Prof. Rajendra Singh (Rajju Bhaiya) University, Prayagraj
(Department of Mathematics)

(2024-2025 onwards)

COURSE STRUCTURE WITH CREDITS DISTRIBUTION
(for BA,B.Sc (Mathematics))

3 Year Undergraduate Programme

Year	Sem.	Course Code	Course Type	Course Name	Credits	MM: 100	
						CIE	ETE
1	I	B030101T	Core	Differential Calculus and Integral Calculus	4	25	75
		B030102P	Core	PRACTICAL/LAB WORK	1	25	75
	II	B030201T	Core	Matrices and Differential Equations and Geometry	5	25	75
2	III	B030301T	Core	Algebra and Mathematical Methods	5	25	75
	IV	B030401T	Core	Differential Equation and Mechanics	5	25	75
3	V	B030501T	Core	Group and Ring Theory and Linear Algebra	5	25	75
		B030502T	Elective (Select Any one)	Number Theory and Game Theory	5	25	75
		B030503T		Graph Theory and Discrete Mathematics			
		B030504T		Differential Geometry and Tensor Analysis			
	VI	B030601T	Core	Metric Space and Complex Analysis	5	25	75
		B030602T	Core	Numerical Analysis & Operations Research	4	25	75
		B030603P	Core	PRACTICAL/LAB WORK	1	25	**75**

Note- There is: CIE – Continuous Internal Evolution, ETE – End Term Examination (University Exams)

Detailed Syllabus for

UG SEMESTER-I

PAPER-I: Differential Calculus and Integral Calculus

PART A: Differential Calculus

Unit-I

Introduction to Indian ancient Mathematics and Mathematicians should be included under Continuous Internal Evaluation (CIE).

Definition of a sequence, theorems on limits of sequences, bounded and monotonic sequences, Cauchy's convergence criterion, Cauchy sequence, limit superior and limit inferior of a sequence, subsequence, Series of non-negative terms, convergence and divergence, Comparison tests, Cauchy's integral test, Ratio tests, Root test, Raabe's logarithmic test, de Morgan and Bertrand's tests, alternating series, Leibnitz's theorem, absolute and conditional convergence.

Unit-II

Limit, continuity and differentiability of function of single variable, Cauchy's definition, Heine's definition, equivalence of definition of Cauchy and Heine, Chain rule, Indeterminate forms.

Unit- III

Rolle's theorem, Lagrange and Cauchy Mean value theorems, mean value theorems of higher order, Taylor's theorem with various forms of remainders, Successive differentiation, Leibnitz theorem, Maclaurin's and Taylor's series, Partial differentiation, Euler's theorem on homogeneous function.

Unit- IV Tangent and Normal, Asymptotes, Curvature, Envelops and evolutes.

Suggested Readings:

1. R.G. Bartle & D.R. Sherbert, Introduction to Real Analysis, John Wiley & Sons
2. T.M. Apostal, Calculus Vol. I, John Wiley & Sons Inc.
3. S. Balachandra Rao & C. K. Shantha, Differential Calculus, New Age Publication.
4. H. Anton, I. Birens and S. Davis, Calculus, John Wiley and Sons, Inc., 2002.
5. G.B. Thomas and R.L. Finney, Calculus, Pearson Education, 2007.
6. Suggestive digital platforms web links: NPTEL/SWAYAM/MOOCS
7. Course Books published in Hindi may be prescribed by the Universities.

PART B: Integral Calculus

Unit -V

Definite integrals as limit of the sum, Riemann integral, Integrability of continuous and monotonic functions, Fundamental theorem of integral calculus.

Unit-VI

Mean value theorems of integral calculus, Differentiation under the sign of Integration, Beta and Gamma functions.

Unit-VII

Rectification, Volumes and Surfaces of Solid of revolution, Multiple integrals, change of order of double integration, Dirichlet's theorem, Liouville's theorem for multiple integrals.

Unit-VIII

Vector Differentiation, Gradient, Divergence and Curl, Normal on a surface, Directional Derivative, Vector Integration, Gauss, Green, Stokes theorems (only statements) and related problems.

Suggested Readings:

1. T.M. Apostal, Calculus Vol. II, John Wiley Publication
2. Shanti Narayan & Dr. P.K. Mittal, Integral Calculus, S.Chand
3. Erwin Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons.
4. Suggestive digital platforms web links: NPTEL/SWAYAM/MOOCS
5. Course Books published in Hindi may be prescribed by the Universities.

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PAPER-II: PRACTICAL/ LAB WORK

Practical / Lab work to be performed in Computer Lab.

List of the practical to be done using Mathematica /MATLAB /Maple /Scilab/Maxima etc.

1. Plotting the graphs of the following functions:

(i) ax

(ii) [x] (greatest integer function)

(iii)

(iv) x^{2n}; $n \in \mathbb{N}$

(v) x^{2n-1}; $n \in \mathbb{N}$

(vi) $\frac{1}{x^{2n-1}}$; $n \in \mathbb{N}$

(vii) $\frac{1}{x^{2n}}$; $n \in \mathbb{N}$

(viii) $\sqrt{}(ax + b)$, $|ax + b|$, $c \pm |ax + b|$

(ix) $\frac{|x|}{x}$, $\sin\left(\frac{1}{x}\right)$, $x\sin\left(\frac{1}{x}\right)$, e^{x}, e^{-x} for $x \neq 0$.

(2) By plotting the graph find the solution of the equation

$x = e^x$, $x^2 + 1 = e^x$, $1 - x^2 = e^x$, $x = \log_{10}(x), \cos(x) = x, \sin(x) = x, \cos(y) = \cos(x)$ etc.

(3) Plotting the graphs of polynomial of degree 2,3, 4 and 5, and their first and second derivatives.

(4) Sketching parametric curves, e.g., Trochoid, Cycloid, Epicycloid and Hypocycloid etc.

(5) Tracing of conic in Cartesian coordinates.

(6) Graph of circular and hyperbolic functions.

(7) Obtaining surface of revolution of curves.

(8) Complex numbers and their representations, Operations like addition, Multiplication, Division, Modulus. Graphical representation of polar form.

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UG SEMESTER-II

PAPER-I: Matrices and Differential Equations and Geometry

PART A: Matrices and Differential Equations

Unit-I

Types of Matrices, Elementary operations on Matrices, Rank of a Matrix, Echelon form of a Matrix, Normal form of a Matrix, Inverse of a Matrix by elementary operations, System of linear homogeneous and non-homogeneous equations, Theorems on consistency of a system of linear equations.

Unit-II

Eigen values, Eigen vectors and characteristic equation of a matrix, Caley-Hamilton theorem and its use in finding inverse of a matrix, Complex functions and separation into real and imaginary parts, hyperbolic functions.

Unit-III

Formation of differential equations, Geometrical meaning of a differential equation, Equation of first order and first degree, Equation in which the variables are separable, Homogeneous equations, Exact differential equations and equations reducible to the exact form, Linear equations.

Unit-IV

First order higher degree equations solvable for x, y, p, Clairaut's equation and singular solutions, orthogonal trajectories, Linear differential equation of order greater than one with constant coefficients.

Suggested Readings:

1. Stephen H. Friedberg, A.J Insel & L.E. Spence, Linear Algebra, Person
2. B. Rai, D.P. Choudhary & H. J. Freedman, A Course in Differential Equations, Narosa
3. D.A. Murray, Introductory Course in Differential Equations, Orient Longman
4. Suggested digital plateform:NPTEL/SWAYAM/MOOCs
5. Course Books published in Hindi may be prescribed by the Universities.

PART B: Geometry

Unit-V

Confocal conics, Polar equation of conics and its properties.

Unit-VI

Three-Dimensional Coordinates, Projection and Direction Cosine, Plane (Cartesian and vector form), Straight line in three dimension.

Unit-VII

Sphere, Cone and Cylinder.

Unit-VIII

Central conicoids, Paraboloids, Plane section of conicoids, Generating lines, Confocal conicoids.

Suggested Readings:

1. Robert J.T Bell, Elementary Treatise on Coordinate Geometry of three dimensions, Macmillan India Ltd.
2. P.R. Vittal, Analytical Geometry 2d & 3D, Pearson.
3. S.L. Loney, The Elements of Coordinate Geometry, McMillan and Company, London.
4. R.J.T. Bill, Elementary Treatise on Coordinate Geometry of Three Dimensions, McMillan India Ltd., 1994.
5. Suggested digital plateform:NPTEL/SWAYAM/MOOCs
6. Course Books published in Hindi may be prescribed by the Universities.

UG SEMESTER-III

PAPER-I: Algebra and Mathematical Methods

PART A: Algebra

Unit-I

Introduction to Indian ancient Mathematics and Mathematicians should be included under Continuous Internal Evaluation (CIE).

Equivalence relations and partitions, Congruence modulo n, Definition of a group with examples and simple properties, Subgroups, Generators of a group, Cyclic groups.

Unit-II

Permutation groups, Even and odd permutations, The alternating group, Cayley's theorem, Direct products, Coset decomposition, Lagrange's theorem and its consequences.

Unit-III

Normal subgroups, Quotient groups, Homomorphism and isomorphism, Fundamental theorem of homomorphism, Theorems on isomorphism.

Unit-IV

Rings, Subrings, Integral domains and fields, Characteristic of a ring, Ideal and quotient rings, Ring homomorphism.

Suggested Readings:

1. J.B. Fraleigh, A first course in Abstract Algebra, Addison-weley
2. I. N. Herstein, Topics in Algebra, John Wiley & Sons
3. Suggested digital plateform: NPTEL/SWAYAM/MOOCS
4. Course Books published in Hindi may be prescribed by the Universities.

PART B: Mathematical Methods

Unit-V

Limit and Continuity of functions of two variables, Differentiation of function of two variables, Necessary and sufficient condition for differentiability of functions two variables, Schwarz's and Young theorem, Taylor's theorem for functions of two variables with examples, Maxima and minima for functions of two variables, Lagrange multiplier method, Jacobians.

Unit-VI

Existence theorems for Laplace transforms, Linearity of Laplace transform and their properties, Laplace transform of the derivatives and integrals of a function, Convolution theorem, inverse Laplace transforms, Solution of the differential equations using Laplace transforms.

Unit-VII

Fourier series, Fourier expansion of piecewise monotonic functions, Half and full range expansions.

Unit-VIII

Calculus of variations-Variational problems with fixed boundaries- Euler's equation for functionals containing first order derivative and one independent variable.

Suggested Readings:

1. T.M. Apostal, Mathematical Analysis, Person

2. G.F. Simmons, Differential Equations with Application and Historical Notes, Tata -McGrawHill

3. Erwin Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons.

4. Suggested digital plateform:NPTEL/SWAYAM/MOOCs

5. Course Books published in Hindi may be prescribed by the Universities.

UG SEMESTER-IV

PAPER-I: Differential Equations and Mechanics

PART A: Differential Equations

Unit-I

Second order linear differential equations with variable coefficients: Use of a known solution to find another, normal form, method of undetermined coefficient, variation of parameters, Series solutions of differential equations, Power series method.

Unit-II

Bessel and Legendre functions and their properties, recurrence and generating relations.

Unit-III

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, Charpit's method of solution.

Unit-IV

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.

Suggested Readings:

1. G.F. Simmons, Differential Equations with Application and Historical Notes, Tata –McGrawHill

2. B. Rai, D.P. Choudhary & H. J. Freedman, A Course of Ordinary Differential Equations, Narosa

3. Ian N. Snedden, Elements of Partial Differential Equations, Dover Publication

4. L.E. Elsgolts, Differential Equation and Calculus of variations, University Press of the Pacific.

5. Suggested digital plateform:NPTEL/SWAYAM/MOOCs

6. Course Books published in Hindi may be prescribed by the Universities.

PART B: Mechanics

Unit-V

Forces in three dimensions, Poinsot's central axis, Wrenches, Null lines and planes.

Unit-VI

Virtual work, Stable and Unstable equilibrium, Catenary, Catenary of uniform strength.

Unit-VII

Velocities and accelerations along radial and transverse directions, and along tangential and normal directions, Simple Harmonic motion, Motion under other law of forces. Elastic strings, Motion in resisting medium, Constrained motion, Motion on smooth and rough plane curves.

Unit-VIII

Motion of particles of varying mass, Rocket motion, Central orbit, Kepler's laws of motion, Motion of particle in three dimensions.

Suggested Readings:

1. R.C. Hibbeler, Engineering Mechanics-Statics, Prentics Hall Publishers
2. R.C. Hibbeler, Engineering Mechanics-Dynamics, Prentics Hall Publishers
3. A. Nelson, Engineering Mechanics Statics and Dynamics, Tata McGraw Hill
4. J.L. Synge & B.A. Griffith, Principles of Mechanics, Tata McGraw Hill
5. Suggested digital plateform:NPTEL/SWAYAM/MOOCs
6. Course Books published in Hindi may be prescribed by the Universities.

UG SEMESTER-V

PAPER-I: Group and Ring Theory and Linear Algebra

PART A: Group and Ring Theory

Unit-I

Introduction to Indian ancient Mathematics and Mathematicians should be included under Continuous Internal Evaluation (CIE).

Automorphism, inner automorphism, Automorphism groups, Automorphism groups of finite and infinite cyclic groups, Characteristic subgroups, Commutator subgroup and its properties.

Unit-II

Conjugacy classes, class equation, *p*-groups, The Sylow theorems and consequences, Applications of Sylow theorems.

Unit-III

Polynomial rings over commutative rings, Division algorithm and consequences, Principal ideal domains, Factorization of polynomials, Reducibility tests.

Unit-IV

Divisibility in integral domains, Irreducibles, Primes, Unique factorization domains, Euclidean domains.

PART B: Linear Algebra

Unit-V

Vector spaces, Subspaces, Linear independence and dependence of vectors, Basis and Dimension, Quotient space.

Unit-VI

Linear transformations, The Algebra of linear transformations, rank nullity theorem, their representation as matrices.

Unit-VII Linear functionals, Dual space, Characteristic values, Cayley Hamilton Theorem.

Unit- VIII

Inner product spaces and norms, Cauchy-Schwarz inequality, Orthogonal vectors, Orthonormal sets and bases, Bessel's inequality for finite dimensional spaces, Gram-Schmidt orthogonalization process.

Suggested Readings:

1. Topics in Algebra by I. N. Herstein.
2. Linear Algebra by K. Hoffman and R. Kunze.
3. Suggested digital plateform: NPTEL/SWAYAM/MOOCs
4. Course Books published in Hindi may be prescribed by the Universities.

PAPER-II (i): Number Theory and Game Theory

PART A: Number Theory

Unit-I Theory of Numbers

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

Unit-II Congruences

Congruence modulo powers of prime, primitive roots and their existence, quadratic residues.

Unit-III Diophantine Equations

Solutions of ax + by = c, $x^n + y^n = z^n$; 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, Recurrence Relations: Recurrence Relation Models, Divide and conquer Relations, Solution of Linear, Recurrence Relations.

Suggested Readings:

1. Niven, I., Zuckerman, H. S. and Montegomery, 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. (1994) Schaum's Outline of Theory and Problems of Combinatorics Including Concepts of Graph Theory, Schaum's Outline.
4. Balakrishnan,V. K. (1996) Introductory Discrete Mathematics, Dover Publications.
5. Suggested digital plateform:NPTEL/SWAYAM/MOOCs
6. Course Books published in Hindi may be prescribed by the Universities.

PART B: Game Theory

Unit-V

Introduction, overview, uses of game theory, some applications and examples, and formal definitions of: the normal form, payoffs, strategies, pure strategy Nash equilibrium.

Unit-VI

Introduction, characteristic of game theory, Two- person zero-sum game, Pure and Mixed strategies, Saddle point and its existence.

Unit-VII

Fundamental Theorem of Rectangular games, Concept of Dominance, Dominance and Graphical method of solving rectangular games.

Unit-VIII

Relationship between rectangular game and Linear Programming Problem, Solving rectangular game by Simplex method, reduction of m x n game and solution of 2x2, 2 x s, and r x 2 cases by graphical method, algebraic and linear programming solution of m x n games.

Suggested Readings:

1. Martin Osborne, An Introduction to Game Theory, Oxford University Press, 2003
2. Vijay Krishna, Game Theory, Academic Press.
3. Prajit Dutta, Strategies and Games, MIT Press, (Website 1) http://www.ece.stevens-tech.edu/~ccomanic/ee800c.html
5. Allan MacKenzie, Game Theory for Wireless Engineers, Synthesis lectures on Communications, 2006
6. Suggested digital plateform:NPTEL/SWAYAM/MOOCS
7. Course Books published in Hindi may be prescribed by the Universities.

PAPER-II (ii): Graph Theory and Discrete Mathematics

PART A: Graph Theory

Unit-I

Introduction to graphs, basic properties of graphs, Simple graph, multi graph, graph terminology, representation of graphs, Bipartite, regular, planar and connected graphs, connected components in a graph, Euler graphs, Directed, Undirected, multi-graph, mixed graph.

Unit-II

Walk and unilateral components, unicursal graph, Hamiltonian path and circuits, Graph colouring, isomorphism and homomorphism of graphs.

Unit-III

Operation of graph circuit, Path and circuits, Eulerian circuits, Hamiltonian path and cycles, Adjacency matrix.

Unit-IV

Tree, Binary and Spanning trees, Coloring, Color problems, Vertex coloring and important properties.

Suggested Readings:

1. "Graph Theory with Applications to Engineering and Computer Science" by Narsingh Deo
2. "Introduction to Graph Theory" by Douglas B West
3. "Graph Theory with Algorithms and Its Applications: In Applied Science and Technology" by Santanu Saha Ray
4. Suggested digital plateform:NPTEL/SWAYAM/MOOCs
5. Course Books published in Hindi may be prescribed by the Universities.

PART B: Discrete Mathematics

Unit-V

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.

Relation- Definition, types of relation, domain and range of a relation, pictorial representation of relation, properties of relation, partial ordering relation.

Unit-VI

Boolean Algebra- Basic definitions, Sum of products and products of sums, Logic gates and Karnaugh maps.

Graphs- Simple graph, multi graph, graph terminology, representation of graphs, Bipartite, regular, planar and connected graphs, connected components in a graph, Euler graphs, Hamiltonian path and circuits, Graph colouring, chromatics number, isomorphism and homomorphism of graphs.

Unit-VII

Combinatories- Inclusion- exclusion, recurrence relations (nth order recurrence relation with constant coefficients, Homogeneous recurrence relations, Inhomogeneous recurrence relations).

Unit-VIII

Finite Automata- Basic concepts of automation theory, Deterninistic Finite Automation (DFA), transition function, transition table.

Suggested Readings:

1. Discrete Mathematics by C. L.Liu.
2. Discrete Mathematics with computer application by Trembley and Manohar.
3. Discrete Mathematics and Its Applications by Kenneth H. Rosen
4. Suggested digital plateform: NPTEL/SWAYAM/MOOCS
5. Course Books published in Hindi may be prescribed by the Universities.

PAPER-II (iii): Differential Geometry & Tensor Analysis

PART A: Differential Geometry

Unit-I

Local theory of curves-Space curves, Examples, Plane Curves, tangent and normal and binormal, Osculating Plane, normal plane and rectifying plane, Osculating circle, osculating sphere Helices, Serret-Frenet apparatus, contact between curve and surfaces, tangent surfaces.

Unit-II

Local Theory of Surfaces- Parametric patches on surface curve of a surface, family of surfaces (one parameter), edge of regression, rues surfaces, skew ruled surfaces and developable surfaces.

Unit-III

Metric-first fundamental form and arc length, Direction coefficients, families of curves, intrinsic properties, geodesics, canonical geodesic equations, normal properties of geodesics, geodesics curvature.

Unit-IV

Gauss-Bonnet theorem, curvature of curves on surfaces, Gaussian curvature, normal curvature, Meusneir's theorem, mean curvature, Gaussian curvature, umbilic points.

Suggested Readings:

1. T.J. Willmore, An Introduction to Differential Geometry, Dover Publications, 2012.
2. B. O'Neill, Elementary Differential Geometry, 2nd Ed., Academic Press, 2006.
3. C.E. Weatherburn, Differential Geometry of Three Dimensions, Cambridge University Press 2003.
4. D.J. Struik, Lectures on Classical Differential Geometry, Dover Publications, 1988.
5. S. Lang, Fundamentals of Differential Geometry, Springer, 1999.
6. B. Spain, Tensor Calculus: A Concise Course, Dover Publications, 2003.
7. An Introduction to Differential Geometry (with the use of tensor Calculus), L. P. Eisenhart, Princeton University Press, 1940.
8. Tensor Analysis, Theory and Applications to Geometry and Mechanics of Continua, 2nd Edition, I. S. Sokolnikoff, John Wiley and Sons., 1964.
9. Suggested digital plateform:NPTEL/SWAYAM/MOOCs
10. Course Books published in Hindi may be prescribed by the Universities.

PART B: Tensor Analysis

Unit-V

Tensor algebra: Vector spaces, the dual spaces, tensor product of vector spaces, transformation formulae, contraction, special tensors-symmetric tensor, inner product, associated tensor with examples.

Unit-VI

Tensor Analysis: Contravariant and covariant vectors and tensors, Mixed tensors, Symmetric and skew-symmetric tensors, Algebra of tensors, Contraction and inner product, Quotient theorem, Reciprocal tensors, Christoffel's symbols, Law of transformation of Christoffel's symbols, Covariant differentiation.

Unit-VII

Gradient of scalars, Divergence of a contravariant vector, covariant vector and conservative vectors, Laplacian of an invariant, curl of a covariant vector, irrotational vector, with examples.

Unit-VIII

Riemannian space, Riemannian curvatures and their properties, geodesics, geodesic curvature, geometrical interpretation of curvature tensor.

Suggested Readings:

1. Tensors- Mathematics of Differential Geometry by Z. Ahsan, PHI,2015
2. David C. Kay, Tensor Analysis, Schaum's Outline Series, McGraw Hill 1988.
3. R. S, Mishra, A Course in Tensors with Applications to Reimannian Geometry, Pothishala Pvt. Ltd, Allahabad.
4. Suggested digital plateform:NPTEL/SWAYAM/MOOCS
5. Course Books published in Hindi may be prescribed by the Universities.

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UG SEMESTER-VI

PAPER-I: Metric Spaces & Complex Analysis

PART A: Metric Spaces

Unit-I Basic Concepts

Metric spaces**:** Definition and examples, Sequences in metric spaces, Cauchy sequences.

Unit-II Topology of Metric Spaces

Open and closed ball, Neighborhood, Open set, Interior of a set, limit point of a set, derived set, closed set, closure of a set, diameter of a set, Cantor's theorem, Subspaces, Dense set.

Unit-III Continuity & Uniform Continuity in Metric Spaces

Continuous mappings, Sequential criterion and other characterizations of continuity, Uniform continuity, Homeomorphism, Contraction mapping.

Unit-IV Connectedness and Compactness

Connectedness, Connected subsets of, Connectedness and continuous mappings, Compactness, Compactness and boundedness.

Suggested Readings:

1. Mathematical Analysis by Shanti Narain.
2. Shirali, Satish & Vasudeva, H. L. (2009). Metric Spaces, Springer, First Indian Print.
3. Kumaresan, S. (2014). Topology of Metric Spaces (2nd ed.). Narosa Publishing House. New Delhi.
4. Simmons, G. F. (2004). Introduction to Topology and Modern Analysis.Tata McGraw Hill. New Delhi.
5. Suggested digital plateform:NPTEL/SWAYAM/MOOCS.
6. Course Books published in Hindi may be prescribed by the Universities.

PART B: Complex Analysis

Unit-V Analytic Functions and Cauchy-Riemann Equations

Functions of complex variable, Mappings; Mappings by the exponential function, Limits, Theorems on limits, Limits involving the point at infinity, Continuity, Derivatives, Differentiation formulae, Cauchy-Riemann equations, Sufficient conditions for differentiability; Analytic functions and their examples.

Unit-VI Elementary Functions and Integrals

Derivatives of functions, Definite integrals of functions, Contours, Contour integrals and its examples, Upper bounds for moduli of contour integrals.

Unit-VII Cauchy's Theorems and Fundamental Theorem of Algebra

Antiderivatives, Proof of antiderivative theorem, Cauchy-Goursat theorem, Cauchy integral formula; An extension of Cauchy integral formula, Consequences of Cauchy integral formula, Liouville's theorem and the fundamental theorem of algebra.

Unit-VIII Series and Residues

Convergence of sequences and series, Taylor series and its examples; Laurent series and its examples, Representations of power series, Isolated singular points, Residues, Cauchy's residue theorem, residue at infinity; Types of isolated singular points, Residues at poles and its examples.

Suggested Readings:

1. Function of Complex Variable by Shanti Narain.
2. Complex variable and applications by Brown & Churchill.
3. Suggested digital plateform:NPTEL/SWAYAM/MOOCS.
4. Course Books published in Hindi may be prescribed by the Universities.

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PAPER-II: Numerical Analysis & Operations Research

PART A: Numerical Analysis

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, Gaussian Quadrature Formulas, System of Linear equations: Direct method for solving systems of linear equations (Gauss elimination, LU Decomposition, Cholesky Decomposition), Iterative methods (Jacobi, Gauss Seidel, Relaxation methods).

Unit-III

Numerical solution of Ordinary differential equations: Euler method, single step methods, Runge-Kutta method, Multi-step methods: Milne-Simpson method.

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.

Suggested Readings:

1. Numerical Methods for Engineering and scientific computation by M. K. Jain, S.R.K. Iyengar & R.K. Jain.
2. Introductory methods of Numerical Analysis by S. S. Sastry
3. Suggested digital plateform:NPTEL/SWAYAM/MOOCs
4. Course Books published in Hindi may be prescribed by the Universities.

PART B: Operations Research

Unit-V

Introduction, Linear programming problems, statement and formation of general linear programming problems, graphical method, slack and surplus variables, standard and matrix forms of linear programming problem, basic feasible solution.

Unit-VI

Convex sets, fundamental theorem of linear programming, basic solution, Simplex method, introduction to artificial variables, two phase method Big-M method and their comparison.

Unit-VII

Duality in linear programming problems, primal dual relationships.

Unit-VIII

Transportation problems, assignment problems.

Suggested Readings:

1. Taha, Hamdy H, "Opearations Research- An Introduction ", Pearson Education.
2. Kanti Swarup , P. K. Gupta , Man Mohan Operations research, Sultan Chand & Sons
3. Hillier Frederick S and Lieberman Gerald J., "Operations Research", McGraw Hill Publication.
4. Winston Wayne L., "Operations Research: Applications and Algorithms", Cengage Learning, 4th Edition.
5. Hira D.S. and Gupta Prem Kumar, "Problems in Operations Research: Principles and Solutions", S Chand & Co Ltd.
6. Kalavathy S., "Operations Research", S Chand.
7. Suggested digital plateform:NPTEL/SWAYAM/MOOCs.
8. Course Books published in Hindi may be prescribed by the Universities.

PAPER-III: PRACTICAL/ LAB WORK

Practical / Lab work to be performed in Computer Lab.
List of the practicals to be done using computer algebra software (CAS), for example Mathematica/MATLAB/Maple/ Maxima/Scilab etc

1. Solution of transcendental and algebraic equations by

i) Newton Raphson method (Simple root, multiple roots, complex roots).

ii) Regula Falsi method.

2. Solution of system of linear equations

i) LU decomposition method

ii) Gaussian elimination method

3. Interpolation

i) Lagrange Interpolation

ii) Newton's forward, backward and divided difference interpolations

4. Numerical Integration

i) Trapezoidal Rule

ii) Simpson's one third rule

5. Method of finding Eigenvalue by Power method (up to 4×4)

6. Solution of ordinary differential equations

i) Euler method

ii) Modified Euler method