The Charles V. Schaefer, Jr. School of Engineering

Department of Systems Engineering and Engineering Management

JOHN V. FARR, DIRECTOR

FACULTY*

Professors

John V. Farr, Ph.D., P.E. (1986), University of Michigan
Bernard Gallois, Ph.D. (1980), Carnegie-Mellon University
Donald N. Merino, Ph.D., P.E. (1975), Stevens Institute of Technology
Dinesh Verma, Ph.D. (1994), Virginia Polytechnic Institute

Associate Professor

Rashmi Jain, Ph.D. (2003), Stevens Institute of Technology

Assistant Professor

Wei Jiang, Ph.D. (2000), The Hong Kong University of Science and Technology
Jose Emmanuel Ramirez Marquez, Ph.D. (2004), Rutgers University

Exemplary Service Professor

John Mihalasky, Ed.D., P.E. (1973), Columbia University

Distinguished Service Professors

Carl Pavarini, Ph.D. (1973), Rensselaer Polytechnic Institute
Michael C. Pennotti, Ph.D. (1974), Polytechnic Institute of New York

Distinguished Service Associate Professor

George Hudak, M.S., P.E. (1995), Stevens Institute of Technology

Visiting Associate Professor

Leon A. Bazil, Ph.D., D.Sc. (1970), St. Petersburg Technical University

Lecturer

Kathryn D. Abel, Ph.D. (2001), Stevens Institute of Technology, Bachelor of Engineering in Engineering Management Program Director

*The list indicates the highest earned degree, year awarded and institution where earned.

UNDERGRADUATE PROGRAMS

Engineering Management

Engineering Management (EM) is a rapidly expanding field that combines engineering, technology, management and business. High-technology companies in the telecommunications, financial services, manufacturing, pharmaceutical, consulting, information technology and other industries utilize the concepts and tools of engineering management such as project management, quality management, engineering

economics, modeling and simulation, systems engineering and statistical tools. These technology-based companies recruit engineering management graduates for their expertise in these tools and techniques.

Recent studies show that most engineers will ultimately take on managerial positions, and that most will spend a considerable part of their professional careers in a management or supervisory capacity. In a recent survey conducted by the American Association of Engineering Societies, it was found that within ten years of the start of their careers, more than 50 percent of engineers find themselves in technical management positions, often without the benefit of formal training in management.

The Engineering Management program combines a strong engineering core with training in accounting, cost analysis, managerial economics, quality management, project management, production and technology management, systems and engineering design. The course selection offered by this major exemplifies the Stevens interdisciplinary approach to developing strong problem-solving skills. The program prepares you 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 assume professional positions of increasing responsibility in management or as key systems integrators.

The mission of the Engineering Management Program is to provide an education based on a strong engineering core, complemented by studies in business and management, to prepare the graduate to work at the interface between technology and management, and to be able to assume positions of increasing technical and managerial responsibility. The objectives of the Engineering Management program can be summarized as follows:

- EM graduates have a strong general engineering foundation and are able to use modern technological tools while working on complex multidisciplinary problems.
- EM graduates will have assumed leadership positions in their chosen areas of work using knowledge gained from their engineering management education.
- EM graduates effectively work in teams on projects to solve real world problems. This effort can involve information research, the use of project management tools and techniques, and the economic justification of the solution that is effectively communicated in a written or oral project report/business proposal that is presented to the client.
- EM graduates possess the ethics, knowledge, skills, and attributes to define, design, develop, and manage resources, processes, and complex systems needed to work in a multidisciplinary team environment.
- EM graduates apply the management tasks of organizing, staffing, planning, financing, and the human element and have the tools to continue sustained intellectual growth in the corporate or academic world.

The Engineering Management Program is accredited by the Engineering Accreditation Commission of the Accreditation Board for Engineering and Technology (ABET). A typical course sequence for Engineering Management follows:

Freshman Year

Term I				
		Hrs. Per Wk.		
		Class	Lab	Sem. Cred.
CH 107	General Chemistry IA	2	0	2
CH 117	General Chemistry Lab I	0	3	1
Ma 115	Mathematical Analysis I	3	0	3
PEP 101	Physics I	3	0	3
E 120	Engineering Graphics	0	2	1
E 121	Engineering Design I	0	3	2

E 115	Intro to Programming	1	1.5	2
Hum	Humanities	3	0	3
PE 200	Physical Education I	0	2	1
	TOTAL	**12**	**11.5**	**18**

Term II

		Hrs. Per Wk.		
		Class	Lab	Sem. Cred.
CH 116	Chemistry II	3	0	3
CH 118	Chemistry Lab II	0	3	1
Ma 116	Mathematical Analysis II	3	0	3
PEP 102	Physics II	3	0	3
E 122	Engineering Design II	0	3	2
E 126	Mechanics of Solids	4	0	4
Hum	Humanities	3	0	3
PE 200	Physical Education II	0	2	1
	TOTAL	**16**	**8**	**20**

Sophomore Year

Term III

		Hrs. Per Wk.		
		Class	Lab	Sem. Cred.
Ma 221	Differential Equations	4	0	4
PEP 201	Physics III	2	0	2
PEP 211	Physics Lab for Engin.	0	3	1
E 231	Engineering Design III	0	3	2
E 234	Thermodynamics	3	0	3
E 245	Circuits & Systems	2	3	3
Hum	Humanities	3	0	3
PE 200	Physical Education III	0	2	1
	TOTAL	**14**	**11**	**19**

Term IV

		Hrs. Per Wk.		
		Class	Lab	Sem. Cred.
Ma 227	Multivariate Calculus	3	0	3
E 232	Engineering Design IV	0	3	2
E 246	Electronics & Instrumentation	3	0	3
EM 270	Engineering Management	3	0	3
EM 275	Project Management	3	0	3
Hum	Humanities	3	0	3

PE 200	Physical Education IV	0	2	1
	TOTAL	**15**	**5**	**18**

Junior Year

Term V

		Hrs. Per Wk.		
		Class	Lab	Sem. Cred.
CE 342	Fluid Mechanics/Transport	3	3	4
E 321	Engineering Design V	0	3	2
E 344	Materials Processing	3	0	3
EM 301	Engr. Cost Management	3	3	4
EM 365	Statistics for Engr. Managers	3	1.5	4
EM 380	EM Laboratory	3	0	3
PE 200	Physical Education V	0	2	1
	TOTAL	**15**	**12.5**	**21**

Term VI

		Hrs. Per Wk.		
		Class	Lab	Sem. Cred.
E 355*	Engineering Economics	3	3	4
EM 322	Engineering Design VI	1	3	2
EM 345	Modeling & Simulation	3	0	3
EM 360	Total Quality Management	3	0	3
EM 366	Statistical Quality Control	3	0	3
Hum	Humanities	3	0	3
PE 200	Physical Education VI	0	2	1
	TOTAL	**16**	**8**	**19**

Senior Year

Term VII

		Hrs. Per Wk.		
		Class	Lab	Sem. Cred.
EM 423	Engineering Design VII	0	8	3
E 421*	Entr. Analysis Of Eng. Design	1	3	2
Mgt 244**	Microeconomics	3	0	3
EM 457	Elements of Ops. Research	3	0	3
EM 402	Innovative System Design	3	0	3
Elec	Free Elective	3	0	3
	TOTAL	**13**	**11**	**17**

Term VIII				
		Hrs. Per Wk.		
		Class	Lab	Sem. Cred.
EM 424	Engineering Design VIII	0	8	3
Mgt 243**	Macroeconomics	3	0	3
EM 450	Operations Management	3	0	3
Hum	Humanities	3	0	3
Elec	Free Elective	3	0	3
	TOTAL	**12**	**8**	**15**

Notes: * E355 and 421 are core courses for all engineers that are taught by department faculty.
**Students can take Mgt243 and 244 in any semester; these courses are part of the humanities requirements for social science.

Requirements for a Minor in Engineering Management

EM 301 Engineering Cost Estimation
EM 275 Project Management
EM 270 Engineering Management
EM 366 Statistical Quality Control or EM 360 Total Quality Management (choose one)

EM Minors are expected to take the following courses as part of the Engineering Curriculum:

Required Engineering Core

EM 365 Statistics for Engineering Managers
E 355 Engineering Economics
E 421 Entrepreneurial Analysis of Engineering Design

Required Humanities Core

Mgt 243 Macroeconomics
Mgt 244 Microeconomics

Four Plus One Program

The SEEM department offers a unique four plus one program designed for Stevens undergraduate engineering and science students who wish to jointly pursue a Master of Engineering in Engineering Management (MEEM) degree concurrently with their undergraduate degree. Admission criteria to the program are junior standing and a GPA of at least 3.2. All undergraduates in this program are expected to take the following courses or their equivalents:

Complete all Calculus courses	by end of 3rd year - Engineering Core
Mgt 243 Microeconomics	by end of 3rd year - Humanities Core
Mgt 244 Macroeconomics	by end of 3rd year - Humanities Core
E 355 Engineering Economics	by end of 3rd year - Engineering Core
EM 365 Statistics for EM or equivalent	by end of 3rd year - Engineering Core
E 421 Entr. Analysis Of Eng. Design	by end of 4th year - Engineering Core
Mgt 680 Org. Behavior and Theory	by end of 4th year - MEEM Core
EM 301 Eng. Cost Estimation	by end of 4th year - Engineering Elective

Certificates in Systems Engineering and Architecting, Engineering Management, Economic Systems, Financial Engineering, Pharmaceutical Manufacturing Practices, and Project Management are approved for this program. Other certificate options must be approved by the Director of Graduate EM program and the department/program responsible for the certificate. These certificates are also approved options for the regular Masters' of Engineering in Systems Engineering and in Engineering Management.

GRADUATE PROGRAMS

The Department of Systems Engineering and Engineering Management (SEEM) offers the Masters' of Engineering degrees in Systems Engineering and in Engineering Management. In addition, the department offers the Systems Engineering master's degree through the Systems Design and Operational Effectiveness (SDOE) executive education program. The degree of Doctor of Philosophy is offered in Systems Engineering and in Engineering Management.

All of the department's programs take a multidisciplinary approach to engineering education by providing a blend of engineering, systems, and management subjects. The traditional engineer and scientist often lacks preparation in the human, financial, and systems integration skills necessary to make project teams more productive, improve product and process quality, and promote the advancement of high technology for complex systems. Our Masters' programs are unique in that we strive to create an engineer who is well prepared for a future in the management of engineering and technology and can address systems integration and life cycle issues.

Many engineers find themselves at a decision point about five years after graduation. They must choose between continuing their technical specialty and entering the ranks of technical management or serve as key systems integrators. Ten years after graduation, more than 75% of engineers have chosen the second route, assuming managerial responsibilities or key systems integration responsibility for which they have often had little or no formal training. They must solve complex problems, requiring the integration and management of many systems across multiple disciplines in a cost-effective manner with many stakeholders. Because of the advent of technology and globalization, we believe this is engineering education for the 21st century.

The SEEM faculty is engaged in a variety of research efforts that include systems architecting, reliability of large-scale systems, engineering economic analysis, life cycle costing, systems integration, and infrastructure systems.

Master's Programs

These programs require a minimum of 30 credit hours of course work. A thesis is optional and may be substituted for up to six credit hours of course work. The thesis option is strongly recommended for full-time students receiving financial support in the form of research assistantships or those students planning to pursue doctoral studies.

An undergraduate degree in engineering or related disciplines with a "B" average or better from an accredited college or university is generally required for graduate study in any one of the department programs. Outstanding applicants in other areas may be conditionally admitted subject to the satisfactory completion of several ramp courses or introductory courses within the specific program. The specific requirements will be determined on an individual basis depending upon the student's background. It is required that any applicants requesting research assistantship appointments and applicants to the Ph.D. program provide evidence of the ability to carry out independent work. Examples of such evidence include the master's degree thesis work and/or completed work-related projects. GRE scores are not 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 (210 for computer based) on the TOEFL examination. Applications for admission from qualified students are accepted at any time.

The Department of Systems Engineering and Engineering Management offers a variety of degree programs: Master of Engineering in Systems Engineering (SE), an executive SE program titled Systems Design and Operational Effectiveness (SDOE), Master of Engineering in Engineering Management (EM), and a Master of Engineering in Integrated Product Development (IPD) and a collection of Graduate Certificate programs. Each student should meet with his/her advisor to develop a study plan that matches the student's background, experience, and interests while satisfying the requirements for any of the department's programs.

Systems Engineering

The Systems Engineering degree is a multidisciplinary program that includes a blend of engineering, systems thinking, and management subjects.

Graduates from this program will be prepared to work effectively at the interface between engineering and management and to assume professional positions of increasing responsibility. The program consists of four core courses:

ALL students must take the following two course sequence:
SYS 625 Systems Operational Effectiveness and Life Cycle Analysis
SYS 650 System Architecture and Design
OR, the following two course sequence:
SYS 651 Agile Systems Engineering and Architecting
SYS 780 Agile Development Strategies

Plus, two of the following **four options**:
- SYS 611 Modeling and Simulation **or** SYS 670 Forecasting and Demand Modeling
- SYS 612 Project Management for Complex Systems
  or Mgt 609 Introduction to Project Management (for students wishing to obtain a certificate in Project Management)
- SYS 660 Decision and Risk Analysis **or** SYS 675 Integrated Supply Chains
- SYS 605 Systems Integration **or** SYS 606 Accelerated Systems Integration and Testing

A candidate may propose a customized track of six elective courses leading to other specialties with approval from a faculty advisor. At least two of the electives must be taken from the SEEM curriculum. Students should review other sections of the graduate catalog for certificate options. Students are encouraged to take an integrated four-course sequence leading to a graduate certificate for the remaining four electives or four additional courses in systems engineering. Many of these certificates are offered on-line via web-based instruction.

Students may desire to take a 3-credit special project class (SYS 800) to serve as one of the electives for the master's programs.

Engineering Management

An advanced degree in Engineering Management builds upon undergraduate engineering and science education with studies in business, management, and systems integration. The traditional engineer and scientist often lacks a formal education in the human, financial, and management skills necessary to advocate the use of technology for high quality, cost efficient, complex systems. Our Master's degree is unique in that we strive to create an engineer who is well prepared for a future in the management of engineering and technology integration.

Graduates from this program will be prepared to work effectively at the interface between engineering and management and to assume professional positions of increasing responsibility. The six core courses for this program are:

EM 600 Engineering Economics and Cost Analysis
EM 605 Elements of Operations Research
SYS 611 Modeling and Simulation
SYS 612 Project Management of Complex Systems
  or Mgt 609 Introduction to Project Management (for students wishing to obtain a certificate in Project Management or Technology Management)
SYS 625 Systems Operational Effectiveness and Life Cycle Analysis
Mgt 680 Organizational Behavior and Theory

Students lacking a strong quantitative background that includes statistics and engineering economics may be required to take several ramp courses as defined by admission conditions listed in the acceptance letter.

Students are encouraged to take an integrated four-course sequence leading to a graduate certificate for the remaining four electives or four additional courses in systems engineering or engineering management. Many of these certificates are offered on-line via web-based instruction. See other sections of the graduate catalog for additional certificate options. Approved four-course sequences:

Systems Engineering,
Project Management,
Technology Management,
Economic Systems,
  or
Value Chain Enterprise Systems.

A faculty advisor must approve other options. Note that some of these certificates are not available to undergraduate students as part of the four plus one program.

A certificate in Engineering Management can be obtained by taking:

EM 600 Engineering Economics and Cost Analysis
SYS 612 Project Management of Complex Systems
or Mgt 609 Introduction to Project Management
EM 605 Elements of Operations Research
Mgt 680 Organizational Behavior and Theory

Masters of Business Administration (MBA) in Technology Management (TM) With A Concentration in Engineering Management

The Wesley J. Howe School of Technology Management (WJHSTM) in conjunction with the SEEM department offer a unique program which combines the quantitative elements of an engineering degree with the business topics typically taught in a MBA program. The program is designed so that students from various backgrounds can tailor their educational experience to meet their career objectives. Programs between the Wesley J. Howe School of Technology Management and the SEEM department can consist of 4, 10, or 20 classes (ranging from a Graduate Certificate to a MBA degree), depending upon the student's backgrounds and objectives.

Courses	**Exit Results**
Mgt 609 Introduction Project EM 605 Elements of Operations EM 600 Engineering Economics and Cost Estimation Mgt 680 Organizational	Graduate Certificate in Engineering Management
EM 760/Mgt 657 Operations Management EM 750/Mgt 656 Total Quality Management SYS 625 Systems Operational Effectiveness and Life Cycle Analysis SYS 611 Modeling and Simulation SYS 660 Decision and Risk Analysis Mgt 671 Technology and Innovation Management EM/Mgt Elective	Master of Engineering in Engineering Management with Graduate Certificates in Technology Management[1] and Engineering Management
Mgt 725 Strategic Management Mgt 600 Managerial Accounting Mgt 607 Managerial Economics Mgt 623 Financial Management Mgt 641 Marketing Management Mgt 690 Organizational Theory Mgt 679 Management Information Systems 3 Advisor Approved Electives	Master of Business Administration (MBA) in Technology Management With a Concentration in Engineering Management with a Graduate Certificate in Engineering Management

[1] Mgt 609, Mgt 671, EM 750/Mgt 656, and EM 760/Mgt 657 are required for the Graduate Certificate in Technology Management.

Students can opt out of the program after the first four courses and obtain a Graduate Certificate in Engineering Management. If they choose to continue, they will take an additional six courses towards the MEEM/MBA degrees. If they opt out of the program after 10 prescribed courses, they will receive the MEEM degree. If they choose not to opt out of the program, they can apply to the WJHSTM for pursuit of an MBA with a concentration in Engineering Management. Students can apply to the WJHSTM at any point in the process for the MBA degree. However, we recommend that they apply as early as possible to better facilitate course scheduling. If the students decide not to opt out of the program after fulfilling the requirement for the MEEM, they must take an additional 30 hours for the MBA in TM degree. Note that students who decide to pursue the MBA degree will **not** be awarded both the MEEM and MBA in TM. They can receive the Engineering and the Technology Management certificates with the MBA in TM degree.

All students should initially apply to the MEEM program within the SEEM department. They should then apply to the WJHSTM for the MBA in TM degree if they plan to pursue that option. Admission to the MEEM program does not guarantee acceptance to the MBA in TM program and vice versa. To gain admission to the MBA program, students must take a GMAT or GRE (see the WJHSTM section of the catalog for specific admission criteria and score standards). Current MEEM students and alumni who wish to obtain an MBA in TM must

formally apply for entry to the MBA in TM program and must take a GMAT or GRE test. A minimum of two years work experience will be required of all students prior to admission to the program. Students applying for this joint program are required to have an undergraduate degree in engineering or science.

Integrated Product Development

The Integrated Product Development (IPD) degree is an integrated Master of Engineering degree program focusing on the integrated and multidisciplinary aspects of product development. The IPD degree is offered by the Department of Mechanical Engineering and supported by the SEEM Department. The core courses emphasize the design, manufacturing, 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 their 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 program director, may design customized tracks. Up to six special problem or thesis credits may be taken in lieu of the course credits toward a project relevant to the selected track.

Core Courses - Integrated Product Development

IPD 601 Integrated Product Development I
IPD 602 Integrated Product Development II
IPD 611 Simulation and Modeling
IPD 612 Project Management and Organizational Design
(Full course descriptions can be found in the Interdisciplinary Programs section.)

Students then choose from one of the four following engineering tracks:
Armament Engineering Track
Electrical and Computer Engineering Track
Manufacturing Technologies Track
Systems Reliability and Design Track
The complete description of the IPD program can be found in the Interdisciplinary Programs section.

Systems Reliability and Design Track:
This program focuses on issues that arise in the design and implementation of specific components or sub-assemblies of a complex system, rather than on the engineering of the overall system itself. Included is the diverse set of engineering skills that must be applied in the design and development of a complex system.

SYS 595 Design of Experiments and Optimization
SYS 605 Systems Integration
SYS 620 Simulation-Based Costing and Acquisition
SYS 625 Systems Operational Effectiveness and Life Cycle Analysis
SYS 650 System Architecture and Design
SYS 660 Decision and Risk Analysis

Graduate Certificate Programs

The SEEM 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, integrated, and highly focused, and consists of 12 graduate credits. All of the courses may be used toward a Master of Engineering degree as well as for the graduate certificate. Current programs include:

Agile Systems Engineering and Design

SDOE 651 Agile Systems Engineering and Architecting: Methods, Processes and Practices
SDOE 606 Accelerated Systems Integration and Testing
SDOE 655 Robust Engineering Design
SDOE 780 Agile Development Strategy

Engineering Management

EM 600 Engineering Economics and Cost Analysis
SYS 612 Project Management of Complex Systems or Mgt 609 Introduction to Project Management
EM 605 Elements of Operations Research

Mgt 680 Organizational Behavior

Economic Systems

Mgt 607 Managerial Economics
Mgt 600 Managerial Accounting or Mgt 626 Cost Analysis and Control
SYS 660 Decision and Risk Analysis or Mgt 794 Decision Analysis for Corporate Networks
SYS 611 Modeling and Simulation or SYS 740 Dynamics of Economic Systems

Systems and Supportability Engineering

SYS 625 System Operational Effectiveness and Life Cycle Analysis
SYS 640 System Supportability and Logistics
SYS 645 Design for System Reliability, Maintainability, and Supportability
SYS 650 System Architecture and Design

Systems Design and Operational Effectiveness

SYS 625 Systems Operational Effectiveness and Life-cycle Analysis
SYS 650 System Architecture and Design
And two advisor-approved electives

Systems Engineering and Architecting

SYS 625 Systems Operational Effectiveness and Life-cycle Analysis
SYS 650 System Architecture and Design
SYS 612 Project Management of Complex Systems
or
Mgt 609 Introduction to Project Management (for students wishing to obtain an additional certificate in Project Management)
SYS 605 Systems Integration

Value Chain Enterprise Systems

SYS 640 Supportability and Logistics
SYS 665 Integrated Supply Chains
SYS 670 Forecasting and Demand Modeling Systems
or
EM 744 Advanced Data Analysis and Forecasting
or
SYS 611 Modeling and Simulation
SYS 675 Dynamic Pricing Systems
or
SYS 660 Decision and Risk Analysis

The Value Chain Enterprise Systems certificate is only available as part of the System Design and Operational Effectiveness (SDOE) Program. This 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.

Doctoral Programs in Systems Engineering and in Engineering Management

The programs leading to the Doctor of Philosophy (Ph.D.) degree are designed to develop your ability to perform research or high-level design in systems engineering or engineering management. Admission to the doctoral program is made through the departmental graduate admissions committee and is based on review of your scholastic record. A master's degree is generally required before a student is admitted to the doctoral program. Your master's level academic performance must reflect your ability to pursue advanced studies and perform independent research. Typically a GPA of 3.5 or better is required for admission to the Ph.D. program.

Ninety 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 toward the doctoral degree. Of the remaining 60 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 to the doctoral program, you must form a Doctoral Advisory Committee (DAC) and take a written qualifying examination that is intended to test your comprehension of undergraduate and master's level engineering fundamentals associated with your general dissertation topic area.

The candidate's graduate advisor serves as the chair of the DAC, and the student should seek the assistance of his/her advisor in identifying faculty who might serve on the committee. The graduate

committee should be composed of those faculty members who can best assist the student in completing his/her graduate research. Each member is added to the student's committee after consenting to serve. For the Ph.D., the advisory committee must include a minimum of four members and its composition consistent with those guidelines contained in the Graduate Student Handbook. Committee members are expected to attend meetings as a collective body. Under unusual circumstances, a member of the committee may attend a meeting via video or telephone. However, a student's advisory committee must be physically present at all such meetings. Faculty participation on graduate student committees is considered to be an important part of SEEM faculty responsibilities. To this end, full time SEEM faculty are expected to attend all committee meetings for students they advise or on the committees they serve.

Written and oral components of the qualification examination must be successfully completed by all Ph.D. students. The intent of the examination is to establish that the student is qualified to pursue creative, original, independent research at a level expected of Ph.D. students. The written portion of the examination requires two weeks for completion. The oral component of the examination is administered two weeks after the completion of the written portion. Students must be registered during the semester that the examination is taken. Students may not schedule the qualification examination until they have an approved Study Plan. The qualification examination is administered by the student's DAC and one negative vote by a committee member is permitted for the successful completion of the examination. All members of the student's advisory committee must attend the oral portion of the examination. If performance on the examination is unsatisfactory, one full semester must lapse (15 weeks) before the examination is administered a second time. Students failing the examination twice will be dismissed from the program. At the discretion of the committee, a candidate may be allowed to change his or her degree option from a Ph.D. to a Master's. The result of the examination is recorded on a form furnished by the Registrar's office on the day of the oral portion of the examination. This form must be signed by each member of the student's advisory committee.

Students pursuing the Ph.D. are required to complete research in the course of graduate study. To initiate research efforts, students are required to pass a preliminary examination upon successful completion of the qualifying examination. The student is required to prepare a research proposal that describes the content of the research, the outcome anticipated, the contribution to the field of endeavor, and the creative content of the effort. This proposal must be in a written form and must be presented to his/her committee at a meeting where all committee members are present. Approval of the research effort is signified by signatures of each committee member on the cover page of the proposal. The signed research proposal must be delivered to the SEEM/SDOE student records office for inclusion in the student's academic record. A student pursuing the Ph.D. degree should demonstrate, through the dissertation, the ability to carry out original and creative research. The results of the research should be sufficiently significant to be publishable in a major technical journal. The writing style, grammar, and spelling of the dissertation should reflect a high level of skill in written communication. Between the research proposal and the final examination the student is required to provide at least one progress report to his/her advisory committee at a meeting where all committee members are present. The time of this meeting is determined by the student's DAC.

At the completion of the research, students must defend the thesis in a public presentation. Doctoral candidates are encouraged to hold a private defense with his or her committee several weeks prior to the public defense. At that time, the committee should raise issues with the candidate prior to the public defense. The final examination must be scheduled through the Registrar's office, at least two weeks prior to its administration. To pass the final examination, a degree candidate must have a favorable vote from a majority of the examining/advisory committee, with a maximum of one negative vote. If a student fails the final examination, there must be a lapse of one full semester (15 weeks) before rescheduling the examination. A student is allowed no more than two opportunities to pass the final examination.

The Systems Integration Initiative – Executive Education: System Design and Operational Effectiveness (SDOE) Program

DINESH VERMA, ASSOCIATE DEAN FOR OUTREACH AND EXECUTIVE EDUCATION
CHARLES V. SCHAEFER, JR. SCHOOL OF ENGINEERING

PARTICIPATING FACULTY*

Professors
SEEM: John V. Farr, Ph.D., P.E. (1986), University of Michigan
SEEM: Dinesh Verma, Ph.D. (1994), Virginia Polytechnic Institute
ME: Costas Chassapis, Ph.D. (1988) City University of New York
ME: Souran Manoochehri, Ph.D. (1986), University of Wisconsin, Madison
ECE: Stuart K. Tewksbury, Ph.D. (1969), University of Rochester

Distinguished Service Professors
SEEM: Michael C. Pennotti, Ph.D. (1974), Polytechnic Institute of New York
SEEM: Spiros Pallas, Ph.D. (1972), University of Texas

Associate Professors
SEEM: Rashmi Jain, Ph.D. (2003), Stevens Institute of Technology
ME: Kishore Pochiraju, Ph.D. (1993) Drexel University

Assistant Professors
SEEM: Wei Jiang, Ph.D., (2000), The Hong Kong University of Science and Technology
SEEM: Jose Emmanuel Ramirez Marquez, Ph.D. (2004), Rutgers University

Academic Fellows
Dr. George Korfiatis, **Chair**
Dean Charles V. Schaefer, Jr. School of Engineering
Mr. Benjamin S. Blanchard
Professor, Portland State University and Professor Emeritus, Virginia Tech
Dr. Wolter J. Fabrycky
Chairman, Academic Applications International, Inc., and Lawrence Professor Emeritus, Virginia Tech
Dr. Richard Nance
Dahlgren Professor Emeritus, Virginia Tech
Dr. Caroline Smith
Associate Professor, James Madison University
Dr. Andy Sage
Dean Emeritus and Professor, George Mason University

Industry Fellows
William D. Miller, Industry Professor, Stevens Institute of Technology
Bruce Barker, Industry Professor, Stevens Institute of Technology
Mr. Robert L. McCaig
Chairman of the Board of Directors and founding member of ASSETT, Inc.
Dr. Donna Rhodes
Senior Lecturer, Engineering Systems Division, Massachusetts Institute of Technology
Mr. Galen Plunkett
Vice President of Technology and founding member of ASSETT, Inc.
Mr. James Long
Chief Executive Officer, Vitech Corporation
Mr. Ralph Giffin
Director of Operations, Lockheed Martin NE&SS-Undersea Systems
Ms. Line H.Hohannesen
ILS Manager, Kongsberg defense and Aerospace AS (NORWAY)

GRADUATE PROGRAMS

The Systems Integration Initiative: The System Design and Operational Effectiveness Program

As part of this initiative in the Charles V. Schaefer, Jr. School of Engineering participants can pursue a number of interdisciplinary graduate certificate programs leading to a Master's degree (ME) or a Doctoral degree in Systems Engineering. All graduate programs offered through this initiative involve a multidisciplinary approach to engineering education by providing a blend of engineering, systems, and management subjects. The traditional engineer and scientist often lacks preparation in the human, financial, and systems integration skills necessary to make project teams more productive, improve product and process quality, and promote the advancement of high technology for complex systems. Our programs are unique in that we strive to create an engineer who is well prepared for a future in the conception, definition, architecting, modeling and simulation, integration, sustenance, and management of modern complex systems in a variety of market domains.

As technology advances, systems tend to become more complex. Complexity can greatly increase the cost of a system over its life cycle. Short-term costs including research, design, test, and production are only part of the life-cycle cost. Post-production costs associated with system operation, maintenance, and support are often 70% to 80% of the total cost.

The traditional approach to system design focuses on key performance characteristics plus cost and schedule. Only near the end of design is it determined exactly how the system-as-already-designed is to be supported. This approach for complex systems compromises their reliability, maintainability, and supportability, thus greatly increasing total ownership costs. At the same time, users are demanding more quality. That is, users want more reliability and availability at a lower total cost.

An integrated approach to system design and development can result in an improved balance between system effectiveness and total ownership cost. Such an approach must concurrently consider all aspects of the entire life cycle of the system/product from design to manufacture, maintenance, repair, and disposal; and bring potential cost drivers to the attention of decision-makers early and in compelling ways.

The Charles V. Schaefer, Jr. School of Engineering, as a leader in engineering education, is offering a graduate degree in Systems Engineering and a variety of certificate programs that stresses system design, modeling, analysis, operations, and life-cycle support. The program objective is to provide an innovative view of the landscape of system design to practitioners from different engineering disciplines, to enhance their practice of engineering today, and to position them for career growth in the global economy.

Uniqueness of the Curriculum and Delivery Format in the System Design and Operational Effectiveness (SDOE) Program

The curriculum in the SDOE Program is focused on the requirements of system integrators across a multitude of domains in the commercial and aerospace sectors. A synopsis of the topical clusters is reflected in the figure. These topical clusters were identified in collaboration with our partners in the aerospace and defense, telecommunications, IT, and automotive industries. Courses within the program address all these functional clusters. A more detailed description of these clusters can be obtained from the SDOE Program website (www.stevens-tech.edu/sdoe).

The delivery mechanism of our courses is also unique. All courses in our program are offered in a unique week-long modular format or offered in a completely web-based format. Modes of instruction of the SDOE program have been structured to allow flexibility. The week-long modular format minimizes time away from "home base" while live and intensive weeklong courses, and associated group exercises, ensure development of team building skills, leadership development, and the real-time negotiation and tradeoffs that characterize reality. Participants are given reading assignments prior to the instructional week. Further, participants pursing a degree or graduate certificate have ten weeks subsequent to the instructional week to complete their homework assignments and projects.

Graduate Certificate Programs

All graduate certificate programs require a minimum of 12 credit hours of course work. An undergraduate degree in engineering or related disciplines with a "B" average or better from an accredited college or university is generally required for graduate study in any of our programs. Outstanding applicants in other areas may be conditionally admitted subject to the satisfactory completion of several ramp courses or introductory courses within the specific program. The specific requirements are determined on an individual basis depending upon the student's background. International students must demonstrate their proficiency in the English language prior to admission by scoring at least 550 (210 for computer based) on the TOEFL examination. Applications for admission from qualified students are accepted at any time.

Each student should communicate with his/her advisor to develop a study plan that matches the student's background, experience, and interests while satisfying the requirements for any of the programs. Each of the graduate certificate programs is a stepping stone towards a Master's degree in Systems Engineering.

A graduate certificate can be obtained by taking the SDOE 625 and 650 and two electives. Students can take a 3-credit special project class (SDOE 800) to serve as one of the electives for the certificate program.

Graduate Certificate in Agile Systems Engineering

SDOE 651 Agile Systems Engineering and Architecting: Methods, Processes and Practices
SDOE 606 Accelerated Systems Integration and Testing
SDOE 655 Robust Engineering Design
SDOE 780 Agile Development Strategy

Graduate Certificate in Systems and Supportability Engineering

SDOE 625 System Operational Effectiveness and Life Cycle Analysis (SDOE-625WS is the web-based version)
SDOE 640 System Supportability and Logistics
SDOE 645 Design for System Reliability, Maintainability, and Supportability
SDOE 650 System Architecture and Design (SDOE-650WS is the web-based version)

Graduate Certificate in Systems Engineering and Architecting

SDOE 625 Systems Operational Effectiveness and Life-Cycle Analysis
SDOE 650 System Architecture and Design
SDOE 612 Project Management of Complex Systems or Mgt 609 Introduction to Project Management (for students wishing to obtain an additional certificate in Project Management)
SDOE 605 Systems Integration

Graduate Certificate in Value Chain Enterprise Systems

SDOE 640 Supportability and Logistics (SDOE-640WS is the web-based version)
SDOE 665 Integrated Supply Chains
SDOE 670 Forecasting and Demand Modeling Systems or EM 744 Advanced Data Analysis and Forecasting or SDOE 611 Modeling and Simulation
SDOE 675 Dynamic Pricing Systems or SDOE 660 Decision and Risk Analysis

Master's Degree
The master's degree requires a minimum of 30 credit hours of course work. A 3-credit hour project or a 6-credit hour thesis is required. An undergraduate degree in engineering or related disciplines with a "B" average or better from an accredited college or university is generally required for graduate study in any of our programs. Outstanding applicants in other areas may be admitted subject to the satisfactory completion of several ramp courses or introductory courses within the specific program. Specific requirements are determined on an individual basis depending upon the student's background. It is required that any applicants requesting research assistantship appointments and applicants to the Ph.D. program provide evidence of the ability to carry out independent work. Examples of such evidence include the master's degree thesis work and/or completed work-related projects. GRE scores are not 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 (210 for computer based) on the TOEFL examination. Applications for admission from qualified students are accepted at any time.

Systems Engineering Master's Degree in the SDOE Executive Education Program
The Systems Engineering degree is a multidisciplinary program that includes a blend of engineering, systems thinking, and management subjects. The increasing complexity of systems, the pervasive realities of global competitiveness, the enhanced focus on cost and profitability, and ever more challenging customer expectations have led a number of premiere organizations in the defense and commercial sectors to assume the role of system integrators. These organizations are increasingly adopting an evolving business model that emphasizes the selling of functionality, a solution, or a capability, instead of focusing on selling and providing systems, system elements, and products. The curriculum emphasizes the development of large-scale, complex, and multifunctional systems in a number of domains, while also addressing the requirements of time-to-market focused organizations in the commercial sector. Core course in the SDOE Program have a strong case study and project orientation to facilitate understanding of the concepts discussed.

Admission to the SDOE program generally requires an undergraduate degree in engineering or related disciplines with a "B" average or better from an accredited college or university. Outstanding applicants in other areas may be conditionally admitted subject to the satisfactory completion of several introductory courses within the program. Specific requirements are determined on an individual basis depending upon the student's background. It is required that any applicants requesting research assistantship appointments and applicants to the Ph.D. program provide evidence of the ability to carry out independent work. Examples of such evidence include the master's degree thesis work and/or completed work-related projects. GRE scores are not 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 (210 for computer based) on the TOEFL examination. Applications for admission from qualified students are accepted at any time.

Graduates from this program will be prepared to work effectively at the interface between engineering and management and to assume professional positions of increasing responsibility. The program consists of four core courses that must be completed if the applicant is pursuing a Master's or Doctoral degree:

ALL students must take the following two course sequence:
SDOE 625 Operational Effectiveness and Life Cycle Analysis
SDOE 650 System Architecture and Design
OR, the following two course sequence:
SDOE 651 Agile Systems Engineering and Architecting
SDOE 780 Agile Development Strategies

Plus, two of the following **four options**:
- SDOE Modeling and Simulation **or** SDOE 670 Forecasting and Demand Modeling
- SDOE Project Management for Complex Systems
- SDOE 660 Decision and Risk Analysis **or** SDOE 675 Integrated Supply Chains
- SDOE 605 Systems Integration **or** SDOE 606 Accelerated Systems Integration and Testing

A candidate may propose a customized track of six elective courses leading to other specialties with approval from a faculty advisor. At least two of the electives must be taken from the SEEM/SDOE curriculum. Students should review other sections of the graduate catalog for certificate options. Students are encouraged to take an integrated four-course sequence leading to a graduate certificate for the remaining four electives or four additional courses in systems engineering. Many certificates are offered on-line via web-based instruction.

Students in the SDOE program are required to take either a 3-credit special project class (SDOE 800) or a 6-credit hour thesis (SDOE 900). Students should communicate with their academic advisor to develop a study plan to coordinate the thesis versus the project options and to match the student's background, experience,

and interests while satisfying the requirements for any of the programs.

Doctoral Programs in Systems Engineering

The programs leading to the Doctor of Philosophy (Ph.D.) degree are designed to develop your ability to perform research or high-level design in systems engineering or engineering management. Admission to the doctoral program is made through the departmental graduate admissions committee and is based on review of your scholastic record. A master's degree is generally required before a student is admitted to the doctoral program. Your master's level academic performance must reflect your ability to pursue advanced studies and perform independent research. Typically a GPA of 3.5 or better is required for admission to the Ph.D. program.

Ninety 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 toward the doctoral degree. Of the remaining 60 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 to the doctoral program, you must form a Doctoral Advisory Committee (DAC) and take a written qualifying examination that is intended to test your comprehension of undergraduate and master's level engineering fundamentals associated with your general dissertation topic area.

The candidate's graduate advisor serves as the chair of the DAC, and the student should seek the assistance of his/her advisor in identifying faculty who might serve on the committee. The graduate committee should be composed of those faculty members who can best assist the student in completing his/her graduate research. Each member is added to the student's committee after consenting to serve. For the Ph.D., the advisory committee must include a minimum of four members and its composition consistent with those guidelines contained in the Graduate Student Handbook. Committee members are expected to attend meetings as a collective body. Under unusual circumstances, a member of the committee may attend a meeting via video or telephone. However, a student's advisory committee must be physically present at all such meetings. Faculty participation on graduate student committees is considered to be an important part of SEEM faculty responsibilities. To this end, full time SEEM faculty are expected to attend all committee meetings for students they advise or on the committees they serve.

The written and oral components of the qualification examination must be successfully completed by all Ph.D. students. The intent of the examination is to establish that the student is qualified to pursue creative, original, independent research at a level expected of Ph.D. students. The written portion of the examination requires two weeks for completion. The oral component of the examination is administered two weeks after the completion of the written portion. Students must be registered during the semester that the examination is taken. Students may not schedule the qualification examination until they have an approved Study Plan. The qualification examination is administered by the student's DAC and one negative vote by a committee member is permitted for the successful completion of the examination. All members of the student's advisory committee must attend the oral portion of the examination. If performance on the examination is unsatisfactory, one full semester must lapse (15 weeks) before the examination is administered a second time. Students failing the examination twice will be dismissed from the program. At the discretion of the committee, a candidate may be allowed to change his or her degree option from a Ph.D. to a Master's. The result of the examination is recorded on a form furnished by the Registrar's office on the day of the oral portion of the examination. This form must be signed by each member of the student's advisory committee.

Students pursuing the Ph.D. are required to complete research in the course of graduate study. To initiate the research effort students are required to pass a preliminary examination upon successful completion of the qualifying examination. The student is required to prepare a research proposal that describes the content of the research, the outcome anticipated, the contribution to the field of endeavor, and the creative content of the effort. This proposal must be in a written form and must be presented to his/her committee at a meeting where all committee members are present. Approval of the research effort is signified by signatures of each committee member on the cover page of the proposal. The signed research proposal must be delivered to the SEEM/SDOE student records office for inclusion in the student's academic record. A student pursuing the Ph.D. degree should demonstrate, through the dissertation, the ability to carry out original and creative research. The results of the research should be sufficiently significant to be publishable in a major technical journal. The writing style, grammar, and spelling of the dissertation should reflect a high level of skill in written communication. Between the research proposal and the final examination the student is required to provide at least one progress report to his/her advisory committee at a meeting where all committee members are present. The time of this meeting is determined by the student's DAC.

At the completion of the research, the student must defend the thesis in a public presentation. Doctoral candidates are encouraged to hold a private defense with his or her committee several weeks prior to the public defense. At that time, the committee should raise issues with the candidate prior to the public defense. The final examination must be scheduled through the Registrar's office, at least two weeks prior to its administration. To pass the final examination, a degree candidate must have a favorable vote from a majority of the examining/advisory committee, with a maximum of one negative vote. If a student fails the final examination, there must be a lapse of one full semester (15 weeks) before rescheduling the examination. A student is allowed no more than two opportunities to pass the final examination.

FACILITIES

The Lawrence Schacht Laboratory complex is located on the 3rd Floor of the Morton-Kidde Building. The laboratory complex consists of conference facilities, multimedia classrooms, and a teaching classroom with 34 personal computers.

The SEEM Systems Integration Laboratory is located in the Carnegie Building. This facility houses the department's research laboratory. The facility contains numerous workstations and personal computers with a wide variety of simulation, decision analysis, systems integration, and data analysis software. The focus of this facility is to conduct research and help corporations in the requirements-definition and operational-conceptualization phases for new products.

UNDERGRADUATE COURSES

TG 401 Entrepreneurship and Business for Engineers and Scientists
(3-0-3)

Aspects of **entrepreneurship and business** most relevant for technical people and the practice of **Technogenesis**. Investigates **business-related considerations in successfully commercializing new technology**. Exposes technologists to *five critical aspects of creating a successful new venture and/or a successful product or service business within an existing enterprise*: (1) market and customer analysis, (2) beating the competition, (3) planning and managing for profitability, (4) high-tech marketing and sales, and (5) business partnerships and acquisitions. Students should take this course if they: (1) desire to maximize their effectiveness as technologists by understanding the business and customer considerations that impact the work of technologists, (2) intend to lead or participate in a technology-based new venture/start-up, or (3) contemplate an eventual transition from a technical to a business management career. It is intended for either advanced undergraduate (junior or senior) or graduate students in engineering or science curricula. Also offered as TG 501.

EM 270 Engineering Management
(3-0-3)
This course deals with the problems associated with the management of engineering personnel, projects and organizations. The applications of the functions of management to engineering related operations, including the engineering aspects of products and process development, are reviewed. The course requires students to apply their knowledge of human behavior, economic analysis, and science to solve problems in the management of technologically oriented organizations. The capstone of the course is a term paper analyzing an engineering management problem taken from actual practice.

EM 275 Project Management
(3-0-3)
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. Corequisite: EM 270

EM 301 Engineering Cost Management
(3-3-4)
This course introduces students to the fundamental concepts of financial and managerial accounting. Key topics covered include the preparation and analysis of financial statements, with emphasis on creating cash flow statements needed for engineering economic analysis; 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, inventory costing. The laboratory portion of the course provides the student with computerized problem solving techniques, such as spreadsheet analysis, and includes related managerial topics, including sessions focused on group dynamics and teamwork, research using the Internet and business ethics.

EM 322 Engineering Design VI
(1-3-2)
Provides students with "hands-on" experience of management of New Product (Process) Development, which they can use in their senior design projects. Students will study the stages of product (technology) life cycle from concept to discharge of a product. Study includes systems consisting of hardware and software design,

manufacturing, testing and installation based on Integrated Product and Process Development (IPPD) model. Different tools for forecasting, optimization and simulation are provided for students to identify the problem, select the project, form the team and prepare proposals suitable for submission to a potential sponsor for the senior design capstone project. Proposal documented according to ISO 9000 Quality Management and ISO 14000 Environment Management Standards. Prerequisite: EM 380. Corequisites: EM 345 and E 355

EM 345 Modeling and Simulation
(3-0-3)
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 by 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

EM 360 Total Quality Management
(3-0-3)
This course will provide the student with the underlying management concepts and principles of Total Quality Management (TQM) and how they apply to Engineering Management. The ideas and concepts of Frederick Winslow Taylor, Edward Deming, Joe Juran, Phil Crosby, Armand Fiegenbaum and Karou Ishikawa will be presented and discussed in relation to how management thought has developed from Scientific Management to Quality Management. Discussion of the Baldridge and Deming awards will include how leadership, information and analysis, strategic quality planning, human resource utilization, quality assurance and customer satisfaction relate to QM in Engineering Management. The use of Concurrent Engineering in Research, Design, & Engineering will be explored. The student will learn various TQM tools explored such as Quality Function Deployment, Design for Cost, and Cost of Quality. The students will learn the methodology and techniques of Continuous Process Improvement and use this knowledge to analyze and correct defects as part of a team project.

EM 365 Statistics for Engineering Managers
(3-1.5-4)
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 366 Statistical Quality Control
(3-0-3)
The focus will be on the use of quality improvement tools and the application of various types of control charts for improving both manufacturing and service industry processes. The concepts and application of acceptance sampling will be demonstrated from both the producer and the users' perspective. Other topics that will be demonstrated for improving processes are Design of Experiments and Robust Design. The course also covers areas of elementary probability and reliability theory. Prerequisite EM 365

EM 380 Engineering Management Laboratory
(3-0-3)
This course prepares the student for the engineering management senior design project. The subjects covered include computerized information search processes, data collection and analysis by survey and other methods, forecasting, economic analysis of projects, project management, ethics, and oral and written presentation methods. Students form small teams and complete projects covering the above-mentioned areas, the results of which are then presented in oral and written form. Closed circuit TV, videotaping, and computer software are used in the instruction process. Senior design teams will be formed and at least half of the laboratory periods will be devoted to initiating the design proposal, literature search, and client agreement. Pre or Corequisite: EM 365

EM 402 Innovative System Design
(3-0-3)
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.

EM 423-424 Engineering Management Design Project
(0-8-3) (0-8-3)
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 380 Engineering Management Laboratory course, as well as skills learned in the other technical and non-technical courses of the Engineering Management curriculum. Prerequisite: EM 270, EM 275, E 355, EM 301, EM 322, EM 345 and EM 380.

EM 450 Operations Management
(3-0-3)
Students learn about planning, organizing, staffing, directing and controlling the production of goods and providing service functions of an organization. Main stages of production cycle and components will include raw materials, personnel, machines, and buildings. Specific topics covered will include forecasting, product design and process planning, allocation of scarce resources, capacity planning and facility location, materials management, scheduling, office layout, and total quality management. Prerequisite: EM 457

EM 457 Elements of Operations Research
(3-0-3)
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

GRADUATE COURSES

All Graduate courses are 3 credits except where noted.

Engineering Management

EM 600 Engineering Economics and Cost Analysis
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.

EM 605 Elements of Operations Research
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 618 Engineering Economics and Management Policy
This course covers the discipline of engineering economics and how this discipline influences management policy and decision-making. The major emphasis is on 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. The first part of the course covers the basics of engineering economy on which the selection process rests. The remaining parts cover the selection process itself, beginning with deterministic analyses based on single-valued estimates, continuing on, where significant, to risk analyses based on multivalued estimates, and concluding with multiattribute analyses in which both the monetary and non-monetary factors involved in investment decisions are combined into single figures of merit. In passing through the process, capital budgeting, cost estimation, probability analysis, uncertainty analysis, and Monte Carlo simulation are introduced and applied. Case studies are used where appropriate. Also listed as Mgt 618. Prerequisite: Mgt 600

EM 690 Selected Topics in Engineering Management
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 744 Advanced Data Analysis and Forecasting
This data driven course focuses on the subjects of data analysis and regression. 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, neural networks, factor analysis, analysis of variance, time series analysis, and other regression techniques will be presented. The course will make extensive use of the MATLAB software packages. However, students will be encouraged to use a wide variety of industry-standard data analysis and mining tools including SPSS, SAS, and BrainMaker.

EM 750 Total Quality Management
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. Also listed as Mgt 750.

EM 760 Production and Operations Management
Covers the general area of management of operations, both in 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. Also listed as Mgt 760.

EM 761 Analysis of Production Systems
Development of models useful in management of production operations under limited resources, optimization of production planning and scheduling. Topics such as line-balancing, shop loading and sequencing, production smoothing, critical path analysis and forecasting models are covered. Also listed as Mgt 761.

EM 796 Statistical Models
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, correlation techniques, regression, statistical inference, and forecasting. Also listed as Mgt 620.

EM 800 Special Problems in Engineering Management*
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 courses in a master's degree program. A department technical report is required as the final product for this course. Prerequisite: consent of instructor

EM 801 Special Problems in Engineering Management*
Three credits 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 courses in a Ph.D. degree program. A department technical report is required as the final product for this course. Prerequisite: consent of instructor

EM 900 Thesis in Engineering Management*
For the degree of Master of Engineering (Engineering Management). A minimum of six credit hours is required for the thesis. Hours and credits to be arranged.

EM 960 Research in Engineering Management*
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.

*By request

Systems Engineering

SYS 595 Design of Experiments and Optimization
This course is 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 to solve real world problems. The student will use the software that is included in the textbook to solve problems. This course will demonstrate also Markov modeling techniques.

SYS 605 Systems Integration (Module version is SDOE 605)
This course is designed to provide students with an understanding of Systems Integration (SI) process, approaches, drivers, tools and techniques required for successful SI, critical success factors, and best practices. The objective of the course is to provide the students an understanding of the technical and business process issues involved in systems integration. Systems integration process is illustrated over the life cycle concept of projects – during design, development, implementation, testing and production. Case studies and examples from the Information Technology (IT), defense, energy, and financial services industry will be used to illustrate the concepts discussed. The students will learn the theory and practice of business process integration, legacy integration, new systems integration, business-to-business integration, integration of commercial-off-the-shelf (COTS) products, interface control and management, testing, integrated program management, integrated Business Continuity Planning (BCP). Specific focus will be given to issues of interface integration and interoperability of systems.

SYS 606 Accelerated Systems Integration and Testing (Module version is SDOE 606)
This course will provide answers to the challenges of planning, designing, architecting, and implementing systems integration and testing for "compressed delivery" of time-to-market sensitive systems, without compromising quality standards. This course is designed to provide the participants an understanding of the concepts and practice of accelerated systems integration (SI) and testing, different SI approaches to design, architect and implement integrated systems, tools and techniques to measure the successful implementation of SI, SI best practices, and SI issues relating to legacy systems, interoperability of systems, interface control, testability etc. The objective of the course is to provide the participants an understanding of the technical and business process issues involved in accelerated systems integration and testing. The course will focus on accelerated systems integration and testing process and concepts such as Test Driven Development (TDD), Rapid Testing, Designing for Testability etc. These accelerated testing tools and techniques will be illustrated by application to all aspects of systems integration testing, namely, planning, designing, architecting, migration strategies, configuration management etc. The participants will learn how to apply accelerated systems integration and testing concepts and practices to business process integration, legacy integration, new systems integration, integration of Commercial-Off-The-Shelf (COTS) products, application integration, architecture integration (protocols, connectivity, and database systems), integrated testing, verification and validation, integrated program management.

SYS 611 Modeling and Simulation (Module version is SDOE 611)
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 612 Project Management of Complex Systems (Module version is SDOE 612)
This project-based course exposes students to tools and methodologies useful for the effective management of systems engineering and engineering management projects. 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. These tools will be presented within the context of a life cycle and a systems approach. Students will be exposed to advanced project management software. Advanced techniques for managing complex systems will also be presented. Also listed as IPD 612.

SYS 620 Simulation-Based Costing and Acquisition (Module version is SDOE 620)
This course will provide an understanding of both the tools and models that can be used throughout the design, development, and support phases of a system to conduct trade-offs between system performance and life-cycle cost. The students will be exposed to the cost benefit analysis process as a strategic tool during system design and development consistent with the principles of Cost as an Independent Variable (CAIV). The students will also be exposed to the formulation of cost-estimating relationships in this context. The course will focus on the use of tools and the development of models from case studies. Prerequisite: IPD 611, SYS 611, or consent of instructor.

SYS 625 Systems Operational Effectiveness and Life-cycle Analysis (Module version is SDOE 625)
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. Also listed as CpE 625.

SYS 630 DAU Level I Certification Examination (Module version is SDOE 630)
This will test the knowledge of students who have achieved Level I certification through the Defense Acquisition University. Upon successful completion (graded pass/fail), students will be awarded 3 credits toward a Master of Engineering in Systems Engineering. The examination is normally given twice each year.

SYS 631 DAU Level II and III Certification Examination (Module version is SDOE 631)
This will test the knowledge of students who have achieved II and III certification through the Defense Acquisition University. Upon successful completion (graded pass/fail), students will be awarded between 3 and 6 credits toward a Master of Engineering in Systems Engineering. The examination is normally given twice each year.

SYS 635 System Maintainability and Maintenance (Module version is SDOE 635)
System maintainability is a design characteristic, whereas maintenance is a consequence of design, and this module focuses on both. Maintainability analysis, and the associated theory, provides a powerful tool with which engineers can gain a quantitative and qualitative description of the ability and cost of systems and products to be restored. On the other hand, and as part of the emphasis of this module on maintenance, participants will be introduced to analysis and optimization techniques to enhance the efficiency of the maintenance system through proper classification of tasks as preventive and/or corrective, and their intelligent clustering to reduce the associated maintenance manpower, cost, time, and resources.

SYS 640 System Supportability and Logistics (Module version is SDOE 640)
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 Reliability, Maintainability, and Supportability (Module version is SDOE 645)
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. Further, the students will learn to exploit this phase of the system design and development process to impart enhanced reliability, maintainability, and supportability to the design configuration being developed. Given the strategic nature of early design decisions, the participants will also learn selected multiattribute design decision and risk analysis methodologies, including Analytic Hierarchy Process (AHP). As part of the emphasis on maintainability, the module addresses issues such as accessibility, standardization, modularization, testability, mobility, interchangeability and serviceability, and the relevant methods, tools, and techniques. Further, the students will learn to exploit this phase of the system design and development process to impart enhanced supportability to the design configuration being developed through an explicit focus on configuration commonality and interchangeability, use of standard parts and fasteners, adherence to open system standards and profiles, and use of standard networking and communication protocols. Examples and case studies will be used to facilitate understanding of these principles and concepts.

SYS 650 System Architecture and Design (Module version is SDOE 650)
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. Module version is SDOE 650. Prerequisite: SYS 625.

SYS 651 Agile Systems Engineering & Architecting: Methods, Processes and Practices (Module version is SDOE 651)
This course presents the systems engineering process with an emphasis on speed and reduced time-to-market. It describes the fundamental principles and processes for designing effective systems, including how to determine customer needs, how to distinguish between needs and solutions, and how to translate customer requirements into design specifications. It explains the fundamentals of system architecting, including functional analysis, decomposition, requirements flow-down and practical heuristics for developing good architectures. The focus of the course is on designing systems that not only provide the required

capabilities and performance, but that are reliable, supportable and maintainable throughout the system life-cycle. The concept of operational effectiveness is introduced and the cause and effect relationship between design decisions and system operation, maintenance, and logistics is discussed. The implications of open systems architectures and the use of commercial technologies and standards (COTS) are explicitly addressed, as are the linkages between the early architectural decisions, driven by customer requirements and the concept of operations, and system operational and support costs. Principles and techniques are illustrated with numerous case studies and examples drawn from commercial and defense/aerospace experience. The course utilizes a "hands-on" approach to convey systems engineering and architectural concepts. Students work in small groups to develop a conceptual design for a system that addresses an operational need of their own choosing. They then develop an architectural model for a case study using a systems engineering tool (CORE) to assist in requirements management and functional modeling. This pragmatic approach allows students to discover and assimilate their own "lessons learned" as they explore design alternatives and analyze functional behavior and the physical implications of their evolving system design. The course concludes with a combined Systems Requirements Review /Preliminary Design Review in which students present the work of their class projects.

SYS 655 Robust Engineering Design (Module version is SDOE 655)
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 (Module version is SDOE 660)
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. Module version is SDOE 660. Prerequisite: Course in Probability and Statistics

SYS 665 Integrated Supply Chain Management (Module version is SDOE 665)
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.

SYS 670 Forecasting and Demand Modeling Systems (Module version is SDOE 670)
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 675 Dynamic Pricing Systems (Module version is SDOE 675)
Dynamic pricing is defined as the buying and selling of goods and services in free markets where the prices fluctuate in response to supply and demand and changing. This course illustrates the difference between static and dynamic pricing, and covers various dynamic pricing models and methodologies for successful pricing. This course also illustrates the fact that effective pricing optimization is based on modeling of demand and elasticity of demand at a very granular level. It will explore various dynamic pricing models and explore and identify factors relevant in choosing dynamic pricing models that best support the operational effectiveness, external environment and business strategy of a particular firm.

SYS 690 Selected Topics in Systems Engineering
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

SYS 720 Designing the Development System
This course addresses the design of the peopled-system that is responsible for designing and testing a product or operational system. Three keys to designing the development system 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-effective success, and the design of risk management activities (with an emphasis on adaptive testing). 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. Prerequisites: SYS 650, SYS 660

SYS 740 Dynamics of Economic Systems
The course introduces students to system dynamics models of business policy analysis and forecasting of associated management problems of complex systems. The course covers advanced techniques of policy and strategy development applications: system thinking and modeling dynamics of growth and stability, including interaction of human factors with the technology. The tools of increasing power and complexity are offered for student's business and management applications: causal feedback diagrams, technology process graphs, information processing flowcharts, decision scenarios. Students will get hands-on training in systems modeling by STELLA and DYNAMO software languages and perform their own case studies of real system of technology and/or business development based on the Technogenesis approach. Prerequisite: Course in statistics.

SYS 760 Advanced Decision and Risk Analysis
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 tradeoffs, and managing systems engineering projects. Prerequisites: SYS 660

SYS 775 Systems Thinking (Module version is SDOE 775)
The ability to "think" and "act" in terms of systems is a prerequisite to being able to organize and operate organizations and their enterprises so that business purpose, goals and missions can be actively pursued. Systems thinking, also called the systemic approach, has evolved, through multiple contributions during 20th century, into a discipline that can be applied in gaining an understanding of the common denominator aspects of various types of systems and, in particular, the dynamic and temporal relationships between multiple systems in operation. Through systems thinking organizations and their enterprises can learn to identify system problems and opportunities and to determine the need for, as well as evaluate the potential effect of, system changes. Having decided upon the need for new systems, removal of systems and/or structural changes in one or more existing systems, it is vital to deploy a controlled means of "acting" for managing the changes in an expedient and reliable manner. In this regard, the international standard ISO/IEC 15288 (System Life Cycle Processes) provides relevant guidance for the management of the life cycle of any type of man-made system. This module has been developed to convey essential properties of systems as well as to focus upon the most central activity of any organization or enterprise; namely the management of change. This is accomplished by introducing the concepts and principles of systems from the perspective of systems (systemic) thinking as well as from the guidance provided by the ISO/IEC 15288 standard. A model for change management based upon paradigms for thinking and acting as well as for the gathering of knowledge provides for a unified discipline independent approach. Prerequisite: SYS 625.

SYS 780 Agile Development Strategy (Module version is SDOE 780)
This course is designed to provide to the participants a strategic view of agile development. The course will include discussions on agile and new product development strategies and approaches practiced by companies that have been successful in leading changes and responding well to changes in the marketplace. This course is extensively case study and project based. Industry speakers will discuss real case studies of their agile development strategies, introduction and launching of new products and services in a competitive marketplace, innovative leadership, and responding to technology opportunities. The role of organizational structures and management in agile development will also be discussed. Development models that would support agile design and capability deployment will also be discussed.

SYS 800 Special Problems in Systems Engineering*
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. Prerequisite: consent of instructor. **Students enrolled in the SDOE program should enroll in course number SDOE 800.**

SYS 801 Special Problems in Systems Engineering*
Three credits 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 courses

in a Ph.D. degree program. A department technical report is required as the final product for this course. Prerequisite: consent of instructor. **Students enrolled in the SDOE program should enroll in course number SDOE 801.**

SYS 900 Thesis in Systems Engineering*
For the degree of Master of Engineering (Systems Engineering). A minimum of six credit hours is required for the thesis. Hours and credits to be arranged. **Students enrolled in the SDOE program should enroll in course number SDOE 900.**

SYS 960 Research in Systems Engineering*
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. **Students enrolled in the SDOE program should enroll in course number SDOE 960.**

*By request