Differential Equations

- Course Number: MA 121
- Credits: 11 [LTP: 3-1-0]
- Semester-offered: II
- Prerequisite: Real Analysis & Calculus
- Instructor(s): Dr. G. Rakshit and Dr. Alpesh Kumar

Course Content

Ordinary Differential Equations:
Unit I (First Order ODE)
Introduction to a differential equation, order of differential equation. Concept of solution: general solution, singular solution, implicit solution explicit solution. Separable form, reduction to separable form, exact differential equations, integrating factors. Bernoulli equations, orthogonal trajectories. Picard's existence and uniqueness theorem, Picard's iteration method.
Unit II (Second Order ODE)
Second-order Homogeneous equations: fundamental system and general solutions of homogeneous equations, Wronskian. Second-order Homogeneous equations with constant coefficients, auxiliary equations: real distinct roots, complex roots, repeated roots, reduction of order.
Non-homogeneous equations: undetermined coefficients, variation of parameters. Euler-Cauchy equation, extensions of the results to higher order linear equations.
Complex Analysis:
Unit III (Series Solution of Linear ODEs)
Power series solutions: ordinary points, Legendre's differential equation. Legendre polynomials and properties. Frobenius series solutions: regular singular points, Bessel's equation.

Unit IV (Laplace Transformation and Fourier Series)
Laplace transforms & properties, inverse Laplace transforms, convolution theorem, applications. Fourier series

Unit V (Partial Differential Equations)
Partial Differential Equation: introduction, linear, nonlinear (semi-linear, quasi-linear) examples, well-posedness. First order linear PDEs, method of characteristics. Classification of second order PDEs, hyperbolic, parabolic and elliptic. Wave equations: d'Alembert's formula, Duhamel's principle. Heat equations: Solutions for initial boundary value, method of separation of variables. Solutions of Laplace's and Poisson's equation.

Readings

Textbooks:

i. Differential Equations with Applications and Historical Notes by G.F. Simmons.
ii. Applied Partial Differential Equations: An Introduction by A. Jeffrey.

Reference books:

i. Differential Equations by S.L. Ross.
ii. Advanced Engineering Mathematics by E. Kreyszig.
iii. An Elementary Course in Partial Differential Equations by T. Amaranth.
iv. Elements of Partial Differential Equations by Ian N. Sneddon.
v. Partial Differential Equations by Fritz John.