M. A. / M. Sc. (Mathematics)
First Semester
Paper-I
(Advanced Abstract Algebra-I)

Time: 3 hours **Max. Marks:** 80

UNIT 1: Subnormal and normal Series, Zassenhauss lemma (statement only), Schreier's refinement theorem, Composition series, Jordan-Holder's theorem, Internal and External direct products and their relationship, Indecomposability.

UNIT 2: Cauchy's theorem for abelian groups, Sylow's subgroups, Sylow's theorems I, II and III, p-groups (their application on groups of order p.q, p.q.r), Direct and inverse image of Sylow subgroups.

UNIT 3: Commutators, Solvable groups, Solvability of subgroups and factor group and of finite p-groups, Examples, Lower and upper central series, Nilpotent groups (its examples and basic properties) and their equivalent characterizations.

UNIT 4: canonical forms, Similarity of linear transformations, invariant subspaces, reduction to triangular forms, Nilpotent transformations, Index of Nilpotency, Invariants of nilpotent transformations, The primary decomposition theorem, Jordan blocks and Jordan forms.

Books Recommended

1. D. S. Dummit and R. M. Foote: Abstract Algebra, John Wiley, N. Y., 2003.
2. N. S. Gopalakrishnan: University Algebra, Wiley Eastern, New Delhi, 1986.
3. N. Jacobson, Basic Algebra, Vol. I and II, Hindustan Publishing Company, New Delhi, 1984.
4. I. N. Herstein, Topics in Algebra< Wiley Eastern Ltd.
5. Ram Ji Lal: Algebra, Vol. I, Shail Publication.
6. S. Lang: Algebra, Addisson Wesley Publication.
7. P. B. Bhattacharya, S. K. Jain and S.R. Nagpaul: Cambridge University Press.

M. A. / M. Sc. (Mathematics)
First Semester
Paper-II
(Theory of Complex Variables)

Time: 3 hours **Max. Marks:**80

UNIT 1: Definition and uniqueness of analytic continuation, Standard methods of continuation, Singularities of functions, Functions with natural boundaries.

UNIT 2: The Maximum Modulus Theorem, Schwarz's theorem, Convex functions, Hadmard's three circles theorem, Vitali's convergence theorem.

UNIT 3: the circle of convergence of a power series, position of singularities, convergence of a series and regularity of a function.

UNIT 4: Factorization, function of finite orders, the coefficients in the expansion of a function with real zeros, The minimum modulus, The a-points of an integral function, Picard's theorem, Borel's theorem.

Books Recommended

1. E. C. Titchmarsch: Theory of function
2. E. T. Copson: Theory of function of complex variables.

M. A. / M. Sc. (Mathematics)
First Semester
Paper-III
(Real Analysis-I)

Time: 3 hours **Max. Marks:**80

UNIT 1: Countable and uncountable sets, infinite sets, cardinal numbers and its arithmetic, Schroder Bernstein's theorem, Cantor's theorem and continuum hypothesis, Zorn's lemma, well ordering theorem.

UNIT 2: Insertion and removal of brackets in an infinite series, rearrangement of terms of a series, Riemann's theorem, Multiplication of series, Cauchy, Merten and Abel's theorem, Failure of multiplication rule.

UNIT 3: Definition and existence of Riemann-Stieltje's integral, integral as a limit of sums, Algebra of RS- integrable functions, relation between Riemann Stieltje's integral and Riemann integral, Integration and Differentiation, first mean value theorem, second mean value theorem, Fundamental theorem of calculus.

UNIT 4: Uniform convergence of series of variable terms, general principle of uniform convergence, Mn-test, Weirstrass's M-test, Dirichlet's test and Abel's test, Properties of uniformly convergent series, Continuity of sum, term by term integration and term by term differentiation.

Books Recommended

1. Bromwich T. J. I.: Infinite series.
2. Walter Rudin: Principles of Mathematical Analysis.
3. Ferrar, W. L.: Convergence.
4. Shanti Narain: Mathematical Analysis.
5. R. R. Goldberg: Real Analysis, Oxford & I.B. H. Publ.
6. D.Soma Sundaram & B. Chaudhary: Mathematical Analysis
7. P.K.Jain and S. K. Kaushik: An introduction to real analysis.
8. S.C. Malik: Mathematical Analysis.

M. A. / M. Sc. (Mathematics)
First Semester
Paper-IV
(Numerical Analysis)

Time: 3 hours **Max. Marks:**80

UNIT 1: Finite difference table and theory of interpolation, Gregory-Newton formula for forward and backward interpolation.

UNIT 2: Divided differences, Newton's divided difference formula, Lagrange's formula for equal and unequal intervals, forward and backward formula of Gauss, Sterling and Bessel.

UNIT 3: Inverse interpolation, Numerical differentiation and Numerical integration (General quadrature formula, Trapezoidal rule, Simpson's 1/3- and 3/8- rule, Weddle's rule).

UNIT 4: Numerical solution of ordinary differential equations of first order by Picard's method, Euler's method, Taylor's series method, Runge-Kutta method and Milne's method.

Books Recommended

1. Kunz, K.S.: Numerical Analysis
2. Saxena, H. C.: Calculus of finite differences and Numerical Analysis
3. S.S. Sastry: Introductory methods of Numerical Analysis, 5th edition-2012, Prentice Hall of India.
4. M. K. Jain, S.R. K. Iyenger and R. K. Jain: Numerical methods for Scientists and Engineers, New Age International Publishers, New Delhi.

M. A. / M. Sc. (Mathematics)
First Semester
Paper-V (A) (Optional)
(Spherical Trigonometry-I)

Time: 3 hours **Max. Marks:**80

UNIT 1: Spherical Triangles.

UNIT 2: Relation between the trigonometrical function of the sides and the angles of spherical triangles.

UNIT 3: Solution of the right-angled triangles.

UNIT 4: Area of Spherical Triangle, Spherical excess.

Books Recommended

1. Prasad G: Spherical Trigonometry.
2. Smart W M: Spherical Astronomy
3. Ball R R: Spherical Astronomy.

M. A. / M. Sc. (Mathematics)
First Semester
Paper-V (B) (Optional)
(Operations Research-I)

Time: 3 hours **Max. Marks:**80

UNIT 1: Mathematical formulation of L.P.P., Graphical solution method, general L.P.P., Canonical and standard forms of L.P.P., basic feasible solutions, Simplex method.

UNIT 2: Fundamental properties of solutions, Big-M method, two phase simplex method, Applications of simplex method.

UNIT 3: Concept of duality, formulation of dual and primal pairs,theorems on duality, problems based on duality and simplex method.

UNIT 4: Dual simplex method, Revised simplex method, Simplex method versus revised simplex method (emphasis should be given on numerical problems).

Books Recommended

1. K. Swaroop, Gupta and Manmohan: Operations Research, S. Chand & Comp., New Delhi.
2. H. A. Taha: Operations research- An introduction, Prentice hall of India, New Delhi.(6^{th} Ed.)
3. G. Hadley: Linear Programming, Narosa Publishing house, 1995.
4. S. S. rao: Optimization theory and applications, Wiley Eastern Ltd., New Delhi.
5. P. K. Gupta and D. S. Hira: Operations Research-An introduction, S. Chand & Sons, New Delhi.

M. A. / M. Sc. (Mathematics)
Second Semester
Paper-I
(Advanced Abstract Algebra-II)

Time: 3 hours **Max. Marks:**80

UNIT 1: Field theory, Extension fields, Finite extensions, Simple extensions, Algebraic and transcendental extensions, Factorization of polynomials in extension fields, Splitting fields and their uniqueness, Separable and inseparable extensions.

UNIT 2: Perfect fields, Separability over fields of prime characteristic, Automorphisms of fields, Fixed fields, Normal extensions, Splitting fields and normality, Galois extensions, Fundamental theorem of Galois theory.

UNIT 3: Modules over a ring, Endomorphism ring of an abelian group, R-module structure on an abelian group M as a ring homomorphism from R to End_z(M), submodules, Direct summands, Homomorphism, factor modules, Isomorphism theorems, $Hom_R(M,N)$ as an abelian group and $Hom_R(M,N)$ as a module.

UNIT 4: Exact sequences, Five lemma, Free modules, Homomorphism extension property, Equivalent characterization as a direct sum of copies of the underlying ring, Split exact sequences and their characterizations, Left exactness of Hom sequences and counter-examples for non-right exactness, Projective modules, Injective modules, Divisible groups, Examples of injective modules.

Books Recommended:

1. D. S. Dummit and R. M. Foote: Abstract Algebra, John Wiley, N. Y., 2003.
2. F. W. Anderson and K. R. Fuller: Rings and Categories of Modules, Springer, N.Y., 1974.
3. I.A. Adamson: An introduction to Field theory, Oliver & Boyd, Edinburgh, 1964.
4. N. S. Gopalakrishnan: University Algebra, Wiley Eastern, New Delhi, 1986.
5. I. N. Herstein, Topics in Algebra< Wiley Eastern Ltd.
6. Ram Ji Lal: Algebra, Vol. I, Shail Publication.
7. I. s. Luther and I.B. S. Passi: Rings and Modules, Vol I & II, Narosa Publ. House.

M. A. / M. Sc. (Mathematics)
Second Semester
Paper-II
(Measures and Integration)

Time: 3 hours **Max. Marks:**80

UNIT 1: Measure of an open set on real line, Measurable sets, Lebesgue measure, Measurability of bounded sets and unbounded sets on real line, Countable additivity of measures.

UNIT 2: Sets of measure zero, Non measurable sets.

UNIT 3: Measurable functions and their properties, Lebesgue integral of bounded measurable function over a measurable set of finite measure.

UNIT 4: Generalization of unbounded functions, Lebesgue dominated convergence theorem, Fatou's theorem, Comparison of Riemann and Lebesgue integral.

Books Recommended:

1. Harman and Minkowski: Theory of Lebesgue measure and integration.
2. I. P. Natanson: Theory of function of real variables vol. I.
3. H. L. Royden: Theory of function of real variables.

M. A. / M. Sc. (Mathematics)
Second Semester
Paper-III
(Real Analysis-II)

Time: 3 hours **Max. Marks:**80

UNIT 1: Functions of several variable, Definitions, Linear Transformation, Derivatives in open subsets of R^n. Chain rule, Partial derivatives, Derivatives of higher orders, Taylor's theorem, Inverse function theorem, Implicit function theorem.

UNIT 2: Convergence of Fourier series, Dirichlet's integral, Riemann-Lebesgue theorem and its consequences, Convergence test of Dini, Jordan, Della Vellee Pousin and their relation. (C,1) summability of Fourier series, Fejer's theorem, Fejer-Lebesgue Theorem, A continuous function with divergent Fourier series, Order of partial sums.

UNIT 3: Integration of Fourier series, Parseval's theorem, Functions of the class L^2, Bessel's inequality, Parseval's theorem for continuous functions, The Riesz Fisher's theorem, Parseval's theorem for the functions of the class L^2, Properties of Fourier coefficients, Cantor's Lemma, Riemann first and second theorem, Schwarz's theorem, Fourier series for any range, Fourier integral formula.

UNIT 4: Fourier transform in $L^1(R)$. Translate of Fourier transform, Riemann Lebesgue theorem, Inverse of Fourier transform, Jordan's theorem, Inversion of Fourier transform using (C,1) summability, simple theorems concerning (C,1) summability regarding inversion of Fourier transform, convolution, Simple properties and some special functions.

Note: Treatment of units 2 and 3 to be followed by the book: **"The theory of functions: E. C. Titchmarsch"**.

Books Recommended:

1. Shanti Narain: Mathematical Analysis
2. Walter Rudin: Principles of mathematical Analysis
3. E. C. Titchmarsch: The Theory of functions
4. R. r. Goldberg: Fourier Transforms, The Cambridge University Press, 1970.
5. T. M. Apostol: Mathematical Analysis, Narosa Publishing House, New Delhi, 1985.

M. A. / M. Sc. (Mathematics)
Second Semester
Paper-IV
(Ordinary Differential Equations)

Time: 3 hours **Max. Marks:** 80

UNIT 1: Picard's iterative method, uniqueness and existence theorem, Lipschitz condition. Series solutions of second order linear differential equations by Frobenius method.

UNIT 2: Solution of Legendre's and Bessel's equation, Generating functions for Legendre polynomial and Bessel's functions, recurrence formulae for $P_n(x)$ and $J_n(x)$, orthogonal properties of $P_n(x)$ and $J_n(x)$ only.

UNIT 3: Solution of Hermite and Laguerre differential equation, their recurrence formulae, Generating functions & their orthogonal properties.

UNIT 4: Solution of Chebyshev differential equation with recurrence formulae, Generating function and orthogonal property, Solution of Hypergeometric equation, differentiation of hypergeometric function, Integral representation for the hypergeometric function, Gauss theorem, Kummer's theorem, Solution of confluent hypergeometric function, Integral representation for the confluent hypergeometric function

Books Recommended:

1. A. R. Forsyth: Treatise on Differential equation.
2. T. N. Pandey: Differential and Integral equation.
3. Sharma J. N. : Differential equation.
4. M. D. raishinghania: Ordinary and Partial Differential equation

M. A. / M. Sc. (Mathematics)
Second Semester
Paper-V (A) (Optional)
(Spherical Astronomy)

Time: 3 hours **Max. Marks:** 80

UNIT 1: System of coordinates and their determination.

UNIT 2: Diurnal motion, Twilight.

UNIT 3: Keplar's laws, Refraction.

UNIT 4: Precession and Nutation.

Books Recommended:

1. Smart W. M: Spherical Astronomy.
2. Ball R. R.: Spherical Astronomy.
3. Prasad G: Spherical Astronomy.

M. A. / M. Sc. (Mathematics)
First Semester
Paper-V (B) (Optional)
(Operations Research-II)

Time: 3 hours **Max. Marks:**80

UNIT 1:L. P. formulation of the transportation problems, transportation table (T.T.), loops in T.T., existence of solution in transportation problem, initial basic feasible solution by different methods

UNIT 2: Duality in transportation problem, solution of transportation problems (balanced and unbalanced), degeneracy, Assignment problem (balanced and unbalanced).

UNIT 3: Problem of sequencing, solution of problems with n-jobs and 2-machines, problems with n-jobs and m-machines. Two person zero sum games, Maximin and Minimax principle, games with saddle points.

UNIT 4: Games without saddle points, graphical solution of $2 \times n$ and $m \times 2$ games, Dominance properties, reducing the game problem to L.P.P.

Books Recommended:

1. K. Swaroop, Gupta and Manmohan: Operations Research, S. Chand & Comp., New Delhi.
2. H. A. Taha: Operations research- An introduction, Prentice hall of India, New Delhi.(6^{th} Ed.)
3. K. G. Murti: Linear Programming.
4. K. V. Mittal: Optimization method.
5. P. K. Gupta and D. S. Hira: Operations Research-An introduction, S. Chand & Sons, New Delhi.

M. A. / M. Sc. (Mathematics)
Third Semester
Paper-I
(Topology-I)

Time: 3 Hours **Max. Marks: 80**

UNIT 1: Definition and examples of topological spaces, open sets, closed sets, closure, interior, dense subsets, no-where dense subsets, neighborhoods, interior, exterior, boundary, accumulation points and derived sets.

UNIT 2: Bases and sub bases, subspaces and relative topology, alternate methods of deriving topology in terms of Kuratowski closure operator and neighborhood systems, First and second countable spaces, Separable spaces, Lindelof theorem.

UNIT 3: Continuous map and its characterizations via the closure, interior, basic open sets and sub-basic open sets, open map, closed map, homeomorphism, topological invariants, pasting lemma.

UNIT 4: Separation axioms, T_0 ,T_1,T_2,T_3,$T_{3/2}$,T_4 spaces and their characterization and basic properties, their preservation under homeomorphism, Urysohn's Lemma, Tietz's extension theorem (Statement and only sketch of proofs).

Books Recommended:

1. James Munkres: Topology
2. James Dugundji: Topology
3. K. D. Joshi: Topology
4. E. H. Spainer: Algebraic Topology

M. A. / M. Sc. (Mathematics)
Third Semester
Paper-II
(Differential Geometry of manifolds)

Time: 3 Hours **Max. Marks: 80**

UNIT 1: Definition and examples of differentiable Manifolds, tangent spaces, differentiable maps, Lie-bracket, one parameter group of transformations.

UNIT 2: Topological groups, Lie groups and Lie algebras, product of two Lie groups, one parameter subgroups & examples of Lie groups, homomorphism and isomorphism of Lie groups.

UNIT 3: Riemannian Manifolds, Riemannian connection, curvature tensors.

UNIT 4: Sectional curvature, Schur's theorem, projective curvature tensor.

Books Recommended:

1. R. S. Mishra: A course in Tensors with application to Riemannian geometry, Pothishala, Allahabad.
2. B. B. Sinha: An introduction to Modern Differential Geometry, Kalyani Prakashan, New Delhi.
3. R. S. Sinha and R. S. Mishra: Differential Geometry.
4. Y. Matsushima: Differentiable Manifolds.
5. Arthur A. Sagle, Ralph E. Walde: Introduction to Lie groups and Lie Algebras, Academic Press, New York & London.

M. A. / M. Sc. (Mathematics)
Third Semester
Paper-III
(Functional Analysis-I)

Time: 3 Hours **Max. Marks: 80**

UNIT 1: Normed linear spaces, Banach spaces, Quotient space of normed linear spaces and its completeness. The set of all bounded operators as a normed linear space.

UNIT 2: Banach-Steinhauss principle of uniform boundedness for operators, Open mapping theorem, Closed graph theorem.

UNIT 3: Convex functional, Hahn-Banach theorem for subspace of a normed linear space. Hahn Banach theorem for real linear spaces and its extension to complex linear spaces.

UNIT 4: Dual spaces of l^p, c_0 and $C[a,b]$ spaces.

Books Recommended:

1. B. V. Limaye: Functional Analysis.
2. B. Chaudhary and S. Nanda: Functional Analysis.
3. Waler Rudin : Functional Analysis.
4. A. E. Taylor: Functional Analysis.
5. G. F. Simmons: Modern Analysis.
6. Erwin Kreyszig: Introductory Functional Analysis and its Applications.

M. A. / M. Sc. (Mathematics)
Third Semester
Paper-IV
(Hydrodynamics)

Time: 3 Hours **Max. Marks: 80**

UNIT 1: Continuity, Equation of motion, Velocity potential.

UNIT 2: Motion of sphere.

UNIT 3: Motion of circular cylinder.

UNIT 4: Motion of elliptic cylinder.

Books Recommended:

1. A. S. Ramsay: Hydrodynamics Vol. II.
2. Synge and Griffith: Principles of Mechanics.

M. A. / M. Sc. (Mathematics)
Third Semester
Paper-V (A) (Optional)
(Special Functions-I)

Time: 3 Hours **Max. Marks: 80**

UNIT 1: The Gamma functions: Analytical Character, Euler's limit formula, Duplication formula, Eulerical integral of first kind, Canonical product, asymptotic expansion, Hankel contour integral.

UNIT 2: Hypergeometric functions: Solution of homogeneous linear differential equation of order two, Second order linear differential equation with three regular singularities.

UNIT 3: Hypergeometric equation and its solution, Properties of Hypergeometric functions, Confluent hypergeometric functions and its properties.

UNIT 4: Legendre's functions: Complete solutions of Legendre's differential equations, integral representations and recurrence formula for $P_n(z)$ and $Q_n(z)$, Neumann's expansion theorem.

Books Recommended:

1. E. T. Copson: Theory of functions of a Complex Variable.
2. Whittaker & Watson: Modern Analysis.

M. A. / M. Sc. (Mathematics)
Third Semester
Paper-V (B) (Optional)
(Operations Research-III)

Time: 3 Hours **Max. Marks: 80**

UNIT 1: Integer Programming: Gomory's all I.P.P. method, Gomory's mixed integer method, Branch and bound algorithm.

UNIT 2: Dynamic programming: Principle of optimality, the recursive equation approach, characteristics of dynamic programming, Dynamic programming algorithm, solution of continuous D.P.P., Solution of L.P.P. by dynamic programming method.

UNIT 3: Queueing Theory: Queuing system and its application, characteristics of queueing system. Poisson process and exponential distribution, classification of queues, Transient and steady states, Different poisson's queues [M/M/I]: (∞/FIF0).

UNIT 4: Birth death process, Finite queue length model (M/M/I): (N/FIF0), limited source model (M/M/I): (F/F0/n/N) Multi channel queueing system (M/M/C): (∞/FIF0), Numerical problem based on above models, Monte Carlo technique and its application to queueing problems.

Books Recommended:

1. K. Swaroop, Gupta and Manmohan: Operations Research, S. Chand & Comp., New Delhi.
2. H. A. Taha: Operations research- An introduction, Prentice hall of India, New Delhi.(6th Ed.)
3. Mustafi: Operations Research.

M. A. / M. Sc. (Mathematics)
Fourth Semester
Paper-I
(Topology-II)

Time: 3 Hours **Max. Marks:** 80

UNIT 1: Compactness, Continuous functions and compact sets, basic properties of compactness, compact hausdorff spaces, finite intersection properties, sequential, countable and B-W compactness, local compactness.

UNIT 2: Connectedness, connected spaces, continuous functions and connected sets, connectedness in real line, components, local connectedness, path connectedness.

UNIT 3: Tychonoff product topology in terms of standard sub-basis and its characterization, Product topology and separation axioms, connectedness and compactness (including the Tychonoff's theorem), product spaces.

UNIT 4: Homotopy between continuous maps and paths, Contractible spaces, Fundamental groups (its example and basic properties), Null homotopic spaces, induced homomorphism and its functional properties.

Books Recommended:

1. James Munkres: Topology.
2. Jmaes Dugundjii: Topology.
3. K. D. Joshi: Topology.

M. A. / M. Sc. (Mathematics)
Fourth Semester
Paper-II
(Integral Equations)

Time: 3 Hours **Max. Marks:** 80

UNIT 1: Kernel, Eigen values & Eigen function, Differentiation under the sign of Integration, connection with differential equation, solution of an integral equation, Transformation of a differential equation to integral equations: Initial value problem, Boundary value problem.

UNIT 2: Solution of Homogeneous Fredholm integral equation of the second kind with separable (or Degenerate) kernel, Orthogonality and reality of Eigen functions, Fredholm integral equation with separable kernel.

UNIT 3: Solution of Fredholm and Volterra integral equation of the second kind by successive substitution, Solution of Fredholm integral equation of the second kind by successive approximation.

UNIT 4: Reciprocal functions, Volterra's solution of Fredholm integral equation of the second kind, Solution of Volterra integral equation of the second kind by successive approximation. Neumann series, some particular cases, Reduction of Volterra integral equation into differential equation, Reduction of Volterra integral equation of first kind into a Volterra integral equation of second kind.

Books Recommended:

1. F. G. Tricomi: Integral equations.
2. T.N. Pandey: Differential &Integral equations.
3. Shanti Narayan: Integral equations.

M. A. / M. Sc. (Mathematics)
Fourth Semester
Paper-III
(Functional Analysis-II)

Time: 3 Hours **Max. Marks:** 80

UNIT 1: Reflexive spaces, Strong, weak, weak* convergence of a sequence of functionals and their relations.

UNIT 2: Hilbert spaces, Adjoint of an operator on a Hilbert space, Self Adjoint operators and order relation theorems, Positive, Normal and Unitary operators.

UNIT 3: Orthogonal Projection, Invariance and reducibility, completely continuous operators.

UNIT 4: Definition and examples of algebra and Banach algebra, Spectral properties of bounded linear operators, Spectral radius.

Books Recommended:

1. B. V. Limaye: Functional Analysis.
2. B. Chaudhary and S. Nanda: Functional Analysis.
3. Waler Rudin : Functional Analysis.
4. A. E. Taylor: Functional Analysis.
5. G. F. Simmons: Modern Analysis.
6. Erwin Kreyszig: Introductory Functional Analysis and its Applications.

M. A. / M. Sc. (Mathematics)
Fourth Semester
Paper-IV
(Analytical Dynamics)

Time: 3 Hours **Max. Marks:** 80

UNIT 1: Generalized coordinates, Lagrange's equation of motion.

UNIT 2: Ignoration of coordinates, Hamilton's canonical equation of motion.

UNIT 3: Hamilton's principle, Principle of least action.

UNIT 4: Hamilton-Jacobi equation, Contact transformation.

Books Recommended:

1. A. S. Ramsey: Analytical Dynamics
2. Synge and Griffith: Principle of Mechanics.

M. A. / M. Sc. (Mathematics)
Fourth Semester
Paper-V (A) (Optional)
(Special Functions-II)

Time: 3 Hours **Max. Marks:** 80

UNIT 1: Bessel's functions: Bessel's differential equation and its series solutions, Recurrence formulae for $J_\nu(z)$, Schlaflis contour integral for $J_\nu(z)$, Generating function for $J_\nu(z)$.

UNIT 2: Solutions for Bessel's equation by complex integral, Hankel's functions, Connection between Bessel and Hankel functions, The complete solution of Bessel's equation, Bessel's function of second order, Neumann's polynomials, Neumann's expansion theorem.

UNIT 3: Elliptic functions: Definition of an elliptic function, the irreducible poles and zeros, The algebraic equation satisfied by Weirstrass's elliptic function, The constants e_1, e_2, e_3. Addition theorem for $\rho(z)$.

UNIT 4: A formula for $\rho(z+\omega_1)$ in terms of $\rho(z)$, the expression of an elliptic function in terms of sigma function, A formula for $\rho(z)-\rho(\alpha)$, the function $\sigma_t(z)$, the expression of an elliptic function in terms of Zeta functions, the expression of an elliptic function in terms of Weirstrass's elliptic functions.

Books Recommended:

1. E. T. Copson: Theory of functions of a complex variable
2. Whittaker & Watson: Modern Analysis.

M. A. / M. Sc. (Mathematics)
Fourth Semester
Paper-V (B) (Optional)
(Operations Research-IV)

Time: 3 Hours **Max. Marks:** 80

UNIT 1: Network analysis: Basic concept of network analysis, Rules of network connection, time calculation in network PERT and CPM, PERT calculations, Advantages of network [PERT/CPM].

UNIT 2: Non-linear programming: General non-linear programming problems of constrained maxima and minima, Lagrange's multiplier method of solving non-linear programming problem, Kuhn Tucker conditions and their use in solving non-linear programming problems.

UNIT 3: Elementary information theory: Measure of information, Axiomatic approach to information, Entropy as a measure of uncertainty, Entropy characterization, some properties of entropy function, communication system, Channel probabilities, Joint and conditional entropies, Mutual information.

UNIT 4: Replacement model: Replacement of items that deteriorate with time (case 1: value of money does not change with time,case 2: value of money changes with time), Replacement of items that fail suddenly, individual and group replacement policies.

Books Recommended:

1. K. Swaroop, Gupta and Manmohan: Operations Research, S. Chand & Comp., New Delhi.
2. H. A. Taha: Operations research- An introduction, Prentice hall of India, New Delhi.(6^{th} Ed.)
3. Goel and Mittal: Operations Research.
4. P. K. Gupta and D, S. Hira: Operations Research-An Introduction, S. chand & Sons, New Delhi.