Semester-I

GE-1: Calculus OR GE-1: Analytic Geometry and Theory of Equations

GE-1: Calculus

Total Marks: 100 (Theory: 75, Internal Assessment: 25)
Workload: 5 Lectures, 1 Tutorial (per week) **Credits:** 6 (5+1)
Duration: 14 Weeks (70 Hrs.) **Examination**: 3 Hrs.

Course Objectives: The main aim of this course is to learn about applications of derivatives for sketching of curves and conics and application of definite integrals for calculating volumes of solids of revolution, length of plane curves and surface areas of revolution. Various notions related to vector-valued functions and functions of several variables are also discussed in this course.

Course Learning Outcomes: This course will enable the students to:

i) Sketch the curves in Cartesian and polar coordinates as well as learn techniques of sketching the conics.
ii) Visualize three dimensional figures and calculate their volumes and surface areas.
iii) Understand limits, continuity and derivatives of functions of several variable and vector-valued functions.

Unit 1: Applications of Derivatives and Limits **(Lectures: 20)**

The first derivative test, Concavity and inflection points, Second derivative test, Curve sketching using first and second derivative test; Limits at infinity, Horizontal asymptotes, Vertical asymptotes, Graphs with asymptotes; L'Hôpital's rule.

Unit 2: Applications of Definite Integrals **(Lectures: 15)**

Volumes by slicing, Volumes of solids of revolution by the disk method, Volumes of solids of revolution by the washer method, Volume by cylindrical shells, Length of plane curves, Arc length of parametric curve, Area of surface of revolution.

Unit 3: Conics, Vector-Valued Functions and Partial Derivatives **(Lectures: 35)**

Techniques of sketching conics, Reflection properties of conics; Polar coordinates, graphing in polar coordinates; Vector-valued functions**:** Limits, Continuity, Derivatives, Integrals, Arc length, Unit tangent vector, Curvature, Unit normal vector; Functions of several variables**:** Graphs and level curves, Limits and continuity, Partial derivatives and differentiability, The chain rule, Directional derivatives and gradient vectors, Tangent plane and normal line, Extreme values and saddle points.

References:

1. Anton, Howard, Bivens, Irl, & Davis, Stephen (2013). *Calculus* (10th ed.). John Wiley & Sons Singapore Pvt. Ltd. Reprint (2016) by Wiley India Pvt. Ltd. Delhi.
2. Strauss, M. J., Bradley, G. L., & Smith, K. J. (2007). *Calculus* (3rd ed.). Dorling Kindersley (India) Pvt. Ltd. (Pearson Education). Delhi. Sixth impression 2011.

Additional Reading:

i. Thomas, Jr. George B., Weir, Maurice D., & Hass, Joel (2014). *Thomas' Calculus* (13th ed.). Pearson Education, Delhi. Indian Reprint 2017.

Teaching Plan (GE-1: Calculus):

Weeks 1 and 2: The first derivative test, Concavity and inflection points, Second derivative test, Curve sketching using first and second derivative test. [2] Chapter 4 (Section 4.3).
Weeks 3 and 4: Limits at infinity, Horizontal asymptotes, Vertical asymptotes, Graphs with asymptotes; L'Hôpital's rule. [2] Chapter 4 (Sections 4.4, and 4.5). [1] Chapter 3 (Section 3.3), and Chapter 6 (Section 6.5).
Weeks 5 and 6: Volumes by slicing, Volumes of solids of revolution by the disk method, Volumes of solids of revolution by the washer method, Volume by cylindrical shells. [1] Chapter 5 (Sections 5.2, and 5.3).
Week 7: Length of plane curves, Arc length of parametric curves, Area of surface of revolution.
[1] Chapter 5 (Sections 5.4, and 5.5).
Week 8: Techniques of sketching conics, Reflection properties of conics. [1] Chapter 10 (Section 10.4).
Week 9: Polar coordinates, Graphing in polar coordinates. [1] Chapter 10 (Section 10.2).
Week 10: Vector-valued functions**:** Limit, continuity, Derivatives, Integrals, Arc length, Unit tangent vector, Curvature, Unit normal vector. [1] Chapter 12 (Sections 12.1 to 12.5).
Weeks 11 and 12: Functions of several variables**:** Graphs, Level curves, Limits and continuity, Partial derivatives and differentiability. [1] Chapter 13 (Section 13.1 to 13.4).
Week 13: Functions of several variables**:** The chain rule, Directional derivatives and gradient vectors.
[1] Chapter 13 (Sections 13.5, and 13.6).
Week 14: Functions of several variables**:** Tangent plane and normal line, Extreme values and saddle points.
[1] Chapter 13 (Sections 13.7, and 13.8).

GE-1: Analytic Geometry and Theory of Equations

Total Marks: 100 (Theory: 75, Internal Assessment: 25)
Workload: 5 Lectures, 1 Tutorial (per week) **Credits:** 6 (5+1)
Duration: 14 Weeks (70 Hrs.) **Examination**: 3 Hrs.

Course Objectives: The goal of this paper is to acquaint students with certain ideas about conic sections, vectors in coordinate system and general properties of roots of polynomial equations with some applications.

Course Learning Outcomes: After completion of this paper, the students will be able to:

i) Classify and sketch conics four different types of conic sections–the circle, the ellipse, the hyperbola and the parabola–in Cartesian and polar coordinates.
ii) Visualize and understand the properties of three dimensional objects– spheres and cylinders– using vectors.
iii) Understand the properties of roots of polynomial equations.

Unit 1: Conic Sections, Parametrized Curves, and Polar Coordinates (Lectures: 25)

Conic sections and quadratic equations**:** Circle, Parabola, Ellipse, and Hyperbola; Techniques for sketching**:** Parabola, Ellipse, and Hyperbola; Reflection properties of Parabola, Ellipse, and Hyperbola, Classifying conic sections by eccentricity, Classification of quadratic equations representing Lines, Parabola, Ellipse, and Hyperbola; Parameterization of plane curves, Conic sections in polar coordinates and their sketching.