1. [8 pts] Find the largest possible domain for \( f(x, y) = \ln(1 - x^2 - y^2) \). For this domain, determine the range of \( f \).

2. [8 pts] Determine if the series converges or diverges, and find its limit if it does converge.
   
   \[
   (a) \quad \frac{3}{10} - \frac{3}{100} + \frac{3}{1000} - \cdots = \sum_{n=1}^{\infty} (-1)^{n-1} \frac{3}{10^n}
   \]

3. [8 pts] Compute the first-order partial derivatives for \( f(x, y) = x^4 - x^3y + x^2y^2 + y^3 \).

4. [8 pts] Evaluate \( \int_0^1 \int_0^\pi x \sin y \, dy \, dx \).

5. [8 pts] Find a non-zero vector that is perpendicular to both of the vectors \( \mathbf{v} = \mathbf{i} + \mathbf{j} + \mathbf{k} \) and \( \mathbf{w} = \mathbf{i} + \mathbf{j} \).

6. [8 pts] Consider the triangle with vertices \( A(-1, 0, 2) \), \( B(2, 1, -1) \), and \( C(1, -2, 2) \). Determine \( \cos \theta \) where \( \theta \) is the angle \( \angle ABC \) as shown in the figure.

7. [8 pts] For the following power series, determine the radius of convergence. [Just the radius of convergence; not necessary to evaluate convergence at the endpoints.]
   
   \[
   \sum_{n=0}^{\infty} \frac{(-1)^n nx^n}{2^n (n + 1)^2}
   \]

8. [10 pts] Determine the third-order Taylor polynomial for \( f(x) = \ln x \) centered at \( x = 1 \), and use this polynomial to approximate \( \ln(0.5) \).
9. [10 pts] Use linear approximation to estimate \( f(0.9, 2.9, 3.1) \), where \( f(x, y, z) = \sqrt{xyz} \).

10. [12 pts] Evaluate the double integral

\[
\iint_D xy \, dA
\]

where \( D \) is the shaded region in the figure.

11. [8 pts] Find \( \partial z / \partial x \) in terms of \( x \), \( y \), and \( z \), assuming the equation \( x^3 + y^3 + z^3 = xyz \) determines a function \( z = f(x, y) \).

12. [10 pts] Determine the position vector \( \mathbf{r}(t) \) for a particle moving in 3-space under the acceleration \( \mathbf{a}(t) = \sin(t) \mathbf{k} \), with initial velocity \( \mathbf{v}(0) = 3 \mathbf{i} \), and initial position \( \mathbf{r}(0) = 2 \mathbf{k} \).

13. [12 pts] Convert the following double integral to polar coordinates and evaluate.

\[
\int_0^1 \int_{\sqrt{4-y^2}}^{\sqrt{4-y^2}} \sqrt{x^2 + y^2} \, dx \, dy + \int_1^2 \int_{\sqrt{4-y^2}}^{\sqrt{4-y^2}} \sqrt{x^2 + y^2} \, dx \, dy
\]

14. [12 pts] Find the points on the ellipsoid \( 4x^2 + 9y^2 + z^2 = 36 \) that are nearest the origin.

15. [10 pts] Determine if each of the following series converge or diverge.

(a) \( \sum_{n=1}^{\infty} \frac{(-1)^{n+1}}{\sqrt{n^2 + 1}} \)  
(b) \( \sum_{n=1}^{\infty} \frac{n^2 + 2}{3n^3 - n} \)

16. [10 pts] Find the equation of the plane containing the three points \( A(1, 1, -1) \), \( B(2, 0, 2) \), and \( C(0, -2, 1) \).