UG Semester V

Paper 9: Numerical Analysis

Credit: 4 T:04

Course Outcomes:

1. Some numerical methods to find the zeroes of nonlinear functions of a single variable and solution of a system of linear equations, up to a certain given level of precision.
2. Interpolation techniques to compute the values for a tabulated function at points not in the table.
3. Applications of numerical differentiation and integration to convert differential equations into difference equations for numerical solutions.

Unit I

Solution of equations: bisection, Secant, Regular Falsi, Newton Raphson's method, Newton's method for multiple roots, Interpolation, Lagrange and Hermite interpolation, Difference schemes, Divided differences, Interpolation formula using differences.

Unit II

Numerical differentiation, Numerical Quadrature: Newton Cotes Formulas, Gaussian Quadrature Formulas, System of Linear equations: Direct method for solving systems oflinear equations (Gauss elimination, LU Decomposition, Cholesky Decomposition),Iterative methods (Jacobi, Gauss Seidel, Relaxation methods). The algebraic Eigen value problem: Jacobi's method, Givens method, Power method.

Unit III

Numerical solution of Ordinary differential equations: Euler method, single step methods, Runge-Kutta method, Multi-step methods: Milne-Simpson method, Types of approximation: Last Square polynomial approximation, Uniform approximation, Chebyshev polynomial approximation.

Unit IV

Difference Equations and their solutions, Shooting method and Difference equation method for solving Linear second order differential equation with boundary conditions of first, second and third type.

References

Text Books:

1. S. S. Sastry, Introductory Methods of Numerical Analysis, PHI
2. Numerical Methods for Engineering and scientific computation by M. K. Jain, S.R.K. Iyengar & R.K. Jain.

Suggested Readings:

3. Kandasamy P. & et Al., Numerical Methods, S. Chand & Co.

Web References:

Digital platforms web links: NPTEL/SWAYAM/ MOOCS/Openstax.org

https://openlearninglibrary.mit/edu/courses

http://heecontent.upsdc.gov.in/SearchContent.aspx

https://www.lkouniv.ac.in/en/article/e-content-faculty-of-science

Paper 10: Analysis

Credit: 4 T:04

Course Outcomes:

1. Understand the basic concepts of metric spaces.
2. Know the concepts such as open balls, closed balls, compactness, connectedness etc.
3. Understand the significance of differentiability of complex valued functions leading to the understanding of Cauchy-Riemann equations.
4. Evaluate the contour integrals and understand the role of Cauchy-Goursat theorem and the Cauchy integral formula.
5. Expand some simple functions as their Taylor and Laurent series, classify the nature of singularities, find residues and apply Cauchy Residue theorem to evaluate integrals.

Unit I

Definition and examples of metric spaces, Neighbourhoods, Interior points, Limit Points, Open and closed sets, Convergent and Cauchy sequences, Completeness, Cantor's intersection theorem.

Uniform convergence of sequences and series of functions, Uniform convergence and continuity, Uniform convergence and integration, Uniform convergence and differentiation, Power series.

Unit II

Stereographic projection, Continuity and Differentiability of complex functions, Analytic functions, Cauchy Riemann equations, Harmonic functions.

Unit III

Complex integration, Cauchy-Goursat theorem, Cauchy's Integral formula, Formulae for first, second and nth derivatives, Cauchy's Inequality, Liouville's Theorem, Elementary functions, Mapping by elementary functions, conformal mapping.

Unit IV

Taylor and Laurent Series, Absolute and uniform convergence of Power series, Residues and Poles, Residue theorem, Zeros and poles of order m, Evaluation of improper real integrals, Definite integrals involving sines and cosines.

References:

Text books:

1. Mathematical Analysis by Shanti Narain.
2. Complex variable and applications by Brown & Churchill.

Suggested Readings:

3. Magnus Robert, Fundamental Mathematical Analysis, Springer Undergraduate Mathematics Series

Web References:

Digital platforms web links: NPTEL/SWAYAM/ MOOCS/Openstax.org

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Paper 11 A: Integral & Partial Differential Equations

Credit: 4 T:04

Course Outcomes:

1. Describe different types of Linear integral equations and partial differential equations for the impart knowledge of formulation of practical problems of applied mathematics.
2. Understand the theoretical basic behavior of different types of arising problems such as Fredholm, Volterra, Singular, Hilbert and Cauchy integral equations.
3. Explain the foundations of various problems related to Wave, Laplace and Diffusion equations by the method of separation of variables.
4. Deal with problems in applied mathematics, theoretical mechanics and mathematical physics and engineering.

Unit I

Origin of first order partial differential equations. Partial differential equations of the first order and degree one, Lagrange's solution, Partial differential equation of first order and degree greater than one. Cauchy's method of characteristic, Charpit's method of solution, Surfaces orthogonal to the given system of surfaces.

Unit II

Origin of second order PDE, Solution of partial differential equations of the second and higher order with constant coefficients, Classification of linear partial differential equations of second order, Solution of second order partial differential equations with variable coefficients, Monge's method of solution, Cauchy's problem for Homogenous wave equation, Properties of Harmonic function, Methods of separation of variable for solving Laplace, wave and diffusion equations.

UNIT III

Linear Integral Equations-Definition and Classification of conditions, Special kinds of Kernels, Eigen values and Eigen functions, Convolution integral, Inner product, Integral equations with separable Kernels. Reduction to a system of algebraic equations.

UNIT IV

Fredholm alternative, Fredholm Theorem, Fredholm alternative theorem, Approximate method, Method of successive approximations, Iterative scheme. Solution of Fredholm and Volterra integral equation, Results about resolvent Kernel.

References:

Text Books:

1. I.N. Sneddon: Elements of Partial Differential Equations, Mc -Graw Hill, 1988.
2. Ram P. Kanwal, Linear Integral Equations (2nd ed.), Birkhäuser, Boston.

Suggested Readings:

3. T. Amarnath: An Elementary Course in Partial Differential Equations, Narosa Publishing House, New Delhi, 2005.
4. Tyn Myint U: Partial Differential Equations of Mathematical Physics, Elsevier Publications.

Web References:

Digital platforms web links: NPTEL/SWAYAM/ MOOCS/Openstax.org

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Paper 11B: Discrete Mathematics

Credit: 4 T: 04

Course Outcomes:

1. Lattices and their types.
2. Boolean algebra, switching circuits and their applications.
3. Graphs, their types and its applications in study of shortest path algorithms.
4. Display familiarity with the mathematical models which are the integral part of the hardware and software of computer science.
5. Elaborate and expand their understanding of the tools helpful in the implementation of circuit design, AI algorithms and compiler construction.

Unit I

Propositional Logic- Proposition logic, basic logic, logical connectives, truth tables, tautologies, contradiction, normal forms (conjunctive and disjunctive), modus ponens and modus tollens, validity, predicate logic, universal and existential quantification, proof by implication, converse, inverse contrapositive, contradiction, direct proof by using truth table.

Unit II

Boolean Algebra- Basic definitions, Sum of products and products of sums, duality principle, Boolean functions, Logic gates and Karnaugh maps. Lattice, Duality, types of lattices, sublattices, bounded lattices, distributive lattices, complemented lattices, modular lattices, join irreducible elements.

Unit III

Combinatorics- Inclusion- exclusion, recurrence relations (nth order recurrence relation with constant coefficients, Homogeneous recurrence relations, Inhomogeneous recurrence relations), generating function (closed form expression, properties of G.F., solution of recurrence relations using G.F. solution of combinatorial problem using G.F.)

Unit IV

Finite Automata- Basic concepts of automation theory, Deterministic Finite Automation (DFA), transition function, transition table, Non Deterministic Finite Automata (NDFA), Mealy and Moore machine, Minimization of finite automation.

References:

Text books:

1. Discrete Mathematics by C. L.Liu.
2. Discrete Mathematics with computer application by Trembley and Manohar.
3. Mendelson, Elliott: Introduction to Mathematical Logic, Chapman & Hall, 1997
4. John E. Hoprcroft, Rajeev Motwani, Jeffrey D. Ullman: Introduction to Automata Theory, Languages and Computation, Pearson Education, 2000

Suggested Readings:

5. Arnold B. H.: Logic and Boolean Algebra, Prentice Hall, 1962
6. K. H. Rosen: Discrete Mathematics and its applications, MGH 1999

Web References:

Digital platforms web links: NPTEL/SWAYAM/ MOOCS/Openstax.org

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Paper 11C: Number Theory

Credit: 4 T:04

Course Outcomes:

1. To have knowledge of primes, congruences, quadratic residues and primitive roots.
2. Solving Diophantine equations.
3. Derive generating functions and recurrence relations.

UNIT I

Divisibility; Euclidean algorithm; primes; congruences; Fermat's theorem, Euler's theorem and Wilson's theorem; Fermat's quotients and their elementary consequences; solutions of congruences; Chinese remainder theorem; Euler's phi-function. Congruences

UNIT II

Congruence modulo powers of prime; primitive roots and their existence; quadratic residues; Legendre symbol, Gauss' lemma about Legendre symbol; quadratic reciprocity law; proofs of various formulations; Jacobi symbol.

UNIT III

Diophantine Equations, Solutions of ax + by = c, $xn+ yn= zn$; properties of Pythagorean triples; sums of two, four and five squares; assorted examples of diophantine equations.

UNIT IV

Generating Functions and Recurrence Relations, Generating Function Models, calculating coefficient of generating functions, Partitions, Exponential Generating Functions, A Summation Method. Recurrence Relations: Recurrence Relation Models, Divide and conquer Relations, Solution of Linear, Recurrence Relations, Solution of Inhomogeneous Recurrence Relations, Solutions with Generating Functions.

References:

Text Books:

1. Niven, I., Zuckerman, H. S. and Montgomery, H. L. (2003) An Int. to the Theory of Numbers (6th edition) John Wiley and sons, Inc., New York.
2. Burton, D. M. (2002) Elementary Number Theory (4th edition) Universal Book Stall, New Delhi.
3. Balakrishnan, V. K. (1996) Introductory Discrete Mathematics, Dover Publications.

Suggested Readings

4. Balakrishnan, V. K. (1994) Schaum's Outline of Theory and Problems of Combinatorics Including Concepts of Graph Theory, Schaum's Outline.

Web References:

Digital platforms web links: NPTEL/SWAYAM/ MOOCS/Openstax.org

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Internship / Term Assignment

Credit :04