pollution and the preservation of natural resources, and the impact of new technologies on the right to privacy.

HPL 456   Ethics of Business and Technology   (3 - 3 - 0)

This course offers an in-depth introduction to the applied ethics of technology-driven business. Beginning with an overview of the principles of business ethics, including Kantian Business Ethics, Virtue Based Ethics, and Stakeholder theories, we will move on to more specific topics including: the proper goals of business in society, the role of the public good in business, intellectual property, globalization, the ethics of advertising, and the status of the corporation as a moral agent.

HPL 457   Bioethics   (3 - 3 - 0)

The course is intended as an introduction to the key issues and methodologies of bioethics. It refers to the central problems in bioethics (autonomy of the patient, organ transplantation, stem cell debate, cloning, etc.), as much as to newer developments, such as genetic enhancement and the commercialization of the body. A main focus is to explore the field of bioethics in an interdisciplinary way and to bring not only ethical, legal, or scientific criteria into play, but also those from an existential, social, or cultural background. An introduction to the moral theories used in applied ethics is given. The course helps to develop a responsible and sensitive conduct in future studies or occupations.

HPL 458   Computability and Logic   (3 - 3 - 0)

The algorithm: its theory, history, and philosophical significance.

HPL 459   The Philosophy of Social Science   (3 - 3 - 0)

This course examines the conceptual foundations of such disciplines as economics, sociology, anthropology, and political science. Readings include excerpts from Smith, Marx, Weber, Durkheim, and Winch, among others.

HPL 460   Philosophy and Feminism   (3 - 3 - 0)

This course is a general introduction to both the history and present concerns of feminist philosophy. Readings include classic essays of feminist thought by Wollstonecraft, Mill, Engels, and others as well as contemporary writings in philosophy and feminism. This course serves as a foundation for a minor in Gender Studies. No prior courses in philosophy are required.

HPL 461   American Philosophy   (3 - 3 - 0)

An examination of the work of the American Pragmatists. Readings from the works of James, Pierce, Dewey, Rorty, Putnam, and West, among others.

HPL 462   Eastern Philosophy   (3 - 3 - 0)

An introduction to classical philosophical texts from India and East Asia, including texts from the Hindu, Buddhist, Confucian, and Daoist tradition.

HPL 463   Existentialism   (3 - 3 - 0)

This course examines the popular philosophical movement known as "Existentialism." In addition to reading such seminar thinkers as Kierkegaard, Nietzsche, Heidegger, Sartre, and Camus, attention will be given to works outside the rubric of philosophy proper, including literature and cinema.

HPL 464   Philosophy in Film   (3 - 3 - 0)

The primary aim of this course is to introduce students to the medium of film as a possible vehicle for the presentation and examination of key philosophical concepts and ideas such as the nature of reality, time, and the question of the good life. Special consideration will be given to the ways this mode of presentation might differ from more traditional methods such as the philosophical treatise or essay. Throughout this course we will analyze classical as well as more recent films.

HPL 468   Women Philosophers of the Twentieth Century   (3 - 3 - 0)

This course follows the work of the following Edith Stein, Simone Weil, Iris Murdoch, Simone de Beauvoir, Hannah Arendt, and Ayn Rand. These are all seminal thinkers who began their philosophical work in the first half of the twentieth century and went on to influence the course of intellectual thought for a generation to come. And yet, more often than not, these women tend to be omitted from the traditional canon of twentieth-century philosophy. One goal of this course is to consider why that is the case.

HPL 480   Environmental Policy: Philosophical and Economic Issues   (3 - 3 - 0)

This course introduces students to environmental policy and ethics, with special attention to the importance of economic considerations. Specific issues to be covered may include: the equity-efficiency contrast, different decision-making structures, the role of narratives in policy-making, externalities, public goods, property rights, market-failure, benefit-cost analysis, justice, the choice of categories in quantifying policy problems, the relationship of formal and informal rules, propaganda versus information, and the normative idea of rights. This course is an introduction to the interplay of politics, economics, and ethics as they enter into policy-making in the environmental arena.

HPL 495   Seminar in Philosophy   (3 - 3 - 0)

The Seminar in Philosophy is intended to provide students with an in-depth examination of the work of either one specific philosopher (or pair of philosophers), or a particular work in the history of philosophy that has had a profound impact on the development of intellectual thought. Special attention will be given to how the philosopher or work in question influenced work outside philosophy.

Social Sciences

HSS 121   Introduction to Urban Studies I: Early Cities and Civilizations (3 - 3 - 0)

An examination of the origins, nature and progress of urban society. Selected readings focus on recurrent and persistent urban problems: overcrowding, traffic congestion, political corruption, faulty sanitation systems, etc.; a student may also engage in field analysis projects which relate either to home town areas or to the North Jersey region.

HSS 122   Introduction to Urban Studies II: Modern Cities and Local Politics (3 - 3 - 0)

Major emphasis is on current economic, environmental and social problems.

HSS 127   Introduction to Political Science I: National Government   (3 - 3 - 0)

An introduction to the evolution and operation of the U.S. federal government. This course focuses on problems in energy policy, foreign policy, elections, and civil rights.

HSS 128   Introduction to Political Science II: Judicial Process   (3 - 3 - 0)

A survey of the evolution of juries and recent legal and social scientific analysis of jury rules. Case studies are used to explain the scope of issues decided by juries and conceptions of justice used to evaluate their performance.

HSS 141   Introduction to Sociology   (3 - 3 - 0)

The objective of this course is to provide students with a general survey of the field of sociology. This course aims at providing students with a way to think about and understand the social world and one's place in it. Therefore, the lectures, readings and assignments will focus on understanding the basic social processes and how they can be applied to everyday events, both small and large, both personal and political.

HSS 142   Introduction to Sociology II   (3 - 3 - 0)

This course is the second part of Introduction to Sociology. This part can be taken alone or in conjunction with the first part (HSS 141). While the first part emphasizes the relationships between individual lives and larger social forces, this part discusses social issues from a global perspective. After taking this course, students will be able to analyze and evaluate globalization and its consequences as well as the positions of different groups of people in the increasingly global social world.

HSS 175   Fundamentals of Psychology   (3 - 3 - 0)

This course presents the beginning student with an overview of the entire field and scope of psychology. Areas covered include research methods, the biological basis of thought and behavior, learning, perception, memory, thinking, personality, pathology, and development. Current theories, research and controversies in each of these fields are highlighted.

HSS 280   Social Psychology   (3 - 3 - 0)

Social psychology is the scientific study of how people's thoughts, feelings, and behavior are influenced by the actual, imagined, or implied presence of other people. This course introduces students to theoretical perspectives, research methods, empirical findings, and practical applications of social psychology. Various topics in social psychology such as interpersonal processes, obedience to authority, social influence, social perception, attitude change, prejudice and discrimination, attraction and liking, and aggression and violence are covered.

HSS 301   Research Design and Methods   (3 - 3 - 0)

This course is an intensive introduction to research design and methods for the disciplines of the Social Sciences and Science, Technology, and Society. It will prepare students to develop their own research projects with a focus on understanding research design and identifying a research topic, formulating theoretically-motivated questions of inquiry, organizing your literature review, selecting an appropriate research design and methodology. The course is intended for majors in the Social Sciences and Science, Technology, and Society in their junior year and students wishing to conduct independent research. Cross-listed with: HST 301

HSS 321   Modern Urban Culture   (3 - 3 - 0)

This course examines aspects of modern subcultural American life including deviancy and delinquency, crime, drug abuse, and ethnicity.

HSS 324   Comparative Ethnic Culture   (3 - 3 - 0)

This course is a survey of various cultural traditions. Typical study units include Afro-American, Asian, Hispanic, and American ethnic cultures in historical perspective.

HSS 325   Identity Politics and Legal Theory   (3 - 3 - 0)

Theories, tactics, goals, and the impact of organized minorities and how they relate and transform American political identity. Groups studied include African Americans, Latinos, Asians, Native Americans, and other politically marginalized minorities. Feminism, queer theory, race conscious theory, and critical race theory are closely examined particularly as they relate to court decisions and legal precedents in case law.

HSS 330   Developmental Psychology   (3 - 3 - 0)

This course presents an overview of the theoretical backgrounds as well as the historical and very current research in the field of life span developmental psychology. Special emphasis will be placed on infancy and childhood, adolescent and young adult development. All aspects of development, i.e. physical, cognitive, emotional and social will be addressed. Ongoing issues such as: critical vs. sensitive periods, brain plasticity and malleability, the nature/nurture controversy will be addressed throughout the semester.

HSS 331   Biological Psychology   (3 - 3 - 0)

Biological Psychology explores the physiological underpinnings of mental processes and behavior by covering the basic anatomy and physiology of the nervous system. The study of topics such as visual perception, language, depression, schizophrenia and their relation to neurological structure and deficit as well as their ultimate relationship to human consciousness will constitute the essential components of the class.

HSS 332   Health Psychology (3 - 3 - 0)

Health psychology focuses on the interaction of psychology and health, including the ways in which thoughts, emotions, and behavior influence one's health. This course will emphasize how psychological, social, and biological factors interact with and determine the success people have in health maintenance, treatment seeking, coping with stress and pain, and recovering from serious illness.

HSS 333   Psychology of Prejudice (3 - 3 - 0)

This course gives an overview of theoretical perspectives, research methods, empirical findings, and practical applications of psychological research on prejudice, stigma, and intergroup relations. Several issues will be examined in depth that are central to research in this area. The topics include, but are not limited to: the development of prejudice among children, the role of cognitive, social, personality, and motivational factors in maintaining prejudice and stigma, the psychological consequences of prejudice and stigma, and strategies for reducing prejudice, stigma, and intergroup conflict.

HSS 360   Public Policy Analysis (3 - 3 - 0)

This course offers perspectives utilized in the analysis and evaluation of public policymaking and policy results. Policy approaches include cost-benefit allocations, budgetary procedures and feasibility impact studies. Normative constraints and political implications of systematic policy analysis are also examined, particularly in relation to public infrastructure projects.

HSS 361   The U.S. Congress (3 - 3 - 0)

As the first branch of government, Congress has great influence on the internal workings and external projections of the United States. The course focuses on the evolution of the U.S. Congress, Congressional elections, fundraising efforts of Congress-people, policymaking in Congress, communicating in Congress, interest group efforts to influence Congress, and inter-branch relations. Nearly every president since WWII has governed with a Congress controlled by the opposite party, making inter-branch relations a necessary area of examination. In addition to lessons centered on the Congress in general, the courses follows select Congressional elections.

HSS 362   Campaigns & Elections (3 - 3 - 0)

This course an opportunity to examine current political campaigns and elections in the United States. Students will closely follow the twists and turns of the elections season with an eye toward understanding how campaigns have come to take their current form and in what ways they impact citizens, particularly the behavior of voters. Topics covered include: evolution of campaigns and elections, the role of institutions and political party system, campaign strategy, public opinion and media effects, and political participation.

HSS 363   Judicial Process (3 - 3 - 0)

This course is designed to introduce students to the operation of the judicial branch in the United States. The class examines theoretical issues regarding judicial processes, decision-making, and the politics involved in this branch. By the end of the semester, students will have a deeper understanding of the federal judiciary in the United States, with the ability to identify and explain particular stages of the legal system (the nomination and confirmation processes, agenda setting, opinion writing, etc.). Special attention is paid to ongoing Supreme Court cases in STEM areas of interest.

HSS 365   Health Politics (3 - 3 - 0)

In this course students will design and conduct research focused on the interplay between domestic U.S. political actors and fields of health including, but not limited to disease outbreak, disease prevention, medicinal and pharmaceutical developments and regulation, prenatal and post-natal health care, health insurance, nutritional guidelines, long term disability care, end of life care, vaccines, and more. A focus on health care based on quantitative social science research will prepare students to better understand health concerns facing the nation and become policy critics when assessing proposed government actions.

HSS 366   Political Theory (3 - 3 - 0)

This course explores fundamental currents of political philosophy, including the history of political thought and normative theory. Topics include classical liberalism and its opponents, the foundations of socialism and Marxism, the nature and scope of political regimes, justice and equality in politics, and rational choice theory and its critics.

HSS 371   Computers and Society (3 - 3 - 0)

An introduction to arguments about the relationship between computing and society, the impact of computing activities on social relationships, and the evolution of institutions to regulate computer-mediated activities.

HSS 373   Social Choice Theory   (3 - 3 - 0)

An introduction to the history of and theoretical principles associated with using voting techniques to resolve conflicts. Emphasis is placed on the analysis of operational rules. Student projects constitute a major part of the course.

HSS 375   History of Psychology   (3 - 3 - 0)

An analysis of the historical development of psychology. Issues such as perception, learning, cognition, and memory are explored within the context of various schools of thought.

HSS 376   Theories of Personality   (3 - 3 - 0)

A review of Freud, Adler, Sullivan, Jung, Rogers, etc., on the nature of personality.

HSS 377   Sociology of Globalization   (3 - 3 - 0)

This course provides an introduction to the concept of globalization, including its history, foundations, and implications from the end of World War II to the present day. Topics covered include the nature of globalism, economic and social trends, the roles of government in embracing globalization, global inequality, the rise of cities in the global economy, and the sociological implications of globalization. Particular emphasis will be placed on global/local tensions, especially as they relate to the response of local societies to global influences in both developed and developing countries. Students will perform analyses of globalization through discussions of current events relating to global society.

HSS 379   International Politics   (3 - 3 - 0)

An analysis of the contemporary international political framework. The course explores the character of the state system, the nation-state, the role of leadership personality, transnational actors, the balance-of-power, security and economic issues, the nature and limitations of power, the uses of terrorism, and Third World issues.

HSS 401   Seminar in Leadership Studies   (3 - 3 - 0)

This course examines leadership motivations and behaviors across varying contexts. Through an emphasis on theories of leadership, current debates, and case studies, students will be encouraged to understand leaders as imperfect human beings: while they may possess great skill, they also have limitations.

HSS 441   Gender and Race in Science and Engineering   (3 - 3 - 0)

This course discusses important issues related to gender and race in science and engineering (S&E). The issues include S&E as professions and social institutions as well as the experiences of women and minorities as S&E students, professionals, and the users of current science and technologies. In addition, this course explores the current social issues and policy concerns regarding gender and race in science and technology.

HSS 458   Sociology of Science and Technology   (3 - 3 - 0)

This course addresses various theories, approaches, and methodologies used in the sociology of scientific knowledge, including the strong programme, relativism, actor-network theory, gendered accounts of science, and laboratory studies. In addition, it discusses the relationships between science, technology, and society, such as how science and technology influence society and how society influences science and technology. Furthermore, the course explores the issues related to science and technology workforces and policies. The issues discussed in the course occur in both the U.S. and other countries, and the readings discussed in the course crosscut sociology and other disciplines. Cross-listed with: CAL 558

HSS 477   Psychology of Religion   (3 - 3 - 0)

A survey of different approaches to the psychological interpretations of religious phenomena such as the image of God, rituals, myths, faith healing, meditation, mysticism, and conversion.

HSS 478   Psychology of Gender   (3 - 3 - 0)

An analysis of gender differences and perceptions in contemporary society.

HSS 479   Sociology of Gender   (3 - 3 - 0)

This course introduces students to the study of gender from a sociological perspective. It focuses on gender as a social construction that occurs during interaction and influences our social relationships as well as personal experiences. We examine how gender and power are interrelated. To address these questions, we will, first of all, investigate theories and studies that explain gender differences from biological and cultural perspectives. then, we will analyze how gender shapes and is shaped by large social institutions such as education, the workplace, the family, politics, and media. In this course, we will also explore the intersections of gender, race, class and sexual orientation. The readings, class discussions, and assignments are designed to help students improve their critical thinking skills, understand the social construction of gender, learn about sociological research, and develop their communication skills.

HSS 480   Introduction to Anthropology   (3 - 3 - 0)

Anthropology, in the broadest sense, is the study of mankind. It is the empirical study of human cultures, societies, and the everyday practices, rituals, representations, beliefs, symbols, relationships, and values involved in navigating in our increasingly interconnected world. This course will introduce students to the concepts, terms, methods, and history of anthropology. Throughout the term, we will focus on how cultures change and shift through time, in relationship to space, and through individual and group action.

HSS 481   Cultural Anthropology   (3 - 3 - 0)

An examination of the varieties of organization of human societies in a comparative ethnographic context.

HSS 489   Freud and Jung   (3 - 3 - 0)

An in-depth and extensive study and discussion of the theories of Sigmund Freud and Carl Jung. Each theory is examined individually; the nature of the unconscious, dream interpretations, religious symbolism, and the aim of psychotherapy are critically examined. Students read from primary sources including Freud's Interpretation of Dreams, Totem and Taboo, Jung's Man and His Symbols and Modern Man in Search of a Soul, as well as from biographical material, and other secondary sources. Emphasis on points of confluence and of departure between the two. The course is limited to 15 students.

HSS 495   Seminar in Social Science   (3 - 3 - 0)

This course will provide more advanced students with an opportunity to pursue in-depth study of a particular problem and/or topic within the field of Social Science (Political Science, Psychology, Sociology) that has either not been covered in other courses or has only been superficially "touched upon."

Science, Technology & Society

HST 120   Introduction to Science and Technology Studies   (3 - 3 - 0)

This course examines the politics and morality of science and technology.It uses an interdisciplinary perspective, known as Science and Technology Studies(STS), that includes anthropology, history, philosophy, and sociology. It begins by exploring the history of the field, which arose from scientists' concerns about nuclear arms, atomic energy, and environmental degradation. It will introduce basic concepts such as social construction and technological determinism. Topics will include social studies of scientific community, the pursuits of objectivity, how politics and values are built into technologies, and perceptions of technological and environmental risk. The course emphasizes conceptual tools that students can apply in their own encounters with technology.

HST 160   Introduction to Science Communication   (3 - 3 - 0)

Students will learn the skills required for researching, analyzing and writing about science-related topics (including medicine, engineering and the environment) in an informed and ethical manner. The course will help prepare students for careers in science journalism and/or science communication for corporate, governmental and nonprofit organizations. The course will also help teach engineering and science majors how to communicate more effectively to peers and the public.

HST 250   Medical Humanities   (3 - 3 - 0)

This course will introduce students to the interdisciplinary field of medical humanities. Course readings and materials will draw from the humanities (literature, history, philosophy, ethics), social sciences (anthropology, sociology, political science, psychology), and the arts (visual arts, theatre, film) to examine the myriad ways in which humans think about, experience, and understand health, illness, and the practice of medicine. Topics may include infectious disease, noninfectious diseases, aging, childcare, fitness, public health, mental health, healthcare delivery, childbirth, and death. Students will be exposed to different ways of thinking about medicine, health, and illness, asked to critically engage with course materials, develop an understanding of the non-scientific aspects of healthcare, and reflect on their own and others' life experiences.

HST 301   Research Design and Methods   (3 - 3 - 0)

This course is an intensive introduction to research design and methods for the disciplines of the Social Sciences and Science, Technology, and Society. It will prepare students to develop their own research projects with a focus on understanding research design and identifying a research topic, formulating theoretically-motivated questions of inquiry, organizing your literature review, selecting an appropriate research design and methodology. The course is intended for majors in the Social Sciences and Science, Technology, and Society in their junior year and students wishing to conduct independent research. Cross-listed with: HSS 301

HST 320   Science and the Media   (3 - 3 - 0)

This course will examine how the various media shape public perceptions of science, with special attention given to engineering and medicine. Our primary focus will be topics with a social and/or political dimension, including brain science, genetic engineering, psychiatric drugs, artificial intelligence, national security, economics as well as the clash between science and religion. Students will learn how to read influential publications with a critical eye, enabling them to distinguish between bias and hype on the one hand, and fairness and accuracy on the other.

HST 325   Visualizing Society   (3 - 3 - 0)

This course examines the creation and reception of visual representations of socially-relevant data. Students analyze existing data visualization methods from the fields of science, health, economics, demography, geography, and science and technology studies. At the same time, students make their own interactive data visualizations for web browsers using data of relevance to social and scientific issues such as crime, medicine, environment, war, and race. While not a course in data visualization, students will be required to do some basic coding, web design, and graphic design in developing their own projects. No prerequisite courses or experience will be required.

HST 330   Environmental Communication   (3 - 3 - 0)

Environmental Communication introduces the study and practice of how individuals and institutions craft, distribute, understand, and use messages about the environment and human interactions with it. Topics include the study of important communication principles, the mass media and social media, the planning of effective communication campaigns, close analysis of global climate change and sustainable energy, and communication across different cultures. This course provides students with the tools, techniques, and strategies necessary for persuasive, professional, and scientifically rigorous communication about environmental issues.

HST 340   Global Public Health   (3 - 3 - 0)

This course examines the emergent field of global public health through the disciplinary lenses of science and technology studies. Throughout the course, students examine the global dimensions in current local and national practices of public health and discuss the impact of developments in science and technology on the development of disease surveillance, prevention, and response programs. Students will read and learn to analyze critically a variety of sources, such as academic texts and scientific papers, news media coverage of global health in action, and policy drafts and reports.

HST 350   Medical Anthropology   (3 - 3 - 0)

Medical anthropologists study the complex connections between culture, society, ecology, political economy, technology, science, disease and health. In this course, we will examine the field of biomedicine as a culture in itself, exploring and analyzing its particular languages, rituals, habits, ethics, costumes, belief systems, and customs. At the same time, we will explore the long history of medical anthropology from its beginnings within sociocultural anthropology, to the more recent development of critical medical anthropology, and finally, to work being done in the field today.

HST 370   Biology and Society   (3 - 3 - 0)

This course examines how matters of biological and environmental determinism have been treated by scientists, humanists, activists, and other prominent Americans from the 18th century through the present day. Students will approach this subject through the disciplinary lenses of science and technology studies, and examine sources that illuminate conceptualizations of the nature-nuture distinction in relation to biology, race, class, intelligence, health, and athletic ability from the "Founding Fathers" through the 21st century. Readings can include selections from Thomas Jefferson, Charles Darwin, Francis Galton, Booker T. Washington, the founders of the American eugenics movement, Franz Boas, Margaret Mead, B.F. Skinner, and the authors of "The Bell Curve."

HST 380   Standardization and Society   (3 - 3 - 0)

This course provides an interdisciplinary overview of the place of standardization in modern societies. Students will explore how standards play important roles in shaping our lives as consumers and citizens, as well as how they might participate in the development and use of standards in technical and social fields. Readings, lectures, and class discussions will consider the past, present, and future of standards-setting regimes in industrial, governmental, and international arenas through examples such as standards for computing, automobiles, food, medicine, and education.

HST 385   Internet Protocols and Politics   (3 - 3 - 0)

This course is about the politics behind the creation and control of Internet protocols and infrastructure. Students will explore the relationship between the design of the Internet and the context in which it was developed, how its underlying protocols require certain forms of control and administration, and how this control confers certain forms of power. Students will learn why the Internet was designed the way it was, why alternative designs were rejected, and the political problems and ideals that were encoded into its protocols.

HST 390   Anthropology of Technology   (3 - 3 - 0)

This course will examine different technologies and scientific developments through the lens of cultural anthropology. Each time the course is taught, the focus will be on how technology affects one of the different aspects of American culture, with topics possibly including: love and kinship; sports and games; death and mourning; work, labor, and money; food and fashion; and language and communication. The course will focus on different global and local subcultures within the US, examining how different groups use and integrate the same technologies. Students will become familiar with anthropological concepts and theory. They will be introduced to the ethnographic method and qualitative analysis of social phenomena, collaborating in small groups to produce an ethnographic research project.

HST 401   Seminar in Science Writing   (3 - 3 - 0)

This course provides an in-depth exploration of scientific controversies that raise ethical, philosophical and political questions. Potential issues include physicists' quest for a "theory of everything," conflicts between science and religion, global warming and other environmental concerns, the search for "clean" energy, the nature-nurture debate, the mind-body problem, genetic engineering of humans and research on nuclear arms and other weapons. The core of the course will be public presentations organized by the Stevens Center for Science Writings (see list of events below). Students are required to attend these CSW events; read books and/or articles by the CSW speakers; prepare questions for CSW speakers; write papers on the issues raised by CSW speakers in their writings and lectures; and discuss these issues in class on non-presentation weeks. There are no exams in this course.

HST 411   Nuclear Energy and Society   (3 - 3 - 0)

This course explores the technical, political, and social aspects of nuclear energy. In its approach to the topic it will look at the historical, present-day, and future policy dimensions, as well as the technical, political, and cultural dimensions. It will explore issues such as the history of nuclear power development, technological choices, nuclear waste, and nuclear accidents, and will also look at other forms of energy generation as a form of contrast.

HST 415   The Nuclear Era   (3 - 3 - 0)

The course provides an overview of the nuclear era, starting with its beginnings during WWII. It demonstrates how developments in scientific research and technological development drove the creation of an immense military-industrial-academic enterprise. The Cold War precipitated an arms race that led to a new social reality based upon Mutually Assured Destruction. Students will learn how nuclear weapons have shaped international relations in the 21st Century, how non-state entities and the related possibilities of nuclear terrorism have come into prime focus, and how societies have integrated the production of nuclear energy. They also will gain a greater appreciation for the cultural novelties of the nuclear era, as well as for the changing social and political contexts of decision-making. Throughout the whole course, the existential threat of nuclear weapons technologies will be examined and discussed.

HST 450   The History of Stevens   (3 - 3 - 0)

This class examines the history of the Stevens family, the Stevens Institute of Technology, and the relationship between the family, the school, and the city of Hoboken, New Jersey. Through these topics, the class will approach the broader subjects of cultural history, economic development, the history of science and technology, and American higher education in the 19th, 20th, and 21st centuries. Student projects will draw on archival manuscripts and artifacts in SC Williams Library.

HST 470   War and Science   (3 - 3 - 0)

This course will examine scientific theories of war--including biological, ecological and cultural models--as well as the historical interactions between science and militarism.

HST 495   Special Topics in Science and Technology Studies   (3 - 3 - 0)

This course will provide more advanced students with an opportunity to pursue in-depth study of a particular problem and/or topic within the field of Science and Technology Studies.

Theater and Film Studies

HTH 201   Introduction to Theater   (3 - 3 - 0)

The theatre's ability to cultivate empathy, to raise questions about societal practices, to explore the human condition, to foster collaboration, and to create community make it a dynamic and unique forum in which to participate as audience or practitioner. This course examines the development of the theatre from its roots in Ancient Greece to the present day. Students will examine that evolution from a number of critical points: theatre's literature, history, technological innovations, and social role. The class will read works of dramatic literature and historical texts. Attendance at NYC theatrical productions and "hands-on" exposure to the process of theatrical creation will complement the course readings. Cross-listed with: HLI 201

HTH 202   Introduction to Theater Design   (3 - 3 - 0)

This course introduces students to theatrical design. The course will examine the collaborative nature of theater and the interrelationship between art and technology in the design fields. An emphasis will be placed on the historic contributions of such key theater artists as Richard Wagner, Edward Gordon Craig, and Bertolt Brecht in the area of design and how their influence is still felt today. In the classroom, students will create a design element for the hypothetical production of a play or musical. Studio Course: Not for General Humanities credit.

HTH 221   Introduction to Cinema   (3 - 3 - 0)

This course provides an introduction to the study of film as a separate genre. The course concentrates on formal analysis of the aesthetic, ideological, and technological elements that comprise the multiple languages of cinema. The course introduces the student to various genres of narrative cinema as well as to different categories of cinema such as experimental, documentary, and hybrid forms. Although this course analyzes some work produced in the United States, it also provides the student with an introduction to cinema as an artistic practice that spans the globe, including contemporary as well as historical modes. Cross-listed with: HLI 221

Language

LCH 101   Elementary Chinese I   (3 - 3 - 0)

An introduction to the fundamentals of the Chinese language; this course is for true beginners. Students will learn basic aspects of the language, including pronunciation (Pinyin), tones, writings systems, radicals, and stroke order. Students will learn speaking and comprehension with a secondary focus on reading and writing. Students will complete the course with the ability to make small talk and navigate simple real-world scenarios. The course will be conducted almost entirely in Chinese. No prerequisites. NOTE: Does not count for Humanities credit.

LCH 102   Elementary Chinese II   (3 - 3 - 0)

The second of the four-core series continues the study of the Chinese language and will emphasize student participation through communicative activities. Students will learn to describe actions in progress, make appointments, discuss wants, navigate travel, and negotiate purchases. Students will further master everyday conversation and gain a better understanding of Chinese cultures. The course will be conducted almost entirely in Chinese. Beginning Chinese I (or equivalent) or placement test required. NOTE: Does not count for Humanities credit. Prerequisite: LCH 101, course equivalent or placement

LFR 101   Beginning French I   (3 - 3 - 0)

An introduction to the fundamentals of the French language; this course is for true beginners. Students will learn basic grammatical structures and develop proficiency in speaking and listening. They will learn to communicate at a novice-high conversational level. Students will also complete the course with the ability to identify unique features of French cultures. The course will be conducted almost entirely in French. NOTE: Does not count for Humanities credit.

LFR 102   Beginning French II   (3 - 3 - 0)

Students will expand their knowledge of grammatical structures. They will learn to communicate in the target language both in professional and real-world settings. Using current terminology, students will begin to explore fields such as technology, science, and business. Students will learn to identify major cultural trends in art, music and literature. The course will be conducted entirely in French. Beginning French I (or equivalent) or placement test. NOTE: Does not count for Humanities credit.

LFR 201   Intermediate French I   (3 - 3 - 0)

The third course of the four-course series continues the study of the four communicative skills (reading, writing, listening, speaking). Students will enrich their vocabulary and learn more advanced grammar combining past tense forms to tell complex stories, give commands, and express doubt. Students will have more opportunities to use the language for real-world purposes. Students will encounter literature from France and the French-speaking world, and further discover popular culture through communicative multimedia videos, French news websites, and class discussions. The course will be conducted entirely in French. Beginning French II (or equivalent) or placement test. NOTE: Does not count for Humanities credit.

LFR 202   Intermediate French II   (3 - 3 - 0)

The capstone course of the four-core series continues the study and practice of the French language's communicative skills (reading, writing, listening, speaking). Students will learn to use various tenses (conditional, plus-que-parfait) to describe and narrate events, give commands, discover more sophisticated usages of the subjunctive to express uncertainty and doubt, and develop a level of fluency that will permit study and work abroad in the foreign language. They will have significant and frequent opportunities to use the language for real-world purposes. Students will encounter literature from France and the French-speaking world, and further discover popular culture through communicative multimedia videos, French news websites, cinema, and class discussions. The course will be conducted entirely in French. Intermediate French I (or equivalent) or placement test. NOTE: Does not count for Humanities credit.

LSP 101   Beginning Spanish I   (3 - 3 - 0)

An introduction to the fundamentals of the Spanish language; this course is for true beginners. Students will learn basic grammatical structures and develop proficiency in speaking and listening. They will learn to communicate at a novice-high conversational level. Students will also complete the course with the ability to identify unique features of Spanish and Latin-American cultures. The course will be conducted almost entirely in Spanish. NOTE: Does not count for Humanities credit.

LSP 102   Beginning Spanish II   (3 - 3 - 0)

Students will expand their knowledge of grammatical structures. They will learn to communicate in the target language both in professional and real-world settings. Using current terminology, students will begin to explore fields such as technology, science, and business. Students will learn to identify major cultural trends in art, music and literature. The course will be conducted entirely in Spanish. Beginning Spanish I (or equivalent) or placement test. NOTE: Does not count for Humanities credit.

LSP 201   Intermediate Spanish I   (3 - 3 - 0)

Students will complete the study of major grammatical structures. They will improve their ability to communicate at a high-intermediate level both in professional and real-world settings. Using current terminology, students will learn to speak about topics in fields such as technology, science, and business. Completing the course will prepare students to take full-immersion courses in a variety of Spanish-speaking countries. The course will be conducted entirely in Spanish. Beginning Spanish II (or equivalent) or placement test. NOTE: Does not count for Humanities credit.

LSP 202   Intermediate Spanish II   (3 - 3 - 0)

The capstone course of the four-core series continues the study and practice of the Spanish language's communicative skills (reading, writing, listening, speaking). The focus of the course is on developing students' language proficiency through grammar instruction and review, vocabulary building exercises, readings of original texts, examination of contemporary film, and the exploration of the link between literature, film, language, and culture through writing and conversation. This course is designed as a general review of most grammatical concepts learned in previous Spanish courses, and to aid students in transition to upper-level Spanish courses. They will have significant and frequent opportunities to use the language for real-world purposes. The course will be conducted entirely in Spanish. Intermediate Spanish I (or equivalent) or placement test. NOTE: Does not count for Humanities credit.

Policy and Innovation

CAL 510   Foundations of Technology and Policy   (3 - 3 - 0)

This course explores perspectives in the policy process for science and technology - agenda setting, problem definition, framing the terms of debate, formulation and analysis of options, implementation and evaluation of policy outcomes with regards to economic, social and ethical dimensions. In addition to lectures on technology policy and ethics, exercises will aim at developing skills to work on the interface between technology and societal/ethical issues. Case studies and group projects that illustrate issues involving multiple stakeholders with different value structures, high levels of uncertainty, multiple levels of complexity and value trade-offs that are characteristic of science and technology policy and ethics problems will be used to illustrate the inherent complexities of the problem landscape.

CAL 529   History of Modern Science and Technology   (3 - 3 - 0)

An in depth survey of the history of science and technology from the Industrial Revolution to the present. Themes include the relationship between science and technology, the emergence of industrial research, the concept of a technological system, the history of innovation policy, and the uneven development of global capitalism. In addition to lectures on the history of science, technology, and industry, class discussions will develop skills in reading and interpreting a variety of primary and secondary sources. Students will learn research skills and gain familiarity with library, archival, and online collections by designing and completing a research project and paper.

CAL 539   Foundations of Ethics   (3 - 3 - 0)

An in-depth study of the most important theories of ethics—virtue ethics; deontological ethics; Utilitarianism—and their 20th and 21st century development. The class covers milestones in the history of ethics, insofar as they still have an impact on current discussions. Virtue ethics is studied in its classical form in Aristotle, which also allows students to address the unresolved problem of the scientific status of ethical theories. The class covers deontological and utilitarian ethics in their canonical form in Kant and Mill. Various methods and approaches that either criticize or transform these ethical theories are discussed in order to explore the theoretical options open to a 21st century ethicist. In addition to the basic moral theories, the class covers some of the necessary elements of human agency, i.e. free will, responsibility, and motivation. Finally, it covers some work in social ethics that has particular relevance for questions of economic justice and injustice.

CAL 541   Sociology of Science and Technology   (3 - 3 - 0)

This course addresses various theories, approaches, and methodologies used in the sociology of scientific knowledge, including the strong programme, relativism, actor-network theory, gendered accounts of science, and laboratory studies. In addition, it discusses the relationships between science, technology, and society, such as how science and technology influence society and how society influences science and technology. Furthermore, the course explores the issues related to science and technology workforces and policies. The issues discussed in the course occur in both the U.S. and other countries, and the readings discussed in the course crosscut sociology and other disciplines.

CAL 555   Engineering and Computer Ethics   (3 - 3 - 0)

The class examines the central ethical problems that arise in the impact of technology on modern society, such as the responsibility of engineers, the precautionary principle, questions of risk/benefit-calculation, whistle-blowing. Special focus is laid on the assessment of emerging technologies, such as nanotechnology. The class also examines issues concerning the use and the development of computer technology, such as privacy, intellectual property, virtual realities, and artificial intelligence.

CAL 556   Ethics of Business & Technology   (3 - 3 - 0)

This course offers an in-depth introduction to the applied ethics of technology-driven business. Beginning with an overview of the principles of business ethics, including Kantian Business Ethics, Virtue Based Ethics, and Stakeholder theories, we will move on to more specific topics including: the proper goals of business in society, the role of the public good in business, intellectual property, globalization, the ethics of advertising, and the status of the corporation as a moral agent. The course will end with a critical examination of more ethical dilemmas arising from technology-driven business and industry. Particular attention will be given to recent corporate scandals as cases of ethical failure.

CAL 557   Bioethics   (3 - 3 - 0)

The course gives an introduction to the key issues and methodologies of bioethics. It refers to the central problems in bioethics (autonomy of the patient, organ transplantation, stem cell debate, cloning, etc.), as much as to newer developments, such as genetic enhancement and the commercialization of the body. A main focus is to explore the field of bioethics in an interdisciplinary way and to bring not only ethical, legal, or scientific criteria into play, but also those from an existential, social, or cultural background. An introduction to the moral theories used in applied ethics is given. The course helps to develop a responsible and sensitive conduct in future studies or occupations.

CAL 558   Sociology of Science and Technology   (3 - 3 - 0)

This course addresses various theories, approaches, and methodologies used in the sociology of scientific knowledge, including the strong programme, relativism, actor-network theory, gendered accounts of science, and laboratory studies. In addition, it discusses the relationships between science, technology, and society, such as how science and technology influence society and how society influences science and technology. Furthermore, the course explores the issues related to science and technology workforces and policies. The issues discussed in the course occur in both the U.S. and other countries, and the readings discussed in the course crosscut sociology and other disciplines. Cross-listed with: HSS 458

CAL 568   Philosophy of Science and Technology   (3 - 3 - 0)

This course provides an in-depth analysis of the area of philosophy that examines the aims, methods, goals, and practices of "science" and the quest for "scientific truth." In addition to the traditional topics of induction and confirmation, falsification, theory-ladeness of observation, demarcation, realism/instrumentalism/relativism debates, and the "science wars" of the late 20th century, special attention is given to current debates regarding the role of cultural, sociological, and psychological factors in scientific work as well as the state of particular scientific fields. Readings include such seminal figures as Hempel, Carnap, Duhem, Goodman, Popper, Kuhn, Lakatos, and Feyerabend, as well as contemporary thinkers like Putnam, McMullin, van Fraassen, and Kitcher.

CAL 580   Environmental Ethics   (3 - 3 - 0)

This course is an in depth overview of various debates in environmental ethics. We will consider the way in which ethical theories inform environmental decision-making in a number of situations including a selection of the following: the conservation of biodiversity, global climate change, human population growth, animal exploitation in agriculture, air and water pollution, and urban solid waste. Questions addressed include the following: Should we be concerned about the impact of human life on the environment? To what extent should sacrifices be made in order to protect the environment? Which ethical frameworks are most effective in resolving disputes? To what extent are solutions based purely on economic concerns inadequate? Special attention will be given to the ways in which traditional ethical theories must be amended in order to address environmental concerns. Prerequisites: CAL 539

CAL 581   Environmental Policy   (3 - 0 - 0)

This course considers issues at the intersection of ecology, economics, public policy, and ethics. Specific issues to be covered may include: the history of environmental policy in the US, the role of Federal agencies in forming environmental policy, how values ought to play a role in environmental science, externalities, public goods, property rights, market-failure, benefit-cost analysis, environmental justice, the policy questions resulting from global climate change, propaganda versus information, and how pollution can infringe on human rights.

CAL 800   Special Problems in Policy and Innovation   (3 - 3 - 0)

CAL 900   Thesis in CAL (MA)   (6 - 6 - 0)

Professional Communications

COMM 500   Foundations of Business and Professional Communications   (3 - 3 - 0)

The course covers topics that include brainstorming, organizing, writing and revision of technical documents, as well as preparation of verbal presentations with visual aids. In this overview class, students will be exposed to these skills, and have time to generate their own documents and presentations for feedback, but COMM 500 is primarily designed to give the students a foundation so that they may continue on with other, more specialized, classes in this field. Students in need of ESL/ESD attention will receive it. The course may be offered as a week-long intensive class designed to get students familiar with the basic concepts and tools they will need to master in order to pursue the Certificate Program in Professional Communications or other Stevens graduate degrees or programs.

COMM 501   Foundations of Technical Communication   (3 - 3 - 0)

This course introduces professional communications: how should professionals construct technical documents for the business or scientific/technical community? What are the techniques writers need for specialized, clear writing? Topics include: genres of technical writing; successful writingstrategies; design principles; format and contents. Students will practice the techniques presented through weekly writing assignments.

COMM 502   Professional Presentations   (3 - 3 - 0)

This course will present a range of professional presentation techniques: oral, web-based, audio-visual. Students' existing skills will be sharpened and enhanced with knowledge of current best professional practices.Weekly assignments will guarantee students will master newtechniques.

COMM 503   Advanced Documentation Techniques   (3 - 3 - 0)

This course sharpens students' ability to deliver written descriptions, explanations and instructions to a diverse audience who may not share the writer's technical expertise. Students will create overviews and abstracts; lay out guidelines for readers; craft orderly instructions and explanations; insert necessary illustrations that enhance the documentation; build links to the next set of instructions; summarize effectively; and format for maximumcomprehension.

COMM 504   Foundations of Business Plan Writing   (3 - 3 - 0)

This course introduces the foundations of writing a business plan. Topics include: what investors and lenders are looking for; the key elements of a business plan; special considerations when writing a business plan for aninternational endeavor or web-based or web-supplemented businesses. Students will demonstrate their knowledge of the material presented through weekly writing assignments.

COMM 510   Masters Thesis Preparation   (1 - 1 - 0)

This course helps students prepare to write their masters theses. Topics covered include use of databases in research; appropriate organization and development of masters-level research writing; review of technical writing; and general grammar and syntax overview. This course is of special use to speakers of English as a Second Language.

COMM 530   Writing for Engineers   (3 - 3 - 0)

This course is an introduction to writing for engineers. As technical writers, engineers may often feel their task to be only one of "informing," but as has been dramatically illustrated over the last few years, "informing" can be vital to successful system deployment and operation. Lives are often affected by not only the accuracy of an engineer's calculations, but by a clear and understandable presentation of conclusions and recommendations. The ability to write clearly and effectively is essential to an engineer.

COMM 535   Writing for International Marketing   (3 - 3 - 0)

This course introduces the issues related to writing for international markets. What factors make writing for an international market different from writing for a domestic market? Topics covered include: the influence on writing of the key elements that make each nation different; the behavior of foreign consumers; translation issues; considerations when writing presentations, instructional texts, business plans, and web content for international audiences.

COMM 540   Foundations of Financial Writing   (3 - 3 - 0)

This course is concerned with the communication of financial information in writing: How should financial professionals construct documents? What are the writing techniques needed to make the numbers tell their own story? Topics include genres of financial writing; successful writing strategies; organizing information; using tables and charts.

COMM 545   Writing for Health Care Professionals   (3 - 3 - 0)

This course introduces essential concepts for writing in pharmaceutical houses, medical advertising agencies, and other medical settings. Topics covered include basic medical terminology, appropriate AMA style, and form and format in the use of professional research; preparation of meeting and conference materials for professionals in the field, and working with physicians.

COMM 550   Writing for the Web   (3 - 3 - 0)

This course dispels the myths about writing for the web and provides students with the skills to move successfully from print to web. The dynamic medium of the Internet not only demands concise, clear, well-organized copy, but an ability to operate in a non-linear world. This course will enable students to: reinforce good technical writing practices; incorporate usability issues when designing information for the web; think in non-linear ways; recognize the different functions of web copy and how to write for each (educational, promotional, information-seeking); understand the different delivery methods and how they influence the layout of the information and audio-visual choices.

COMM 555   Writing for Project Management   (3 - 3 - 0)

This course introduces the writing tasks that are critical to project management as it is used across a wide variety of industries. Topics covered include: the language of work breakdown structures; addressing project requirements; the semantics of risk analysis; assessing scope; and designing and building a project plan. Students will review online project management tools. Students will apply the techniques of writing for project management by creating a project plan to manage some aspect of an academic or extra-curricular activity.

COMM 560   Writing For and About the Science Community   (3 - 3 - 0)

This course introduces the interpretation and analysis of complex scientific information—and the translation of difficult scientific concepts into lively and readable prose. Topics include: effective interview techniques; information-gathering skills; news and feature article structure; editing; writing for the general public, scientists and industry. Students will practice these skills through in-class and take-home writing assignments. Writing assignments will progress from short, weekly articles to longer pieces. By the end of the semester, each student will write a feature article.

COMM 565   Publicity Writing: Techniques of Packaging Information   (3 - 3 - 0)

This course introduces the technical aspects of publicity writing. Topics include: writing a press bio; writing a topic summary; the art of the press release; the basics of the op-ed; and organizing the short informational feature. The course will include "how-to" discussions regarding inquiries from the press and the public, and ways to negotiate direct contacts with both. Guest speakers from the press/marketing field will make occasional presentations during the length of the course.

COMM 570   Proposal Writing   (3 - 3 - 0)

This course helps students developing a case for support for a nonprofit organization, making long-range programmatic and financial plans, researching potential funders, and preparing proposal materials. Students will learn how to find funding sources and will make regular presentations on their research and writing samples. The class will compile a comprehensive set of funding resources, as well as sample grants and planning documents. Guest speakers will share professional insights and experiences.

COMM 810   Special Topics in Professional Communications   (3 - -)

A participating seminar on topics of current interest and importance in Professional Communications.