

Differential Equations: Existence and Uniqueness of solutions of initial value problems for first order ordinary differential equations, singular solutions of first order ODEs, system of first order ODEs. First and second order partial differential equations. Lagrange and Charpit methods for solving first order PDEs, Cauchy problem for first order PDEs. Classification of second order PDEs, General solution of higher order PDEs with constant coefficients, Method of separation of variables for Laplace, Heat and Wave equations.

Numerical Analysis: Numerical solutions of algebraic equations, Method of iteration and Newton-Raphson method, Rate of convergence, Finite differences, Lagrange interpolation, Numerical differentiation and integration, Numerical solutions of ODEs using Picard, Euler and Runge-Kutta methods.

Applied Statistics and Data Analytics: Probability Theory, basic distribution theory, Testing of Hypothesis, Basic ideas and distinctive features of sampling, Exploratory Data Analysis

Functional Analysis: Metric Spaces, Holder Inequality and Minkowski Inequality, Convergence, Cauchy Sequence, Completeness, Complete and Incomplete Metric Spaces, Vector Spaces, Banach Spaces, Finite Dimensional Normed Spaces and Subspaces, Compactness of Metric/Normed Spaces, Linear Operators, Bounded Linear Operators in a Normed Space, Concept of Algebraic Dual and Reflexive Space, Inner Product & Hilbert Space, Projection Theorem, Orthonormal Sets and Sequences, Representation of Functionals on a Hilbert Spaces, Hilbert Adjoint Operator, Self Adjoint, Unitary & Normal Operators, Total Orthonormal Sets And Sequences, Partially Ordered Set and Zorn's Lemma, Hahn Banach Theorem for Real Vector Spaces, Hahn Banach Theorem for Complex V.S. & Normed Spaces, Baire's Category & Uniform Boundedness Theorems, Open Mapping Theorem, Closed Graph Theorem, Strong and Weak Convergence, Convergence of Sequence of Operators and Functionals, L^p - Space

Integral transforms and special functions: Knowledge of Fourier transforms, Laplace transforms, Hankel, Mellin, Hilbert and Stieltjes transforms, Z transforms, Jacobi and Gegenbauer, Laguerre, Hermite transforms, Radon transforms, wavelets etc. with fractional calculus, in continuous and discrete types. Solutions related to transforms of important functions. Parseval and Plancherel formula related to the transforms. Bessel functions and other special functions with recurrence formula and other relations. The related operators and operational calculus. Ranging from applications transforms in the theory of differential equations to boundary and initial value problems in partial differential equations and continuum mechanics, signal processing etc.

Operational Research: Introduction to Inventory Management – Its types and functionality, Cost associated with inventory system, EOQ model with and without shortages, Production model with and without shortages, EOQ model with quality discount, Optimal policy for multi-item inventory system

Computational fluid dynamics: Mathematical behaviour of parabolic, hyperbolic and elliptic equations, Finite difference method and finite volume method, Derivation of finite difference equation, General methods for first and second order accuracy, Finite volume formulation for steady state One, Two and Three - dimensional problems, Parabolic equations, Explicit and Implicit schemes, Example problems on elliptic and parabolic equations, Finite element method for 1D problems, Numerical solution of a linear system

Fractal Geometry: The completeness of space of fractals, transformations Mobius transformations on the Riemann sphere, contraction mapping theorem, dynamical systems, shadowing theorem. Fractal dimension, fractal interpolation, Julia sets, IFS for Julia sets, Mandelbrot's set.

Discrete Mathematics: Sets, relations and functions, Propositional logic, permutations and combinations, mathematical induction, pigeonhole principle, graphs and trees, groups and rings

Fixed point theory and its applications: Vector Spaces, Linear Metric Spaces, Normed Linear Spaces. Vector Spaces, Linear Metric Spaces, Inner Product Spaces, Orthonormal Sets, The Contraction Mapping Theorem And Its Applications, Brouwer's Fixed Point Theorem And Its Applications, Schauder's Fixed Point Theorem And Some Related Results. The Contraction Mapping Theorem And Its Applications, Brouwer's Fixed Point Theorem And Its Applications, Schauder's Fixed Point Theorem And Some Related Results.