Semester-III
Generic Elective (GE) Course -Mathematics

Any *one* of the following:

GE-3: Differential Equations (with Practicals)

GE-3: Linear Programming and Game Theory

GE-3: Differential Equations (with Practicals)

Total Marks: 150 (Theory: 75, Internal Assessment: 25, and Practical: 50)
Workload: 4 Lectures, 4 Practicals (per week) **Credits:** 6 (4+2)
Duration: 14 Weeks (56 Hrs. Theory + 56 Hrs. Practical) **Examination:** 3 Hrs.

Course Objectives: This course includes a variety of methods to solve ordinary and partial differential equations with basic applications to real life problems. It provides a solid foundation to further in mathematics, sciences and engineering through mathematical modeling.

Course Learning Outcomes: The student will be able to:

i) Solve the exact, linear and Bernoulli equations and find orthogonal trajectories.
ii) Apply the method of variation of parameters to solve linear differential equations.
iii) Formulate and solve various types of first and second order partial differential equations.

Unit 1: Ordinary Differential Equations and Applications

First order exact differential equations, Integrating factors and rules to find integrating factors, Linear equations and Bernoulli equations, Orthogonal trajectories and oblique trajectories, Basic theory of higher order linear differential equations, Wronskian and its properties; Solving differential equation by reducing its order.

Unit 2. Explicit Methods of Solving Higher-Order Linear Differential Equations

Linear homogenous equations with constant coefficients, Linear non-homogenous equations, Method of undetermined coefficients, Method of variation of parameters, Cauchy–Euler equations; Simultaneous differential equations.

Unit 3. First and Second Order Partial Differential Equations

Partial differential equations: Basic concepts and definitions. Mathematical problems; First order equations: Classification, Construction, Geometrical interpretation; Method of characteristics, General solutions of first order partial differential equations; Canonical forms and method of separation of variables for first order partial differential equations; Classification of second order partial differential equations; Reduction to canonical forms; Second order partial differential equations with constant coefficients, General solutions.

References:

1. Kreyszig, Erwin. (2011). *Advanced Engineering Mathematics* (10th ed.). Wiley India.
2. Myint-U, Tyn and Debnath, Lokenath (2007). *Linear Partial Differential Equations for Scientist and Engineer*s (4th ed.). Birkkäuser Boston. Indian Reprint.
3. Ross, Shepley. L. (1984). *Differential Equations* (3rd ed.). John Wiley & Sons.

Additional reading:

i. Sneddon I. N. (2006). *Elements of Partial Differential Equations*. Dover Publications.

Practical / Lab work to be performed in a Computer Lab:

Use of Computer Algebra Systems (CAS), for example MATLAB/Mathematica /Maple/Maxima/Scilab etc., for developing the following programs:

1. Solution of first order differential equation.
2. Plotting of second order solution family of differential equation.
3. Plotting of third order solution family of differential equation.
4. Solution of differential equation by variation of parameter method.
5. Solution of system of ordinary differential equations.
6. Solution of Cauchy problem for first order partial differential equations.
7. Plotting the characteristics of the first order partial differential equations.
8. Plot the integral surfaces of first order partial differential equations with initial data.

Teaching Plan (GE-3: Differential Equations):

Weeks 1 and 2: First order ordinary differential equations: Basic concepts and ideas, First order exact differential equation, Integrating factors and rules to find integrating factors.

[3] Chapter 1 (Sections 1.1, and 1.2), and Chapter 2 (Sections 2.1, and 2.2).

[1] Chapter 1 (Sections 1.1, 1.2, and 1.4).

Week 3: Linear equations and Bernoulli equations, Orthogonal trajectories and oblique trajectories.

[3] Chapter 2 (Sections 2.3, and 2.4), and Chapter 3 (Section 3.1).

Weeks 4 and 5: Basic theory of higher order linear differential equations, Wronskian and its properties, Solving a differential equation by reducing its order.

[3] Chapter 4 (Section 4.1).

Weeks 6 and 7: Linear homogenous equations with constant coefficients, Linear non-homogenous equations, Method of undetermined coefficients.

[3] Chapter 4 (Sections 4.2, and 4.3), and

[1] Chapter 2 (Section 2.2).

Weeks 8 and 9: Method of variation of parameters, Cauchy–Euler equations, Simultaneous differential equations.

[3] Chapter 4 (Sections 4.4, and 4.5), and Chapter 7 (Sections 7.1, and 7.3)

Week 10: Partial differential equations**:** Basic concepts and definitions, Mathematical problems; First order equations**:** Classification and construction.

[2] Chapter 2 (Sections 2.1 to 2.3).

Weeks 11 and 12: Geometrical interpretation, Method of characteristics, General solutions of first order partial differential equations.

[2] Chapter 2 (Sections 2.4, and 2.5).

Week 13: Canonical forms and method of separation of variables for first order partial differential equations.

[2] Chapter 2 (Sections 2.6, and 2.7)

Week 14: Second order partial differential equations**:** Classification, Reduction to canonical forms, With constant coefficients, General solutions.

[2] Chapter 4 (Sections 4.1 to 4.4).