Scheme of teaching and examination under credit based semester pattern for

M.Sc. Programme in Mathematics

S.No.	Semester	Theory Paper/ Practical	Teaching Scheme (Hrs/ week)		Credits			Examination Scheme					
			Theory	Total	Theory	Int.* Ass.	Total	Duration (Hrs)	Max. Marks		Total Marks	Min. Passing Marks	
									External Marks	Internal Ass.		Th (Ext.Mar)	Int. Ass.
1	I	I	5	5	4	1	5	3	100	25	125	40	10
2	I	II	5	5	4	1	5	3	100	25	125	40	10
3	I	III	5	5	4	1	5	3	100	25	125	40	10
4	I	IV	5	5	4	1	5	3	100	25	125	40	10
5	I	V	5	5	4	1	5	3	100	25	125	40	10
		Total	**25**	**25**	**20**	**05**	**25**		**500**	**125**	**625**	**200**	**50**

S.No.	Semester	Theory Paper/ Practical	Teaching Scheme (Hrs/ week)		Credits			Examination Scheme					
			Theory	Total	Theory	Int.* Ass.	Total	Duration (Hrs)	Max. Marks		Total Marks	Min. Passing Marks	
									External Marks	Internal Ass.		Th (Ext.Mar)	Int. Ass.
1	II	I	5	5	4	1	5	3	100	25	125	40	10
2	II	II	5	5	4	1	5	3	100	25	125	40	10
3	II	III	5	5	4	1	5	3	100	25	125	40	10
4	II	IV	5	5	4	1	5	3	100	25	125	40	10
5	II	V	5	5	4	1	5	3	100	25	125	40	10
		Total	**25**	**25**	**20**	**05**	**25**		**500**	**125**	**625**	**200**	**50**

S.No.	Semester	Theory Paper/ Practical	Teaching Scheme (Hrs/ week)		Credits			Examination Scheme					
			Theory	Total	Theory	Int.* Ass.	Total	Duration (Hrs)	Max. Marks		Total Marks	Min. Passing Marks	
									External Marks	Internal Ass.		Th (Ext.Mar)	Int. Ass.
1	III	I	5	5	4	1	5	3	100	25	125	40	10
2	III	II	5	5	4	1	5	3	100	25	125	40	10
3	III	III	5	5	4	1	5	3	100	25	125	40	10
4	III	IV	5	5	4	1	5	3	100	25	125	40	10
5	III	V	5	5	4	1	5	3	100	25	125	40	10
		Total	**25**	**25**	**20**	**05**	**25**		**500**	**125**	**625**	**200**	**50**

S.No.	Semester	Theory Paper/ Practical	Teaching Scheme (Hrs/ week)		Credits			Examination Scheme					
			Theory	Total	Theory	Int.* Ass.	Total	Duration (Hrs)	Max. Marks		Total Marks	Min. Passing Marks	
									External Marks	Internal Ass.		Th (Ext.Mar)	Int. Ass.
1	IV	I	5	5	4	1	5	3	100	25	125	40	10
2	IV	II	5	5	4	1	5	3	100	25	125	40	10
3	IV	III	5	5	4	1	5	3	100	25	125	40	10
4	IV	IV	5	5	4	1	5	3	100	25	125	40	10
5	IV	V	5	5	4	1	5	3	100	25	125	40	10
		Total	**25**	**25**	**20**	**05**	**25**		**500**	**125**	**625**	**200**	**50**

*__Internal Assessment__: For the purpose of internal assessment the department will conduct three tests (with equal weight of marks). Best two scores of a student in these tests will be considered to obtain the internal assessment score of that student.

M. Sc. Mathematics
Semester wise Syllabus

Total Marks : 2500

Each Paper : 100 marks theory + 25 marks sessional

Periods Allotted per week per paper : 05 Hrs.

M. Sc. Semester-I
Compulsory Papers

1. Paper I Algebra-I
2. Paper II Real Analysis-I
3. Paper III Topology-I
4. Paper IV Linear Algebra and differential equations

Optional Papers (Any One)

5. Paper V Numerical Analysis
6. Paper VI Integral Equations
7. Paper VII Fuzzy Mathematics-I

M. Sc. Semester-II

Compulsory Papers

1. Paper I Algebra-II
2. Paper II Real Analysis-II
3. Paper III Topology-II
4. Paper-IV Differential geometry

Optional Papers (Any One)

5. Paper-V Classical Mechanics
6. Paper VI Mathematical Methods
7. Paper VII Fuzzy Mathematics-II

M. Sc. Semester-III

Compulsory Papers

1. Paper I Complex Analysis
2. Paper II Functional Analysis

Optional Papers (Any three)

3. Paper-III Fluid Dynamics-I
4. Paper- IV General Relativity
5. Paper-V Operations Research-I
6. Paper VI Algebraic Topology-I
7. Paper- VII Operator Theory
8. Paper –VIII Non-linear programming
9. Paper IX MATLAB Programming

M. Sc. Semester-IV

Compulsory Papers

1. Paper-I Dynamical Systems
2. Paper-II Partial Differential Equations

Optional Papers (Any three)

3. Paper-III Fluid Mechanics-II
4. Paper-IV Cosmology
5. Paper V Operations Research-II
6. Paper VI Advanced Algebra
7. Paper VII Algebraic Topology-II
8. Paper- VIII Banach Algebras
9. Paper – IX Computational Fluid Dynamics

Detailed Syllabus

Semester-I

Paper-I
Algebra-I

Unit1: Permutation Group. Group of Symmetry. Dihedral group. Commutator group. Isomorphism Theorems. Automorphisms. Characteristic subgroup. Conjugacy and G- Sets.

Unit 2: Normal Series. Solvable groups. Nilpotent groups.Cyclic decomposition of permutation group. Alternating groups. Simplicity of A_n.

Unit3 : Direct product, semi-direct product of groups. Sylows theorems. Groups of order p^2 and pq.

Unit4 : Ideals and Homomorphisms. Sum and direct sum of ideals. Maximal and prime ideals. Nilpotent and Nil ideals. Modules. Submodules. Direct sums. R-homomorphisms and quotient modules. Completely reducible modules. Free modules.

Text Book:

Basic Abstract Algebra :Bhattacharya, Jain, and Nagpal ,Second Edition, Cambridge University Press.

Reference Books :

1.Topics in Algebra, I. N. Herstein, Second Edition, John Wiley.
2. Abstract Algebra: David S.Dummit and Richard M. Foote, John Wiley.

Paper-II
Real Analysis-I

Unit1:Uniform convergence.Uniform convergence and continuity. Uniform convergence and integration. Uniform convergence and differentiation. Equicontinuous families of functions. TheStone- Weierstrass theorem.

Unit2: Differentiation. The Contraction Principle. The Inverse Function Theorem. The Implicit Function Theorem. The Rank Theorem. Partitions of unity.

Unit3: The space of tangent vectors at a point of R^n. Another definition of $T_a(R^n)$. Vector fields on open subsets of R^n.Topological manifolds. Differentiable manifolds. Real Projective space. Grassman manifolds. Differentiable functions and mappings.

Unit4: Rank of a mapping. Immersion. Sub manifolds. Lie groups. Examples of Lie groups.

Text Books :

1.Principles of Mathematical Analysis (Third Edition) : Walter Rudin
Mc GRAW – HILL Book Company.

2.An Introduction to Differentiable Manifolds and Riemannian Geometry : W. Boothby, Academic Press, 1975.

Reference Books :

1.Methods of Real Analysis: R.R. Goldberg , John Wiley..

2.Calculus of Several Variables: C Goffman , Harper and Row.

Paper-III
Topology-I

Unit1: Countable and Uncountable sets. Examples and related Theorems. Cardinal Numbers and related Theorems. Topological Spaces and Examples.

Unit2:Open sets and limit points. Derived Sets. Closed sets and closure operators. Interior, Exterior and boundary operators. Neighbourhoods, bases and relative topologies.

Unit3: Connected sets and components. Compact and countably compact spaces. Continuous functions, and homeomorphisms.

Unit4: T_o- and T_1- spaces, T_2- spaces and sequences. Axioms of countability. Separability. Regular and normal spaces.

Text Book:

Foundations of General Topology: W.J. Pervin, Academic press, 1964.

Reference Books:

1.Topology: J.R. Munkres, (second edition), Prentice Hall of India, 2002.
2. Introduction to Topology and Modern Analysis: G.F. Simmons, Mc Graw Hill 1963.
3. General Topology: J.L. Kelley, Van Nostrand, 1995.
4. Introduction to general Topology: K.D. Joshi, Wiley Eastern Ltd. 1983

Paper-IV
Linear Algebra and differential equations

Unit1: Matrices and operators, Subspaces, Bases and Dimension. Determinants, trace, and Rank. Direct sum decomposition. Real Eigen Values. Differential equations with Real Distinct Eigen values. Complex Eigen values.

Unit2: Complex vector spaces. Real operators with Complex Eigen values. Application of complex linear algebra to differential equations.Review of topology in R^n. New norms for old. Exponential of operators.

Unit3:. Homogeneous linear systems. A non-homogeneous equation. Higher order systems. The primary decomposition. The S+N decomposition.Nilpotent canonical forms.

Unit4:. Jordan and real canonical forms. Canonical forms and differential equations. Higher order linear equations on function spaces. Sinks and sources. Hyperbolic flows. Generic properties of operators. Significance of genericity.

Text Book :

Differential equations, dynamical systems and linear algebra: M.W. Hirsch and S. Smale, Academic Press, 1975.

Reference Book :

Dynamical systems: V.I. Arnold, Springer Verlag, 1992.

Paper-V
Numerical Analysis
(Optional)

Unit1:Simple enclosure methods, Secant method, Newton's method, general theory for one point iteration methods. Aitken extrapolation for linearly convergent sequences, Error tests, Numerical evaluation of multiple roots, roots of polynomials, Mullers method, Non-linear systems of equations, Newton's method for non- linear systems.

Unit2: Polynomial interpolation theory, Newton's divided differences, finite difference and table oriented interpolation formulas. Forward-differences. Hermite interpolation.

Unit3: The Weierstrass theorem and Taylor's theorem. The minimax approximation problem, the least square approximation problem, orthogonal polynomial, economisation of Taylor series, minimax approximation.

Unit4:The trapezoidal rule and Simpson's rule, Newton- Cotes integration formulas.

Text book :

An Introduction to Numerical Analysis : Kendal E. Atkinson, Johan Wiley and sons, Inc.

Paper-VI
Integral Equations
(Optional)

Unit1: Preliminary concepts of integral equations. Some problems which give rise to integral equations. Conversion of ordinary differential equations into integral equations. Classification of linear integral equations. Integro- differential equations.

Unit2: Fredholm equations. Degenerate kernels. Hermitian and symmetric kernels. The Hilbert- Schmidt theorem. Hermitization and symmetrization of kernels. Solutions of integral equations with Green's function type kernels.

Unit3: Types of Voltera equations. Resolvent kernel of Voltera equations, Convolution type kernels. Some miscellaneous types of Voltera equations. Non-linear Voltera equations. Fourier integral equations. Laplace integral equations.

Unit4: Hilbert transform. Finite Hilbert transforms. Miscellaneous integral transforms. Approximate methods of solutions for linear integral equations. Approximate evaluation of Eigen values and Eigen functions.

Text Book :
Integral Equations: A short course: LI. G Chambers :International text book company Ltd, 1976.

Paper-VII
Fuzzy Mathematics-I
(Optional)

Unit1: Crisp Sets. Fuzzy Sets. Fuzzy sets versus Crisp sets Operations on Fuzzy sets.

Unit2: Fuzzy Arithmetic.

Unit3: Fuzzy relations.

Unit4: Fuzzy relation equations.

Text Book :
Fuzzy Sets and Fuzzy Logic, theory and applications. George J. Klir and Bo Yuan, Prentice Hall India.

Semester II
Paper I
Algebra-II

Unit1:Unique factorization domains. Principal Ideal domains. Euclidean domains. Polynomial rings over unique factorization domains.

Unit2: Irreducible polynomials and Eisenstein criterion. Adjunction of roots. Algebraicextensions. Algebraically closed fields. Splitting fields. Normal extensions. Multiple roots.

Unit3:Finite fields. Separable extensions. Automorphism groups, and fixed fields. Fundamental theorem of Galois theory. Fundamental theorem of algebra.

Unit4: Roots of unity and Cyclotomic polynomials. Cyclic extensions. Polynomials solvable by radicals. Ruler and compass constructions.

Text Book :
Basic Abstract Algebra: Bhattacharya, Jain, Nagpaul; Second Edition, Cambridge University Press.

Reference Books :
1. Topics in Algebra, I. N. Herstein, Second Edition, John Wiley.
2. Abstract Algebra, David S.Dummit and Richard M.Foote, John Wiley.

Paper- II
Real Analysis-II

Unit1: Outer measure.Measurable sets and Lebesgue measure. Anon-measurable set, Measurable functions, Littlewood's three principles.

Unit2: The Riemann integral. Lebesgue integral of a bounded function over a set of finite measure. Integral of a non-negative function.General Lebesgue integral.Convergence in measure. Differentiation of monotone functions. Functions of bounded variation. Differentiation of an integral.

Unit3: Absolute continuity.Convex functions. L^p-spaces. Holder and Minkowski inequality. Riesz-Fischer theorem. Approximation in L^p. Bounded linear functionals on L^p-spaces.

Unit4: Compact metric spaces. Baire category theorem. Arzela Ascoli theorem. Locally compact spaces. Sigma compact spaces.

Text Book :
Real Analysis, H.L. Royden, Third edition, Prentice Hall, 1988.

Reference Books :
1. Measure theory and Integration, G. de Barra Wiley Eastern Limited, 1981.
2. An introduction to Measure & Integration, Inder K. Rana, Narosa Publishing House

Paper-III
Topology-II

Unit 1 : Urysohn's lemma. Tietze extension theorem. Completely regular spaces.Completely normal spaces. Compactness for metric spaces. Properties of metric spaces.

Unit 2 :Quotient topology. Nets and filters.

Unit3 : Product topology : Finite products, product invariant properties, metric products ,Tichonov topology, Tichonov theorem.

Unit 4 :Locally finite topological spaces. Paracompact spaces, Urysohn's metrization theorem.

Text books:
1. Foundations of General Topology: W.J. Pervin, Academic press, 1964.

2. Introduction to general Topology: K.D. Joshi, Wiley Eastern Ltd. 1983.

Reference books:

1. Topology: J.R.. Munkres, second edition, Prentice Hall of India, 2002.
2. Introduction to topology and modern analysis :G.F. Simmons, Mc Graw Hill 1963.
3. General Topology: J.L. Kelley, Van Nostrand, 1995.

Paper- IV
Differential Geometry

Unit1: Definition of surface. Curves on a surface. Surfaces of revolution. Helicoids. Metric. Direction coefficients. Families of curves. Isometric correspondence. Intrinsic properties. Geodesics. Canonical geodesic equations.

Unit2: Normal property of geodesics. Existence theorems. Geodesic parallels.Geodesic curvature. Gauss Bonnet theorem. Gaussian curvature. Surfaces of constant curvature. Conformal mapping. Geodesic mapping.

Unit 3: Second fundamental form. Principal curvatures. Lines of curvature. Developables. Developables associated with space curves. Developables associated with curves on surfaces. Minimal surfaces and ruled surfaces. Fundamental equations of Surface theory. Parallel surfaces.

Unit 4:. Compact surfaces whose points are umbilics. Hilbert's lemma. Compact surfaces of constant Gaussian or mean curvature. Complete surfaces. Characterisation of complete surfaces. Hilbert's theorem. Conjugate points on geodesics. Intrinsically defined surfaces. Triangulation. Two dimensional Riemannian manifolds. Problem of metrization. Problem of continuation.

Text Book:

An introduction to Differential Geometry: T.J. Wilmore; Oxford University Press

Reference Book:

Geometry of curves and surfaces: do Carmo, Academic Press.

Paper-V
Classical Mechanics
(Optional)

Unit 1: Variational Principle and Lagrange's equations; Hamilton's Principle, some techniques of calculus of variations, Derivation of Lagrange equations from Hamilton's principle. Extension of principle to nonholonomic systems. Conservation theorems and symmetry properties.

Unit 2: Legendre transformations and the Hamilton equations of motion. Cyclic coordinates and conservation theorems. Routh's procedure and oscillations about steady motion, The Hamiltonian formulation of relativistic mechanics, The Principle of least action.

Unit 3: The equations of canonical transformation. Examples of canonical transformation. The symplectic approach to canonical transformations. Poisson brackets and other canonical invariants.

Unit 4: Equations of motion. Infinitesimal canonical transformations and conservation theorems in the Poisson bracket formulation, the angular momentum, Poisson bracket relations, symmetry groups of mechanical systems. Liouville's theorem.

Text Book :

Classical Mechanics: By H. Goldstein, Second Edition Narosa publishing house, New Delhi.

References:

1.Lectures in Analytic Mechanics: F. Gantmacher, MIR Publishers, Moscow, 1975.

2.Classical Mechanics: Narayan Chandra Rana and Pramod Sharad Chandra Jog, Tata Mc Graw Hill.

Paper-VI
Mathematical Methods
(Optional)

Unit 1: Fourier integral theorem. Fourier transform. Fourier cosine and sine transform. The convolution integral. Multiple Fourier transform. Solution of partial differential equation by means of Fourier transform.

Unit 2:Calculations of the Laplace transform of some elementary functions. Laplace transform of derivatives. The convolution of two functions. Inverse formula for the Laplace transform. Solutions of ordinary differential equations by Laplace transform.

Unit 3: Finite Fourier transform. Finite Sturm – Liouville transforms. Generalized finite Fourier transform.

Unit 4 : Finite Hankel transform. Finite Legendre transform. Finite Mellin transform.

Text Book :

The use of integral transforms: I N. Sneddon, Tata Mc Graw Hill Publishing Company Ltd.

References Books :

Modern Mathematics For Engineers: Edwin F Beckenbach, Second series, Mc Graw Hill Book Company.

Paper-VII
Fuzzy Mathematics-II
(Optional)

Unit 1: Possibility theory

Unit 2: Fuzzy Logic

Unit3: Constructing Fuzzy sets and operations on Fuzzy sets. Approximate reasoning.

Unit4: Fuzzy Systems. Pattern Recognition.

Text Book:

Fuzzy Sets and Fuzzy Logic, theory and applications. George J. Klir and Bo Yuan , Prentice Hall, India.

Semester-III

Paper- I
Complex Analysis

Unit1: Impossibility of ordering Complex numbers. Extended complex plane and stereographic projection. Elementary properties and examples of analytic Functions: Power series, analytic functions.

Unit2: Analytic functions as mappings, Mobius transformations.Power series representation of analytic functions, zeros of an analytic function, index of a closed curve.

Unit3: Cauchy's theorem and integral formula, the homotopic version of cauchy's theorem and simple connectivity, counting zeros; the open mapping theorem, Goursat's theorem,Classification of singularities, residues, the argument principle.

Unit4: The maximum principle. Schwarz's lemma. convex functions and Hadamards three circles theorem. Phragmen-Lindelof theorem.

Text Book: Functions of one complex variable: John B. Conway, Second edition, Springer international Student Edition.

Reference Book: Complex Analysis, L.V. Ahlfors. Mc-Graw Hill, 1966.

Paper- II
Functional Analysis

Unit 1 : Normed spaces, Banach spaces, Further properties of normed spaces. Finite dimensional normed spaces and subspaces. Compactness and finite dimension. Bounded and continuous linear operators.

Unit 2 : Linear functionals. Normed spaces of operators. Dual spaces.
Inner product space. Hilbert space. Further properties of inner product spaces. Orthogonal complements and direct sums. Orthonormal sets and sequences. Total orthonormal sets and sequences.

Unit 3 : Representation of functionals on Hilbert spaces. Hilbert adjoint operators, self adjoint, unitary and normal operators.
Hahn-Banach Theorem, Hahn-Banach Theorem for complex vector spaces and normed spaces. Adjoint operator. Reflexive spaces.

Unit 4 : Category theorem, Uniform boundedness theorem, strong and weak convergence, Convergence of sequences of operators and functionals. Open mapping theorem, Closed linear operators and closed graph theorem.

Text Book:
Introductory Functional Analysis with Applications by E. Kreyszig, John Wiley and Sons.

Reference Books :

1.Introduction to Functional Analysis by A.E.Taylor and D.C.Lay, John Wiley and Sons.
2. Introduction to Topology and Modern Analysis: G.F. Simmons, Mc Graw Hill

Paper- III
Fluid Dynamics-I
(Optional)

Unit1: Real fluids and ideal fluids. Velocity of a fluid at a point. Stream lines and path lines. Steady and unsteady flows. Velocity potential. Velocity vector. Local and particle rate of change. Equation of continuity. Acceleration of a fluid. Condition at a rigid boundary. General analysis of fluid motion. Euler's equation of motion. Bernoulli's equation. Worked examples. Discussion of the case of steady motion under conservative body forces. Some further aspects of vortex motion.

Unit2: Sources, sinks and doublets. Images in a rigid infinite plane. Images in solid spheres. Axi-symmetric flows. Stokes' stream function. The complex potential for two-dimensional irrotational, incompressible flow. Complex velocity potential for standard two dimensional flow. Uniform stream. Line source and line sink. Line doublets. Line vortices. Two dimensional image systems. The Milne-Thomson circle theorem. Circle Theorem. Some applications of circle theorem. Extension of circle theorem. The theorem of Blasius.

Unit3: The equations of state of a substance, the first law of thermodynamics, internal energy of a gas, functions of state, entropy, Maxwell's thermodynamic relation, Isothermal Adiabatic and Isentropic processes.Compressibility effects in real fluids, the elements of wave motion. One dimensional wave equation, wave equation in two and three dimensions, spherical waves, progressive and stationary waves.

Unit4: The speed of sound in a gas, equation of motion of a gas. Sonic, subsonic, supersonic flows; isentropic gas flow. Reservoir discharge through a channel of varying section, investigation of maximum mass flow through a nozzle, shock waves, formation of shock waves, elementary analysis of normal shock waves.

Text Book :

F. Chorlton, Text book of Fluid Dynamics, CBS Publishers, Delhi 1985.

Reference Books :

1.G.K. Batchelor , An Introduction to fluid Mechanics, Foundation Books, New Delhi 1994.
2.M.D. Raisinghania, fluid Mechanics, S. Chand and Company , Delhi.

Paper-IV
General Relativity
(Optional)

Unit 1: Tensor Algebra, Riemannian geometry, Curvature Tensor: Covariant Curvature tensor, Ricci tensor, Einstein Tensor, The Bianchi identity.

Unit 2:The principle of covariance, The principle of equivalence, Geodesic principle, Newton's equations of motion as an approximation of geodesic equations, Poisson's equations as an approximation to Einstein field equations.

Unit 3: Gravitational field equations in free space, Exterior Schwarzchild's solution and its isotropic form, Birkhoff's theorem, Schwarzchild singularity, planetary orbit, Advance of Perihelion of a planet, Bending of light rays in the gravitational filed, Gravitational Red shift in the spectral lines.

Unit 4: Gravitational field equations for non empty space, Linearization of the field equations, The Weyl's solution of linearized Field equations, Interior Schwarzchild's solution.

Text Book :

Introduction to General Relativity: Ronald Adler, Maurice Bezin and Manamen Schiffer, McGraw-Hill Kogakusha Ltd.

References Books:

1.Introduction to theory of relativity , Rosser W.G.V., ELBS(1972).
2.Relativity Special, General and Cosmology, Rindler W., Pub. Oxford University Press(2003).
3.The Classical Theory of Fields By Landau I.D. and Lifshitz E.M., Pub. Pergamon Press(1978).

Paper-V
Operational Research–I
(Optional)

Unit1: Simplex method, Theory of Simplex method, duality, dual simplex method.

Unit2: Transportation and Assignment problems.

Unit3: Two–person Zero – sum games. Games with mixed strategies, graphical solution, solution by linear programming.

Unit4: Dynamic programming

Text book:

Operations Research :Kanti-Swarup P.K. Gupta and Man Mohan: Sultan Chand and Sons New Delhi.

Reference books :

1.Linear programming: G. Hadley, Narosa Publishing House1995.
2. Introduction to operations Research: F.S. Hillier and G.J.Lieberman (Sixth Edition), Mc Graw Hill International Edition 1995.
3.Operations Research – In Introduction: H.A Taha, Macmillan publishing company inc, New York

Paper- VI

Algebraic Topology- I

(Optional)

Unit1: Geometric complexes and polyhedra. Simplicial homology groups.

Unit2: Simplicial approximation.

Unit3: The Fundamental group.

Unit4: Covering spaces.

Text Book :

Basic Concepts of Algebraic Topology: Fred H.Croom, Springer-Verlag.

Reference Books :

1. Topology : J.R.Munkres, Prentice Hall, Second Edition, 2000
2. Topology : J.G. Hocking and G.S. Young : Addison Wesley, 1961

Paper- VII

Operator Theory

(Optional)

Unit 1: Basic concepts about spectrum. Spactral properties of bounded linear operators. Further properties of resolvent and spectrum. Use of complex analysis in spectral theory.

Unit 2: Banach Algebras. Further properties of Banach Algebras. Compact linear operators on normed spaces. Further properties of Compact linear operators. Spectral properties of compact linear operators.

Unit 3: Further spectral properties of Compact linear operators. Operator equations involving compact linear operators. Further theorems of Fredholm type. Fredholm alternative.

Unit 4: Spectral properties of bounded self adjoint linear operators. Further Spectral properties of bounded self adjoint linear operators. Positive operators. Square roots of a positive operator. Projection operator. Further properties of projections. Spectral family. Statement of spectral representation theorem.

Text Book:

Introductory Functional Analysis with Applications by E. Kreyszig, John Wiley and Sons

Reference book :

Introduction to Functional Analysis by A.E.Taylor and D.C.Lay, John Wiley and Sons

Paper- VIII
Non-linear Programming
(Optional)

Unit1: The non-linear programming problem and its fundamental ingredients. Linear inequalities and the theorem of the alternative. The optimality criteria of linear programming. Tucker's lemma and existence theorems. Theorems of the alternative Convex sets – Separation theorems.

Unit2: Convex and concave functions - basic properties and some fundamental theorems for convex functions. Generalised Gordan theorem. Bohnenblust – Karlin – Shapley theorem.

Unit3: Saddle point optimality criteria without differentiability – The minimization and the local minimization problems and some basic results. Sufficient optimality theorem. Fritz John Saddle point necessary optimality theorem. Slater's and Karlin's constraint qualifications and their equivalence. The strict constraint qualification. Kuhn – Tucker saddle point optimality theorems.

Unit4: Differentiable concave and convex functions - Some basic properties. Twice differentiable convex and concave functions. Theorems in cases of strict convexity and concavity of functions.Optimality criteria with differentiability- Optimality theorems, Fritz John stationary point necessary optimality theorem.

Text Book : Non- linear programming: O.L. Mangasarian, Mc Graw Hill, New York.

Reference Book : Non- linear programming-Theory and Algorithms,: Mokhtar S. Bazaraa and C.M.Shetty, John Wiley, New York.

Paper- IX
MATLAB PROGRAMMING
(optional)

Unit1: Input output of data from Matlab command. File types. Creating, saving and executing the script file. Creating and executing functions file. Working with files and directories.

Unit2: Matrix manipulation. Creating vectors. Arithmetic operations. Relational operations. Logical operations. Matrix functions. Determinant of matrix. Eiugen values and Eigen vectors.
Programming in Matlab: function files, sub functions, global variations, loops, branches and control flow. Interactive input. Recursion. Publishing a report. Controlling command windows. Command line editing.

Unit3: Linear Algebra and interpolation: Solving the linear equation. Gaussian elimination, matrix factorization, curve fitting, polynomial curve fitting, least squares curve fitting. General non linear fits. Interpolation.

Unit4: Differential equations and graphics: First order and second order ODE. Double integration. Roots of polynomial. Two and three dimensional plots. Matlab plotting tools. Mesh and surface plots.

Text Books:

1.Applied numerical Methods using MATLAB: Won Young Yang, Tae-Sang-Chung, John Morris: John Wiley and Sons.
2.Solving ODE's with Matlab: L.F. Shampine, I Gladwell, S. Thompson; Cambridge University Press.
3.Getting Started with MATLAB 7: Rudra Pratap; Oxford Press.

Semester- IV

Paper-I
Dynamical Systems

Unit1: Dynamical systems and vector fields. The fundamental theorem. Existence and uniqueness. Continuity of solutions in initial conditions. On extending solutions. Global solutions. The flow of a differential equation.

Unit2: Nonlinear sinks. Stability. Liapunov function. Gradient systems. Gradients and inner products.

Unit3: Limit sets, local sections and flow boxes, monotone sequences in planar dynamical systems. The Poincare- Bendixson theorem, Applications of Poincare-Bendixson theorem; one species, predator and prey, competing species.

Unit4: Asymptotic stability of closed orbits, discrete dynamical systems. Stability and closed orbits. Non Autonomous equations and differentiability of flows. Persistence of equilibria, persistence of closed orbits. Structural stability.

Text Book:
Differential equations, dynamical systems & linear algebra: M.W. Hirsch & S. Smale, Academic Press, 1975.

Reference Book :
Dynamical systems: V.I. Arnold, Springer Verlag, 1992.

Paper II
Partial Differential Equations

Unit 1: First order partial differential equations in two independent variables and the Cauchy problem. Semilinear and quasi linear equations in two independent variables. First order non linear equations in two independent variables. Complete integral.

Unit 2: Classification of second order partial differential equations. Potential theory and elliptic differential equations (sections 2.1-2.5).

Unit 3: The diffusion equation and parabolic differential equations (sections 3.1-3.4).

Unit 4: The Wave equation (sections 4.1, 4.2, 4.4, 4.8, 4.9)

Text Book :
Partial Differential Equations: Phoolan Prasad and Renuka Ravindran; New Age International(P) Limited.

Paper-III
Fluid Dynamics-II
(Optional)

Unit 1: Stress components in a real fluid, relation between Cartesian components of stress translation motion of fluid elements, the rate of strain quadric and principal stresses, some further properties of the rate of the strain quadric, stress analysis in fluid motion, relation between stress and rate of strain, the coefficient of viscosity and laminar flow, the Navier-Stokes equations of motion of a viscous fluid, some solvable problems in viscous flow, diffusion of vorticity, energy dissipation due to viscosity, steady flow past a fixed sphere.

Unit 2: Nature of magnetohydrodynamics, Maxwell electromagnetic field equations; Motion at rest, Motion in medium , Equation of motion of conducting fluid, Rate of flow of charge, Simplification of electromagnetic field equation. Magnetic Reynold number; Alfven's theorem, The magnetic body force. Ferraro's Law of Isorotation.

Unit3: Dynamical similarity, Buckingham Theorem. Renold number. Prandtl's boundary layer, Boundary layer equation in two dimensions, Blasius solutions, Boundary layer thickness, Displacement thickness. Karman integral conditions, Separation of boundary layer flow.

Unit4: Turbulence: Definition of turbulence and introductory concepts. Equations of motion for turbulent flow. Reynolds Stresses Cylindrical coordinates. Equation for the conservation of a transferable scalar quantity in a turbulent flow. Double correlations between turbulence-velocity components. Change in double velocity correlation with time. Introduction to triple velocity correlations.Features of the double longitudinal and lateral correlations in a homogeneous turbulence. Integral scale of turbulence.

Text Books :

1. Text book of Fluid Dynamics: F. Chorlton; CBS Publishers, Delhi 1985.
2. Fluid Mechanics: Joseph Spurk; Springer.
3. Turbulence: J. O. Hinze, Second edition, Mc Graw-Hill, chapter 1 sections 1.1 to 1.7

Reference Books :

1 An Introduction to fluid Mechanics: G.K. Batchelor; Foundation Books, New Delhi, 1994.
2. Boundary Layer Theory: H. Schichting; Mc Graw Hill Book Company, New York 1971.

Paper-IV
Cosmology
(Optional)

Unit 1: Static cosmological models of Einstein and de Sitter and their derivation and its Properties: (i) The geometry of the Universe (ii) Density and pressure (iii) Motion of test particle (iv) Doppler shift (v) comparison with actual universe, Comparison between Einstein and de-Sitter models.

Unit 2: Cosmological principle, Hubble law, Weyl's postulate,Derivation of Robertson Walker Metric and its properties, Motion of a particle and light rays in FRW model, Red shift, Deceleration parameter and Hubble's constant, Matter Dominated era.

Unit 3: Friedman Model, Fundamental equation of dynamical cosmology, density and pressure of the present universe, Matter dominated era of the universe, critical density, flat,
closed and open universe, age of the universe,

Unit 4: Steady state cosmology, Distance measure in cosmology, Comoving distance, Apparent luminosity and luminosity distance, Angular diameter and Lookback time, Galaxy count

Text Books :

1. Relativity, Thermodynamics and Cosmology: Richard C. Tolman, Oxford Press
2. Gravitation and Cosmology : Principles and Applications of the General Theory of Relativity. By Steven Weinberg.

References Books :

1. The Classical Theory of Fields, By Landau I.D. and Lifshitz E.M., Pub. Pergamon Press(1978).
2. The Theory of Relativity Moller C, Pub. Oxford University Press(1982).
3. Introduction to theory of relativity , Rosser W.G.V., ELBS(1972).
4. Relativity Special, General and Cosmology, Rindler W., Pub. Oxford University Press(2003).
5. Relativity: The General Theory, Synge J.L., North Holland Pub. Comp.(1971).

Paper-V
Operations Research–II
(Optional)

Unit1: Integer programming.

Unit2: Queuing theory and sequencing.

Unit3: Non- Linear programming- one and multi- Variable unconstrained optimization, Kuhn-Tucker conditions for constrained optimization.

Unit4: Quadratic programming, fraction programming and goal programming.

Text book:

Kanti-Swarup P.K. Gupta and Man Mohan: Operations Research, Sultan Chand and Sons New Delhi.

Reference books :

1.G. Hadley: Linear programming, Narosa Publishing House1995.

2.F.S. Hillier and G.J.Lieberman: Introduction to operations Research (Sixth Edition) Mc Graw Hill International Edition 1995.

3.H.A Taha: Operations Research – In Introduction, Macmillan publishing company inc, New York

Paper- VI
Advanced Algebra
(Optional)

Unit1: Noetherian Rings and Affine algebraic sets. Radicals and affine varieties. Integral extensions and Hilbert Nullstellensatz..

Unit2: Localization. The prime spectrum of a ring.

Unit3: Artinian rings.Discrete valuation rings. Dedekind domains.

Unit4: Representation theory and character theory. Characters of groups of small order.

Text Book:
Abstract Algebra: David S. Dummit and Richard M. Foote; second edition, John Wiley.

Paper- VII
Algebraic Topology-II
(Optional)

Unit 1: Seaparation theorems in the plane

Unit 2: The Seifert-van Kampen theorem.

Unit 3 : Classification of surfaces.

Unit 4 : Classification of covering spaces, applications to Group theory.

Text Book: Topology: James R Munkres, 2nd Edition, Prentice-Hall of India.
Reference Book: Topology: J.G. Hocking and G.S. Young : Addison Wesley, 1961

Paper- VIII
Banach Algebras
(Optional)

Unit 1 : Fundamental algebraic concepts, Topological algebras, Normed algebras

Unit 2 : Symmetric algebras, Realisation of a commutative normed algebra in the form of an algebra of functions.

Unit 3 : Homomorphism and isomorphism of commutative algebras, Completely symmetric commutative algebras, Regular algebras, Completely regular commutative algebras.

Unit 4: Fundamental concepts and propositions in the theory of representations, Embedding of a symmetric algebra in an algebra of operators, In decomposable functionals and irreducible representations.

Text Book :
M.A.Naimark, Normed Algebras, Noordhoff, Groningen, Netherlands, 1972.

Reference Books :
1.General Theory of Banach Algebras : C.E.Rickart, Von Nostrand, 1960,
2. Banach Algebras , Vol. I: T.W.Palmer ; Cambridge University Press, 1994

Paper- IX
Computational Fluid Dynamics
(Optional)

Unit 1: Analytic aspects of PDE. Finite volume and finite difference methods on non uniform grids.

Unit 2: Stationary convection- diffusion equation (Finite volume discretization, schemes of positive type, upwind discretization)

Unit 3: Non Stationary convection- diffusion equation: Satbility, discrete maximum principle.

Unit 4: Incompressible Navier Stokes Equation- Boundary conditions, Spatial and temporal discretization on collocated and staggered grids.

Text Book:
Principles of Computational Fluid Dynamics: P Weaseling; Springer-Verlag.

Reference Books:
1. Computational Fluid Dynamics- An Introduction: J.E. Wendt, J.D. Anderson, G. Degrez, E Dick; Springer-Verlag
2. Computational Fluid Dynamics: J.D. Anderson; Mc Graw Hill, 1995