

Syllabus for URET(Mathematics)

PART-I: RESEARCH METHODOLOGY AND COMPUTATIONAL MATHEMATICS-100 Marks

The Basics, Topics Specific to the Writing of Mathematics, Exposition, Other types of Writing, computational Models, basics of algorithm, Divide and conquer, Greedy Method, Dynamic Programming, Further Divide and Conquer.

PART-II : SUBJECT SPECIFIC- 100 Marks

1. PARTIAL DIFFERENTIAL EQUATIONS AND ITS APPLICATIONS

Basic Concepts and Classifications of Second Order equation, The Cauchy Problem, The Method of Separation of Variables, Eigenvalue Problems, Boundary value problems, Fourier Transforms and Laplace Transforms

2. TOPOLOGY

Open sets and limit points, closed sets and closure, Bases and relative topologies, Connected Sets and components, compact and .Countable compact spaces, continuous functions, homeomorphisms, T_0 -and T_1 -spaces & sequence, Axioms of countability. T_2 Spaces, Axiom of Countability, Regular and Normal Spaces, Completely regular Spaces. Urysohn's metrization theorem, Finite products, product invariant properties, metric products, product topology.

3. ALGEBRA

Automorphisms, Cayley's Theorem, Permutation Groups, Another Counting Principle, Sylow's Theorems. More Ideals and Quotient Rings, The Field of Quotients of an Integral Domain. Euclidean Rings. A Particular Euclidean Ring, Polynomial Rings, Polynomial Rings over the Rational Field, Elementary Basic Concepts of Vector Space, Linear Independence and Bases, Extension Fields, The Transcendence of e , Roots of Polynomials, Construction with Straightedge and Compass, More about Roots, Dual Spaces, Inner Product Spaces, The Elements of Galois Theory, Solvability by Radicals, The Algebra of Linear Transformation, Characteristic Roots, Matrices, Canonical Forms 1 Triangular Form, Nilpotent Transformations, Jordan Form, Trace and Transpose, Determinants, Hermitian, Unitary and normal Transformations.

4. COMPLEX ANALYSIS

Complex Numbers, Complex Functions, Conformality and linear transformations, Complex Integration : Fundamental theorems, Cauchy's Integral formula, local properties of analytic functions, Complex integration continued : General form of Cauchy's theorem, Complex Integration Calculus of Residues, Series and Product development : Power series expansion, partial fraction and factorization, Series and product development continued : Entire function, Riemann Zeta Function, Elliptic Functions : Simple periodic functions and Double periodic functions, Elliptic Functions, Weierstrass Theory.

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5. NUMERICAL ANALYSIS AND ITS APPLICATIONS

Interpolation & Approximation: Introduction, Lagrange and Newton interpolations, finite difference operators. Interpolating Polynomials using finite differences, Hermite Interpolation, Piecewise and spline interpolation, Interpolation and Approximation (contd)

:Bivariate interpolations, Approximation, least square approximation, uniform approximation, Rational approximation, choice of the method, Differentiation and Integration : Introduction, Numerical differentiation, Optimum choice of step length, extrapolation method, partial differentiation, Numerical Integration, Methods based on interpolation. Methods based on undetermined coefficients, Composite Integration methods, Romberg Integration, Double integration, Ordinary Differential Equations, Initial Value Problems : Introduction, Difference Equations, Ordinary Differential Equations, Initial Value Problem (contd.) : Numerical methods, single step methods, stability analysis of single step methods, Multi step methods.

6. ABSTRACT MEASURE

Introduction, Outermeasure, Measurable sets and Lebesgue measure, A nonmeasurable set. Measurable functions, Littlewood's three principle, The Lebesgue Integral, Differentiation and Integration, The classical Banach Spaces.

7. ADVANCED CALCULUS

Derivatives for Functions on \mathbb{R}^n - Differentiation of composite functions, Taylors Theorem, Transformations, Linear function and transformations, Differentials of transformations, Inverse of transformations, Implicit function theorems, functional dependence, set function transformation of multiple Integrals, Curves and Arc length, surfaces and surface area, Integrals over curves and surface, Differential forms, Theorem of Green, Gauss and Stokes, exact form and closed form.

8. FUNCTIONAL ANALYSIS

Normed spaces, continuity of linear maps, Hahn-Bachach Theorems, Banach spaces, Uniform Boundedness principle. Closed Graph and Open Mapping Theorems, Bounded Inverse Theorem, Spectrum of a Bounded operator, Duals and Transposes, Weak and Weak *convergence Reflexivity, Inner product spaces, Orthonormal sets, Approximation and Optimization Projection and Riesz Representation Theorems, Bounded Operators and Adjoints, Normal, Unitary and Self-Adjoint Operators.

9. NUMBER THEORETIC CRYPTOGRAPHY

Time estimates for doing arithmetic, Divisibility and Euclidean algorithm, congruences, Some applications to factoring, finite fields, Quadratic residues and reciprocity, Some simple cryptosystems, Enciphering matrices, The idea of public key cryptography, RSA, Discrete log, Knapsack, Zero knowledge protocol and oblivious transfer, pseudo primes, The rho method, Fermat factorization and factor bases, The continued fraction method, The quadratic sieve method.

10. GRAPH THEORY

Introduction to Graphs, Trees and Connectivity, Applications of trees and connectivity, Euler Tours and Hamiltonian Cycles, Planar Graphs.

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