Subject Code: MA

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Course Syllabus

**Section A: Linear Algebra**

- Finite dimensional vector spaces
- Linear transformations and their matrix representations:
  - Rank
  - Systems of linear equations
  - Eigenvalues and eigenvectors
  - Minimal polynomial
  - Cayley-hamilton theorem
  - Diagonalization
  - Jordan-canonical form
  - Hermitian
  - Skewhermitian
  - Unitary matrices
- Finite dimensional inner product spaces:
  - Gram-Schmidt orthonormalization process
• Self-adjoint operators, definite forms

Section B: Complex Analysis

- Analytic functions, conformal mappings, bilinear transformations
- Complex integration:
  - Cauchy’s integral theorem and formula
  - Liouville’s theorem
  - Maximum modulus principle
- Zeros and singularities
- Taylor and Laurent’s series
- Residue theorem and applications for evaluating real integrals

Section C: Real Analysis

- Sequences and series of functions:
  - Uniform convergence
  - Power series
  - Fourier series
  - Functions of several variables
  - Maxima
  - Minima
- Riemann integration:
  - Multiple integrals
  - Line
  - Surface and volume integrals
  - Theorems of green
  - Stokes
  - Gauss
- Metric spaces:
  - Compactness
  - Completeness
  - Weierstrass approximation theorem
- Lebesgue measure:
  - Measurable functions
- Lebesgue integral:
  - Fatou’s lemma
  - Dominated convergence theorem
Section D: Ordinary Differential Equations

- First order ordinary differential equations:
  - Existence and uniqueness theorems for initial value problems
  - Systems of linear first order ordinary differential equations
  - Linear ordinary differential equations of higher order with constant coefficients
- Linear second order ordinary differential equations with variable coefficients
- Method of Laplace transforms for solving ordinary differential equations, series solutions (power series, Frobenius method)
- Legendre and Bessel functions and their orthogonal properties

Section E: Algebra

- Groups, subgroups, normal subgroups, quotient groups and homomorphism theorems
- Automorphisms
- Cyclic groups and permutation groups
- Sylow’s theorems and their applications
- Rings, ideals, prime and maximal ideals, quotient rings, unique factorization domains, Principle ideal domains, Euclidean domains, polynomial rings and irreducibility criteria
- Fields, finite fields, and field extensions

Section F: Functional Analysis

- Normed linear spaces
- Banach spaces
- Hahn-Banach extension theorem
- Open mapping and closed graph theorems
- Principle of uniform boundedness
- Inner-product spaces
- Hilbert spaces
- Orthonormal bases
- Riesz representation theorem
- Bounded linear operators

Section G: Numerical Analysis

- Numerical solution of algebraic and transcendental equations:
  - Bisection
- Secant method
- Newton-Raphson method
- Fixed point iteration

**Interpolation:**
- Error of polynomial interpolation
- Lagrange, newton interpolations

**Numerical differentiation**

**Numerical integration:**
- Trapezoidal and Simpson Rules

**Numerical solution of systems of linear equations:**
- Direct methods (Gauss Elimination, Lu Decomposition)

**Iterative methods** (Jacobi and Gauss-Seidel)

**Numerical solution of ordinary differential equations**

**Initial value problems:**
- Euler’s method
- Runge-Kutta methods of order 2

### Section H: Partial Differential Equations

- Linear and quasilinear first order partial differential equations:
  - Method of characteristics
- Second order linear equations in two variables and their classification
- Cauchy, Dirichlet and Neumann problems
- Solutions of Laplace, wave in two dimensional Cartesian coordinates, interior and exterior Dirichlet problems in polar coordinates
- Separation of variables method for solving wave and diffusion equations in one space variable
- Fourier series and Fourier transform and Laplace transform methods of solutions for the above equations

### Section I: Topology

- Basic concepts of topology
- Bases
- Subbases
- Subspace topology
- Order topology
- Product topology
- Connectedness
- Compactness
- Countability
- Separation axioms
Section J: Probability and Statistics

- Probability space, conditional probability, Bayes theorem, independence, Random
- Variables, joint and conditional distributions, standard probability distributions and their properties (Discrete uniform, Binomial, Poisson, Geometric, Negative binomial, Normal, Exponential, Gamma, Continuous uniform, Bivariate normal, Multinomial), expectation, conditional expectation, moments
- Weak and strong law of large numbers, central limit theorem
- Sampling distributions, UMVU estimators, maximum likelihood estimators
- Interval estimation
- Testing of hypotheses, standard parametric tests based on normal, distributions
- Simple linear regression

Section H: Linear programming

- Linear programming problem and its formulation, convex sets and their properties, graphical method, basic feasible solution, simplex method, Big-M and two phase methods
- Infeasible and unbounded LPP’s, alternate optima
- Dual problem and duality theorems, dual simplex method and its application in post optimality analysis
- Balanced and unbalanced transportation problems, Vogel’s approximation method for solving transportation problems
- Hungarian method for solving assignment problems