DIFFERENTIAL EQUATIONS AND MATHEMATICAL MODELING
(SEMESTER V)

Total marks: 150(Theory: 75, Practical: 50, Internal Assessment: 25)
5 Periods (4 lectures +1 students' presentation),
Practical (4 periods per week per student),

(1st Week)

First order ordinary differential equations: Basic concepts and ideas, Modeling: Exponential growth and decay, Direction field, Separable equations, Modeling: Radiocarbon dating, Mixing problem

Sections 1.1, 1.2, 1.3 (Pages 12 to 14) [1]

(2ndWeek)

Modeling: Newton's law of cooling, Exact differential equations, Integrating factors, Bernoulli equations, Modeling: Hormone level in blood, Logistic equation

Sections 1.3 (Pages 14 to 15 and Page 17), 1.4, 1.5 (Pages 29 to 31) [1]

(3rdWeek)

Orthogonal trajectories of curves, Existence and uniqueness of solutions, Second order differential equations: Homogenous linear equations of second order

Sections 1.6, 1.7, 2.1 [1]

(4thWeek)

Second order homogenous equations with constant coefficients, Differential operator, Euler-Cauchy equation

Sections 2.2, 2.3, 2.5 [1]

(5thWeek)

Existence and uniqueness theory: Wronskian, Nonhomogenous ordinary differential equations, Solution by undetermined coefficients

Sections 2.6, 2.7 [1]

(6thWeek)

Solution by variation of parameters, Higher order homogenous equations with constant coefficients, System of differential equations, Modeling: Mixing problem involving two tanks

Sections 2.10, 3.2, 4.1(Pages130 to 132) [1]

(7thWeek)

System of differential equations: Conversion of n^{th} order ODEs to a system, Basic concepts and ideas, Homogenous system with constant coefficients, Phase plane, Critical points

Sections 4.1 (Pages 134, 135), 4.2, 4.3 [1]

(8thWeek)

Criteria for critical Points and stability, Qualitative methods for nonlinear systems: Linearization of nonlinear systems, Lotka–Volterra population model

Sections 4.4, 4.5 (Pages 151 to 155) [1]

(9thWeek)

Power series method: Theory of power series methods, Legendre's equation, Legendre polynomial

Sections 5.1, 5.2, 5.3 [1]

(10thWeek)

Partial differential equations: Basic Concepts and definitions, Mathematical problems, First order equations: Classification, Construction, Geometrical interpretation, Method of characteristics

Sections 2.1, 2.2, 2.3, 2.4 [2]

(11thWeek)

General solutions of first order partial differential equations, Canonical forms and method of separation of variables for first order partial differential equations

Sections 2.6, 2.7 [2]

(12th Week)

Classification of second order partial differential equations, Reduction to canonical forms, Second order partial differential equationswith constant coefficients, General solutions

Sections 4.1, 4.2, 4.3, 4.4 [2]

PRACTICALS

1. To determine whether a given number is prime or composite.
2. To find the sum of digits of a number and decide its divisibility.
3. To compute the roots of a quadratic equation.
4. To Linear Sort a given set of numbers.
5. To compute higher degree polynomials using Horner's method.
6. To plot the direction field of first order differential equation.
7. To find the solution and plot the growth and decay model (both exponential and logistic).
8. To find the solution and plot the Lotka–Volterra model.
9. To find the solution of Cauchy problem for first order partial differential equations.
10. To plot the integral surfaces of a given first order partial differential equations with initial data.

Note: Programming is to be done in any one of Computer Algebra Systems: MATLAB/MATHEMATICA/MAPLE.

REFERENCES:

[1] Erwin Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons, Inc., 9/e, (2006)

[2] TynMyint–U and LokenathDebnath; Linear Partial Differential Equations for Scientists and Engineers, Springer, Indian Reprint (2009)

FOR PRACTICALS/SUGGESTED READING:

[3] Randall J. Swift and Stephen A. Wirkus, A Course in Ordinary Differential Equations, Chapman & Hall /CRC (2007)

[4] Ioannis P. Stavroulakis and Stepan A. Tersian, Partial Differential Equations, An Introduction with Mathematica and Maple, World Scientific, 2/e (2004)