SYLLABUS

M.A./M./Sc. Ist SEMESTER

ABSTRACT ALGEBRA : MMM-7001

UNIT-1 Groups, Subgroups, normal subgroups and Quotient groups, Homomorphisms.

UNIT-2 Cayley's Theorem, Permutation groups, Sylow's Theorems, Finite Abelian Groups, Decomposition and invariants.

UNIT-3 Examples and Fundamental properties of rings and homomorphism (Review), quotient rings sums of ideals, direct sum of ideals, prime ideals and m-systems, semi prime ideals, The prime radical of a ring, Prime rings, D.C.C. and the prime radical.

UNIT-4 Jacobson radical: Definition and simple properties, The D.C.C.

Books Recommended:

1. N. Herstein: Topics in Algebra
   Contents: Sections- 2.1, 2.2, 2.3, 2.4, 2.6, 2.7, 2.9, 2.10, 2.12, 2.14

2. N. H. McCoy: Theory of Rings
   Contents: Sections- 2.7, 4.18, 4.19, 4.20, 4.21, 4.22, 6.31, 6.32, 6.34

SYLLABUS

M.A./M./Sc. Ist SEMESTER

REAL ANALYSIS : MMM-7002

UNIT-1 Sequence and Series of functions, Pointwise and uniform convergence, Cauchy criterion for uniform convergence, Weierstrass M test, Abel's and Dirichlet's test, for uniform convergence and differentiation, Uniform convergence and integration.

UNIT-2 Weierstrass approximation theorem, The fundamental theorem of integral calculus, Definition and existence of Reimann Stieltjes integral, Properties and some important theorems on Reimann Stieltjes integral, Integration of vector valued functions, Rectifiable curves.

UNIT-3 Power series, Uniqueness theorem of power series, Abel's and Taylor's theorem, Rearrangement of terms of series, Riemann's theorem.

UNIT-4 Functions of several variables, linear transformation, Derivatives is an open subject, Chain rule, Partial derivatives, Jacobian, interchange of the order of differentiation, Derivation of higher order, inverse function theorem, implicit function theorem.

Books Recommended:

1. W. Rudin: Principle of Mathematics Analysis
2. D. Somasundram and B. Choudhary: A First Course in Mathematical Analysis, Narosa, 1999.
3. S. C. Malik: Mathematical Analysis, Wiley Eastern, India.

SYLLABUS

M.A./M./Sc. Ist SEMESTER

TOPOLOGY-I : MMM-7003

UNIT-1 Definitions and examples of topological spaces, Topology induced by a metric, closed sets, Closure, Dense subsets, Neighbourhoods, Interior, Exterior and boundary accumulation points and derived sets, Bases and subbases, Topology generated by the subbasis, subspaces and relative topology, Alternative methods of defining a topology in terms of Kuratowski closure operator and neighbourhood systems, Continuous functions and homomorphism.

UNIT-2 First and second countable spaces, Lindelof spaces, Separable spaces, Second countability and separability, Separation axioms, T_0,T_1,T_2,$T_{3.5}$,T_4 spaces and their characterizations and basic properties, Brysohn's lemma, Tietze extension theorem.

UNIT-3 Compact spaces and their basic properties, Separation of a space, Connected spaces, Connected sets in the real line, Totally disconnected spaces, Intermediate value theorem, path connected, Components, Path components, Locally connected spaces, Locally path connected spaces, Totally disconnected spaces, Continuous functions and connected sets.

UNIT-4 Product topology (finite and infinite number of spaces), Tychonoff product topology in terms of standard sub-base and its characterizations, Projection maps, Separation axioms and product spaces, Connectedness and product spaces, Compactness and product spaces (Tychonoll's theorem), Countability and product spaces.

Books Recommended:

1. James R. Munkres: Topology, A first course, Prentice Hall of India Pvt. Ltd., New Delhi, 2000.

SYLLABUS

M.A./M./Sc. Ist SEMESTER

COMPLEX ANALYSIS : MMM-7004

UNIT-1 Complex integration, Cauchy-Goursat Theorem, Cauchy's integral formula. Higher order derivatives, Morera's theorem, Cauchy inequality and Liouville's theorem, The fundamental theorem of algebra.

UNIT-2 Taylor's theorem, Maximum modulus principle, Schwarz lemma, Laurent's series, Isolated singularities, Residues, Cauchy's residue theorem, Evaluation of integrals, Branches of many valued functions with arg z, log z, and z^a.

UNIT-3 Meromorphic functions, The argument principle, Rouche's theorem, Inverse function theorem.

UNIT-4 Bilinear transformations and their properties and classification, Definition and examples of conformal mappings.

Books Recommended:

1. B. Choudhary: Elements of Complex Analysis, Wiley Eastern Ltd., New Delhi, 1993.
2. J.B. Conway: Functions of one Complex variavle, Springer-Verlag, International Student-Edition, Narosa Publishing House, 1980.

SYLLABUS

M.A./M./Sc. Ist SEMESTER

FUNCTIONAL ANALYSIS : MMM-7006

UNIT-1 Normed spaces, Banach spaces and examples, Incomplete normed spaces, completion of normed linear spaces, some properties of Banach spaces, Open and Closed spheres in normed spaces, Quotient spaces of normed linear spaces and its completion.

UNIT-2 Finite dimensional normed spaces and subspaces, Equivalent norms, Compactness and finite dimension, Riesz's lemma, Topological properties of normed spaces.

UNIT-3 Bounded linear operators and bounded linear functions and their norms and properties, Dual spaces and their examples, Reflexive normed spaces and different kinds if topologies (weak topology, weak topology etc.), Properties of reflexive normed spaces, weak convergence and strong convergence (convergence in norm), Geometric properties of normed spaces.

UNIT-4 Hahn-Banach theorems and their consequences (Analytic and Geometric forms), Uniform boundedness principle and its applications, Open mapping and closed graph theorems and their consequences, Banach contracliar theorem with its applications, Solvability of linear equations in Banach spaces, The closed range theorem.

Books Recommended:

1. E. Kreyazig: Introductory Functional Analysis with Applications, John Wiley, 1978.
2. M. Thumban Nair: Functional Analysis: A First Course, Prentice Hall of India, New Delhi, 2002.

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SYLLABUS

M.A./M./Sc. Ist SEMESTER

ORDINARY DIFFERENTIAL EQUATIONS : MMM-7007

UNIT-1 Introduction, initial value problem, boundary value problem, linear dependence equations with constant as well as variable coefficient, Wronskian, variation of parameter, method of undetermined coefficients, reduction of the order of equation, method of Laplace's transform.

UNIT-2 Lipchilz's condition and Gron Wall's inequality, Picards theorems, dependence of solution on initial conditions and on function, Continuation of solutions, Non-local existence of solutions Systems as vector equations, existence and uniqueness of solution to systems and existence and uniqueness of solution for linear systems.

UNIT-3 Introduction, Strum-Liouvilles system, Green's function and its applications to boundary value problems, some oscillation theorems such as Strum theorem, Strum comparison theorem and related results.

UNIT-4 Introduction, System of first order equation, fundamental matrix, Non-homogeneous linear system, Linear system's with constant as well as periodic coefficients.

Books Recommended:

1. E.A. Coddington: An introduction to Ordinary Differential Equations, Prentice Hall of India, New Delhi, 1991.
2. S.C. Deo, Y. Lakshminathan and V. Raghavendra: Text Book of Ordinary Differential Equation (Second Edition) Tata McGraw Hill, New Delhi (Chapters IV, VII and VIII).

Reference Books:

1. P. Haitman: Ordinary Differential Equations, Wiley, New York, 1964.
2. E.A. Coddington and H. Davinson: Theory of Ordinary Differential Equations, McGraw Hill, NY, 1955.

SYLLABUS

M.A./M./Sc. IInd SEMESTER

LINEAR ALGEBRA AND FIELD THEORY : MMM-8001

UNIT-1 Vector spaces, subspaces, examples, Linear dependence, Basis and dimension, Direct sums and complements, Matrices and change of Basis.

UNIT-2 Linear Transformations, Algebra of linear transformations, Dual spaces, rank nullity of linear transformations, Inner product spaces, orthonormal basis, Orthogonality, Schwartz inequality, Eigen values, Eigen vectors.

UNIT-3 Extensions, Algebraic extensions, Splitting fields, normal extensions, multiple roots, finite fields and separable extensions.

UNIT-4 Automorphism groups and fixed fields, Fundamental Theorems of Galois Theory, Fundamental Theorem of Algebra.

Books Recommended:

1. I.N. Herstein: Topics in Algebra
   Unit I and II: Sections- 4.1, 4.2, 4.3, 4.4, 6.1, 6.2

2. S.Singh and Qazi Zameeruddin: Modern Algebra
   Unit III and IV: relevant article of Chapters 13 and 14

Reference Books:

1. I.T. Adamson: Field Theory

SYLLABUS

M.A./M./Sc. IInd SEMESTER

MEASURE THEORY : MMM-8002

UNIT-1 Lebesgue outer measure, Measurable and non-measurable sets measurable functions, Borel Lebesgue measureablity.

UNIT-2 Measure and outer measure, Extensions of a measure, Uniqueness of extension, Completion of measure, integration of non-negative functions, the general integral.

UNIT-3 Riemann and Lebesgue integrals, The four derivatives, Lebesgue differentiation, The differentiation and integration, Measure spaces, Convergence in measure.

UNIT-4 The L^p-spaces, Convex functions, Jensen's inequality, Holder and Minkowski inequalities, Completeness of L^p.

Books Recommended:

1. H.L. Royden: Real Analysis, Macmillan, 1993.
2. P.R. Halmos: Measure Theory, Van Nostrand, Princeton, 1950.

Reference Books:

1. Inder .K. Rana: An Introduction to Measure and Integration, Narosa, 1997.
2. P.K. Jain and V.P. Gupta: Lebesgue Measure and Integration, New Age International, 1986.

SYLLABUS
M.A./M./Sc. IInd SEMESTER
TOPOLOGY-II : MMM-8003

UNIT-1 Urysohn Metrization Theorem, Partitions of unity, local finiteness, The Nagota Metrization Theorem, para-compactnes, The Smirnov Metrization Theorem.

UNIT-2 Nets and filters, topology and convergence of nets, Hausdorffness and nets, compactness and nets, filters and their convergence, canonical way connecting nets to filters and vice-versa, Ultra filters and compactness.

UNIT-3 Homotopy, relative homotopy, path homotopy, homotopy classes, construction of fundamental groups for topological spaces and its properties.

UNIT-4 Covering maps, local homomorphism, covering spaces, lifting lemma, The fundamental group of circle, Torus and punctured plane, The fundamental Theorem of Algebra.

Books Recommended:

(A) For Units I, III and IV:

1. Topology, A first course by J.M. Munkres 1987, (relevant portion)

(B) For Units II: (relevant portions of the following books)

2. Elementary Topology by M.C. Gemignani
3. Elementary General Topology by Jheral O. Moore
4. Topology by J. Dugundji
5. Topology by Sheldon W. Daves
6. Topology by H. Schubert

SYLLABUS

M.A./M./Sc. IInd SEMESTER

ADVANCED COMPLEX ANALYSIS : MMM-8004

UNIT-1 Weierstrass factorization theorem, Gamma function and its properties, Riemann Zeta function, Riemann's functional equation, Runge's theorem, Mittang-Leffler's theorem.

UNIT-2 Analytic continuation, Uniqueness of direct analytic continuation, Uniqueness of analytic continuation along a curve, Power series method of analytic continuation, Power series method of method of analytic continuation, Schwarz reflection principle.

UNIT-3 Monodromy theorem and its consequences, Harmonic functions on a disk, Harnack's inequality and theorem, Dirichlet problem, Green's function.

UNIT-4 Canonical products, Jensen's formula, Poisson-Jensen formula, Hadamard's three circles theorem, Order of an entire function, Exponent of convergence, Borel's theorem, Hadamdard's factorization theorem.

Books Recommended:

1. B. Choudhary: Elements of Complex Analysis, Wiley Eastern Ltd., New Delhi, 1993.
2. J.B. Conway: Functions of one Complex variavle, Springer-Verlag, International Student-Edition, Narosa Publishing House, 1980.
3. L.V. Ahlfons: Complex Analysis, McGraw Hill, 1979,
4. M. Heins: Complex Function Theory, Academic Press, 1968.
5. Walter Rudin: Real and Complex Analysis, McGraw Hill Book Co., 1966.
6. E.C. Titchmarch: The Theory of Functions, Oxford University Press, London
7. S. Ponnuamy: Foundation of Complex Analysis, Narosa Publishing House, 1999.

SYLLABUS

M.A./M./Sc. IInd SEMESTER

PARTIAL DIFFERENTIAL EQUATIONS : MMM-8005

UNIT-1 Classification of seconds order partial differential equation, Laplace's equation solution by the method of separation of variables, Fourier series solution, Applications to two dimensional heat flow, Mean value formulas, Properties of Harmonic functions, Green's functions.

UNIT-2 Heat equation-solution by the method of separation of variables, Fourier series solution, Applications to one dimensional heat flow, Mean value formula, Properties of solutions.

UNIT-3 Wave equation-solution by the method of separation of variables, Fourier series solution, Solution by spherical means and Riemann method of solution, Applications to vibration of strings..

UNIT-4 Numerical solution of partial differential equations, The wave equation, One dimensional heat flow and Laplace's equation.

Books Recommended:

1. Elements of Partial Differential Equations by I.N. Sneddon, McGraw Hill Book Company, 1957.
2. Partial Differential Equations by Phoolan Prasad and Renuka Ravindran, Wiley Eastern Limited, 1987.
3. Numerical Methods in Science and Engineering by M.K. Venkatraman, The national Publ. Company, 1990.
4. Calculus of Variations by I.M. Gelfand and S.V. Formin, Prentice Hall, Inc., 1963.
5. Partial Differential Equations by L.C. Ivans, M Graduate Studies in Mathematics, Volume 19, AMS, 1968

SYLLABUS

M.A./M./Sc. IInd SEMESTER

DIFFERENTIAL GEOMETRY-I : MMM-8006

UNIT-1 Charts, Atlases, Manifolds, Differentiable structure on a manifold, Smooth maps, Tangent vectors and Tangent space.

UNIT-2 Vector fields, Lie product of Jacobian of a smooth map, Integral curves on a manifold, One parameter group of a transformation.

UNIT-3 Cotangent spaces, pullback of l-form, Tensor fields, Differential forms, Exterior product and derivative, Exterior algebra.

UNIT-4 Connexion, parallelism, Geodesic, Covariant differentiation Torsion, Curvature, Structure equation of Cartan, Bianchi identities.

Books Recommended:

1. Differentiable Manifolds: K. Matsushima.
2. Lecture Notes on Differentiable Manifolds: S.I. Husain

SYLLABUS
M.A./M./Sc. IIIrd SEMESTER
FUNCTIONAL ANALYSIS : MMM-9001

UNIT-1 Inner product spaces, Hilbert spaces, Schwartz and triangle inequalities, Orthogonality, Orthogonal complements and projection, Projection theorem, Orthogonal and Orthonormal sets and sequences, Bessel's inequality, Total Orthonormal set, Parseval's formula.

UNIT-2 Separability, Separable Hilbert spaces, Riesz Representation, Theorem (Functional on Hilbert spaces), Sesquilinear form, Riesz Fisher Theorem, Reflexivity of Hilbert spaces, Bilinear form, Lax-Milgram Theorem and related results.

UNIT-3 Adjoint of bounded linear operators on a Hilbert space, Hilbert adjoint operator, Self adjoint, Unitary and normal operators, Spectral properties of bounded Self-adjoint linear operators and Hilbert-adjoint operators.

UNIT-4 Compact operators, Eigen-value of an operator, Spectrum point, continuous and residual spectrums, Spectral properties of bounded linear operators, Spectral radius.

Books Recommended:

1. E. Kreyazig: Introductory Functional Analysis with Applications, John Wiley, 1978.
2. M. Thumban Nair: Functional Analysis: A First Course, Prentice Hall of India, New Delhi, 2002.

SYLLABUS

M.A./M./Sc. IIIrd SEMESTER

THEORY OF RINGS AND MODULES : MMM-9002

UNIT-1 Definition and simple properties of rings, ideals in complete matrix rings, subdirectly irreducible rings, Boolean rings.

UNIT-2 Rings and modules or quotient, Extension and contraction of ideals, local rings, Localization of a ring at a prime ideal, Properties of rings of quotients.

UNIT-3 Modules and submodules, sum and intersection of submodules, Linear combinations and spanning set, Homomorphisms, Isomorphisms Theorems, Inverse image of submodules, Annihilator, Order of elements.

UNIT-4 Direct summands, split homomorphisms, projections, idempotent endomorphisms, essential and superfluous submodules, semi-simple modules, socle and radical of modules, basis and rank free modules.

Books Recommended:

1. Neal H. McCoy: Theory of Rings.
2. Anderson and Fuller: Rings and Categories of Modules.

SYLLABUS
M.A./M./Sc. IIIrd SEMESTER
MECHANICS : MMM-9003

UNIT-1 General force system, euipollent force system, equilibrium conditions, Reduction of force systems, couples, moments and wrenches, Necessary and sufficient conditions of rigid bodies, General motion of rigid body, Moments and products of inertia and their properties, Momental ellipse, Kinetic energy and angular motion of rigid bodies.

UNIT-2 Moving frames of references and frames in general motion, Euler's dynamical equations, Motion of a rigid body with a fixed point under no force, Method of pointset Constraints, Generalized coordinates, D'Alembert's principle and Lagrange's equations, Applications of Lagrangian formulation.

UNIT-3 Hamilton's principle, Techniques of calculus of variations, Lagrange's equations through Hamilton's principle, Cyclic coordinates and conservation theorems, Canonical equations of Hamilton, Hamilton's equations from variational principle, Principle of least action.

UNIT-4 Galilean transformation, Postulates of special relativity, Lorentz transformation and its consequences, Length contraction, Time dilation, Addition of velocities, variation of mass with velocity, Equivalence of mass and energy, Four dimensional formalism, Relativistic classification of particles, Maxwell's equations and their Lorentz invariance.

Books Recommended:

1. J.L. Synge and B.A. Griffith: Principle of Mechanics, McGraw-Hill Book Company (1970) (relevant portion only).
2. H. Goldstein: Classical Mechanics: Second Edition, Narosa Publishing House (1980), (relevant portion only).
3. Zafar Ahsan: Lecture Notes on Mechanics, Department of Mathematics, AMU, (1999), (Chapters III-VI).

SYLLABUS

M.A./M./Sc. IIIrd SEMESTER

DIFFERENTIAL GEOMETRY-II : MMM-9004

UNIT-1 Partition of unity, paracompactness, Riemannian matrix of a paracompact manifold, First fundamental form on a Riemannian manifold, Riemannian connexion, Riemannian curvature, Ricci and scalar curvature.

UNIT-2 Immersion, Imbedding, Distribution, Submanifold, Submanifold of Riemannian manifold, Sypersurfaces, Gauss and Weingarten formulae, Equation of Gauss, Coddazi and Ricci.

UNIT-3 Complex and almost manifolds, Nejenhuis tensor and integrability of a structure, Almost Hermitian, Kaehler and nearly Kaehler manifolds, Almost contact and Sasakian manifolds.

UNIT-4 Submanifolds of almost Hermitian manifolds, Invariant and Anti- Invariant distributions of a Hermitian manifold, C.R.-submanifolds of Kaehler and nearly Kaehler, Generic and slant submanifolds of Kaehler manifold.

Books Recommended:

1. Riemannian Geometry: R.S. Mishra
2. Geometry of Submanifolds: B.Y. Chen
3. Foundation of Geometry (Volume I): S. Kobayashi and K. Nomizu
4. Lecture Notes on Differentiable Manifolds: S.I. Husain

SYLLABUS

Optional M.A./M./Sc. IIIrd SEMESTER

ALGEBRAIC STRUCTURES : MMM-9011

Total Lectures: 48

UNIT-1 **Lattices (12 Lectures)**

Partially order sets, Lattices, Modular Lattice, Schreier's theorem, The chain conditions, Decomposition theorem for lattices with ascending chain condition, Independence, Complemented modular lattices, Boolean Algebras.

UNIT-2 **Modules and Ideals (12 Lectures)**

Generators, Unitary Modules, Chain conditions, Hilbert Basis Theorem, Noetherian Rings, Prime and Primary ideals, Representation of an ideal as intersection of primary ideals, Uniqueness Theorems, Integral dependence.

UNIT-3 **Lie and Jordan Structures in Rings (12 Lectures)**

Lie and Jordan ideals in ring R, Jordan simplicity of ring R, Lie structure of [R, R], Subring fixed by automorphism, Simple rings with involutions, Involution of second kind, Skew elements and related results.

UNIT-4 **Homomorphisms and Derivations (12 Lectures)**

Jordan Homomorphisms onto Prime rings, n – Jordan mappings, Derivations, Lie Derivations and Jordan derivations, Some results of Martindale, Herstein theorem on Jordan derivation.

Books Recommended:

1. Lectures in Abstract Algebra by Nathan Jacobson
2. General Lattice Theory by George Gratzer
3. Topics in Rings Theory by I.N. Herstein
4. Rings with Involutions by I.N. Herstein

SYLLABUS

Optional M.A./M./Sc. IIIrd SEMESTER

THEORY OF SEMIGROUPS & NONCOMMUTATIVE RINGS: MMM-9019

Total Lectures: 48

UNIT-1

Basic definitions, group with zero, monogenic semigroups, ordered sets, semilattices and lattices, binary relations, equivalence.

UNIT-2

Congruences, free semigroups and monoids, presentation of semigroups, ideals and Reas congruences, lattices of equivalences and congruences.

UNIT-3

Wedderburn-Artin Theory, Basic terminology and examples, Jacobson radical theory, Some commutativity problems in rings, Wedderburn Theorem on finite division rings, Jacobson's theorem, Jacobson Herstein Theorem, Kaplansky Theorem.

UNIT-4

Rings of quotients, Goldie rings, Ore domains, Prime Goldie rings, First Goldie theorem, faith Utumi theorem, Semi prime Goldie rings, Prime left ideal rings, Nil rings satisfying ascending chain conditions, Nil Goldie rings

Books Recommended:

1. J.M. Howie: Fundamental of Semigroup Theory (Clarendon Press).
2. R. Keown: An Introduction to Group Represntation Theory (Academic Press).

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Books Recommended:

1. T.Y. Lam: A First Course in Non-commutative rings.
2. I.N. Herstein: Topics in Rings Theory, University of Chicago Press, Chicago.

SYLLABUS

Optional M.A./M./Sc. IIIrd SEMESTER

LINEAR APPROXIMATION AND WAVELET ANALYSIS: MMM-9017

Total Lectures: 48

LINEAR APPROXIMATION

UNIT-1

Basic notion, Linear operator, nth partial sum of Fourier series, Arithmetic mean of the sums, Fejer theorem, Approximation theorems and their generalization, Existence of polynomials of best approximation, Characterization of polynomials of best approximation, Kolmogorov theorem.

UNIT-1I

Convexity and its applications, Convex hull, Hyperplane, Theorems on convex hull and best approximation, Revlin and Shapiro theorem, Chebyshev systems, Uniqueness of polynomials of best approximation, Chebyshev polynomials, Bernstein theorem on the degree of approximation by algebraic polynomioals, Inequalities of Bernstein and Markov, Modulii of continuity and smoothness.

WAVELET ANALYSIS

UNIT-1 (Gabor and Wavelet Transform)

Fourier and inverse Fourier transform, Parseval identity, Convolution, Dirac delta function, Gabor transform, Gaussian function, Centre and width of Gaussian function, Time-frequency window of Gabor transform, Advantages in using Gabor transform, time frequency window of wavelets, Discrete wavelet transform, Haar wavelet ψ and its Fourier transform, Wavelets by convolution, Mexican hat wavelet, Morlet wavelet.

UNIT-2 (Multiresolution Analysis and Construction of Wavelets)

Parseval theorem of wavelet transform, Inversion formula of wavelets, Multiresolution Analysis, Decomposition and reconstruction algorithm, Applications of wavelets, Filter coefficients and their properties, Wavelets and Fourier transform, Orthonormality in frequency domain, Construction of wavelets, Numerical evaluation of scaling function and wavelets.

Books Recommended:

1. G.G. Lorentz: Approximation of Functions, Holt Rinechart and Winston, New York, 1966.
2. C.K. Chui: An Introduction to Wavelets, Academic Press, New York, 1992.

Reference Book:

1. Huzoor H. Khan: Lecture Notes on Approximation Theory, 1997.
2. I. Daubechies: Ten Lectures on Wavelets, CBS-NSF Regional Conferences in Applied Mathematics, SIAM, Phildelphia, 1992.
3. Y. Meyer: Wavelets: Algorithms and Applications, SIAM, Phildelphia, 1993.
4. M.V. Wickerhauser: Adapted Wavelets Analysis from Theory to Software, A.K. Peters Ltd., Wellesley, 1994.

SYLLABUS

Optional M.A./M./Sc. IIIrd SEMESTER

NONLINEAR FUNCTIONAL ANALYSIS: MMM-9018

Total Lectures: 48

UNIT-1

1. **A Brief Introduction:** Topological Vector Spaces, Locally Convex Spaces and their Basic Results and Concepts.
2. **Geometry of Banach Spaces:** Convexity of Banach Spaces, Duality mappings, Differentiability of norms, (Sections 4.1, 4.2, 4.3 from Takahashi [2]).
3. **Fixed Point Theorems:** Banach contraction principle and its extensions; Takahashi's minimization theorem, Ekeland variational principle, Caristi's fixed point theorem.
4. **Multivalued maps:** Definitions and Examples; lower and upper semicontinuity, Hausdorff metric; Nadler's fixed point theorem

UNIT-2

5. **The Method of Successive Approximation:** The iteration process for continuous functions, The Mann iterative process, The sequence of iterates of nonexpansive mappings, Browder fixed point theorem.

Variational Inequalities: Introduction of variational inequalities, Projection method, Lions-Stampacchia theorem, Iterative methods for variational inequalities.

Books Recommended:

1. S.P. Singh, B. Watson and P. Srivastava, Fixed Point Theory and Best Approximation: The KKM-map Principle, Kluwer Academic Publishers, Dordrecht / Boston / London, 1997, ISBN 0-7923-4758-7.
2. W. Takahashi, Nonlinear Functional Analysis: Fixed Point Theory and its Applications, Yokohama Publishers, Yokohama, Japan, 2000, ISBN 4-946552-04-9.

Reference Book:

1. V.I. Istratescu, Fixed Poin Theory: An Introduction, D. Reidel Publishing Company, Dordrecht / Boston / London, 1981, ISBN 90-277-1224-7.
2. M.A. Khamsi and W.A. Kirk: Metric Fixed Point Theory, Academic Press, New York.

SYLLABUS

M.A./M./Sc. IV SEMESTER

HOMOLOGICAL ALGEBRA AND MODULE THEORY : MMM-X001

UNIT-1 Direct product and Direct sum of modules, Free modules, Annihilation, Chain conditions, Noetherian modules, Artinian modules.

UNIT-2 Exact sequences, Short exact sequences, Splitting sequences, The Four lemma, The Five Lemma, Semi-Exactness, Tensor Product of modules.

UNIT-3 Modules of Monomorphisms, Homomorphisms of modules of Homomorphisms and their effect on exactness, Projective modules, Connection between Projective and free modules, Direct sum of projectives.

UNIT-4 Injective modules, Character modules of free modules, Connections to injectivity, Maximal essential extensions, Modules with composition series, Jordan_Holder Theorem, Composition length.

Books Recommended:

1. S.T. Hu: Introduction to Homological Algebra.
2. F.W. Anderson and K.R. Fuller: Rings and Categories of Modules.
3. J. Lamback: Lectures on Rings and Modules

SYLLABUS

M.A./M./Sc. IVth SEMESTER

INTEGRATION THEORY : MMM-X002

UNIT-1 Review of Lebesgue – integration, Measure spaces, Measurable functions, general convergence theorems and convergence in measure signed measure, Hahn decomposition theorem, mutually singular measure.

UNIT-2 Radon measure, Radon-Nikodym derivative, Radon-Nikodym theorem, Lebesgue decomposition, Riesz representation theorem on L_p spaces, The outer measure and measurability, The extension theorem, Lebesgue-Stiellges integral.

UNIT-3 Product measures, integration on product measures, Fubini's theorem, Inner measure, Carotheodery outer measure space.

UNIT-4 Borel sets and Baire sets, Regularity of measures on locally compact spaces, Generation of Borel measure, Regular contents, Classes of continuous functions with compact support and linear functionals.

Books Recommended:

1. H.L. Royden: Real Analysis, Macmillan, 1993.
2. P.R. Halmos: Measure Theory, Van Nastrand, Princeton, 1950.

Reference Books:

1. Inder .K. Rana: An Introduction to Measure and Integration, Narosa, 1997.
2. P.K. Jain and V.P. Gupta: Lebesgue Measure and Integration, New Age International, 1986.

SYLLABUS

M.A./M./Sc. IVth SEMESTER

CATEGORY THEORY & INFINITE ABELIAN GROUPS : MMM-X018

UNIT-1 Definition and examples of a category, small category, sub-category, full sub-category, dual category, monomorphism, epimorphism, bimorphism, section, retraction, isomorphism, balanced category, Initial object, terminal object, zero object connected category, Products and coproducts, Equalizers and coequalizers, Pullbacks and Pushouts, Intersection.

UNIT-2 Factorization of morphisms, kernel and cokernel of a morphism, normal, conormal and binormal category, Exact sequence semi additive and additive category, Abelian category, Functors, covariant and contravariant Functors, Natural transformation.

UNIT-3 Maps and diagrams, Direct sums and Direct Products, Direct summands, Free abelian groups, Projective groups, Finitely generated groups.

UNIT-2 Divisibility, Injective groups, The structure of divisible groups, The divisible hull, Purity, Bounded pure subgroups, Quotient groups module Pure subgroups.

Books Recommended:

1. T.S. Blyth: Categories.
2. B. Pareiars: Categories and Functors.

Reference Books:

1. Mitchell: Theory of Categories.
2. Freyd: Abelian Categories.

Books Recommended:

3. Infinite Abelian groups by Laszle Fuchs, Vol. 1, Academic Press, New York.

SYLLABUS

M.A./M./Sc. IVth SEMESTER

RELATIVITY THEORY AND SPECIAL FUNCTIONS: MMM-X020

UNIT-1 **(Lectures 10)**

Tensor Algebra of tensors: Inner and outer products, Symmetric and anti symmetric tensors, contraction of tensors, Quotient law, Riemannian metric, Christoffel symbols, Geodesic covariant derivatives, Divergence and curl of tensors, Riemann curvature tensor, Ricci tensor and their properties, Bianchi identities, Einstein tensor.

UNIT-2 **(Lecture 14)**

Postulates and hypothesis of general relativity, Principles of equivalence and covariance, Einstein field equations and Newtonian approximation, Schwarzchild exterior solution, Planetary orbits, Advance of perhilion, Bendine of light ray in a gravitational field, Energy-momentum tensor and Schwarzchild interior solution, Cosmological model, Einstein and De Sitter cosmological models and their properties.

UNIT-3

Introduction, Hypergoemtric functions: Definition and special cases, convergence, integral representation, differentiation, transformations and summation theorems, Bessel functions: Definition, connection with hypergeometric function, differential and pure recurrence relations, generating function, integral representation.

UNIT-4

Hermite polynomials: Definition, generating function, special values, differential and pure recurrence relations, differential equation, Rodrigues formula, Orthogonality, Lie groups, Lie bracket, Lie algebra, general linear group GL(2) and special linear group SL(2) and their Lie algebras, Laguerre polynomials: Construction of partial differential equation, linear differential operators, group of operators, extended form of the group generated by the operators, generating functions.

Books Recommended:

1. Zafar Ahsan and Shahid Ali: Lecture Notes on Relativity, Dept. of Mathematics, AMU., 1994.
2. R. Adber, M. Cazin and M. Schiffer: Introduction to General Relativity, McGraw Hill Inc., 1975.
3. S. Weinbeig: Gravitation and Cosmology, John Wiley and Sons, 1972.

Books Recommended:

1. E.D. Rainville: Special Functions, Macmillan Company, New York, 1960.
2. W. Jr. Miller: Lie Theory and Special Functions, Academic Press, New York and London, 1968.
3. E.B. Mcbride: Obtaining Generating Functions, Springer Verlag, Berlin Heidelberg, 1971.
4. M.A. Pathan, P.K. Banerjee and M.C. Goyal: Special Functions and Calculus of Variations, Ramesh Book Depot, Jaipur, India, 2003.

SYLLABUS

M.A./M./Sc. IVth SEMESTER

SEQUENCE SPACES : MMM-X019

UNIT-1

Classical sequence spaces, Separability, Reflexivity and other properties, Linear metric spaces and paranormed spaces, Sequence spaces of Maddox.

UNIT-2

Frechet spaces, FK-spaces and BK spaces, Schauder basis and AK-property, Continuous, Kothe-Toeplitz and generalized Kothe-Toeplitz duals of various sequence spaces.

UNIT-3

Matrix transformations, Regular, Conservative and Schur matrices, Some other matrix transformations of classical sequence spaces.

UNIT-4

Strong and weak convergence and Schur property, Continuous and compact linear operators and their applications in matrix transformations.

Books Recommended:

1. Element of Functional Analysis by I.J. Maddox, Cambridge University Press (1970) and (1988).
2. Elements of Metric Spaces by Mursaleen, Anamaya Publ. Company, 2005.

SYLLABUS

M.A./M./Sc. IVth SEMESTER

NON-COMMUTATIVE RINGS-MMM-X017

UNIT-1

Wedderburn-Artin Theory, Basic terminology and examples, Jacobson radical theory, Some commutativity problems in rings, Wedderburn Theorem on finite division rings, Jacobson's theorem, Jacobson Herstein Theorem, Kaplansky Theorem.

UNIT-2

Rings of quotients, Goldie rings, Ore domains, Prime Goldie rings, First Goldie theorem, faith Utumi theorem, Semi prime Goldie rings, Prime left ideal rings, Nil rings satisfying ascending chain conditions, Nil Goldie rings.

Books Recommended:

1. T.Y. Lam: A First Course in Non-commutative rings.
2. I.N. Herstein: Topics in Rings Theory, University of Chicago Press, Chicago.

M.Phil. (Mathematics) SYLLABUS

1. Algebra

Part – A: Symmetric groups, alternative groups, Simple groups, Conjugate elements, Class equations of finite groups, Sylow theorems, Solvabale groups, Jordan Holder theorems, nilpotent groups, direct product, structure theorems of finite abelian groups, Rings, Maximal ideals, Prime ideals, Integral domains, Euclidean domains, Principal ideals domains, Polynomial rings, Modules and isomorphism theorems, Injective and Projective modules and Krull-Schmidt theorem.

Part – B: Vector space, Basic and dimensions, linear transformations, Dual spaces rank of linear transformation and matrices, Bilinear forms, Quadratic forms, characteristic roots and vectors, Caley-Hamilton theorem, invariant subspaces, algebra of linear transformation, Reduction of matrices to canonical forms, inner-product spaces and orthogonality, Quotient fields, finite fields, characteristic of a field, Elements of Galois theory, Solvability by radicals, Ruler and compass construction.

Books:

1. T. Lam: Lectures of Modules and Rings
2. I. Herstein: Topics in Algebra
3. P. Bhattacharya, S. Jain and Nagpaul: Basic Abstract Algebra (2^{nd} Edition)
4. N. Jacobson: Lectures in Abstract Algebra
5. S. Singh and Q. Jameeruddin: Modern Algebra
6. S. Sharma: Modern Algebra
7. Anderson and Fuller: Rings and Categories of Modules, 2^{nd} Edition (Springer- Verlag)

2. Functional Analysis

Part – A: Normal linear spaces, Banach spaces, Series in normal spaces, Function spaces, sequence space, L^p-space, Completion of L^p, Holder and Minkowsky inequalities, Uniform boundness principle, Banach-Steinhans Theorem, Open mappings and closed graph theorems, Hahn-Banch extension theorem and their applications.

Part – B: Inner product spaces, Hilbert spaces, Orthonormal sets, Bessel's inequality, Complete orthonormal sets and Parseval's identity, structure of Hilbert spaces, projection theorem, Riesz representation theorem, adjoint of an operator on Hilbert spaces, Reflexivity of Hilbert spaces, Self-adjoint operators, Positive, Projection normal and unitary operators, The generalized Lax-Milgram Theorem.

Books:

1. B. Kreyszig: Functional Analysis
2. I.J. Maddox: Elements of Functional Analysis

3. Discrete Mathematics

Partially ordered sets, Lattices, Complete lattices, Distributive lattices, Complement, Boolean Algebra, Boolean Expressions, Applications to switching circuits, Elements of graph Theory, Eulerian and Hamiltonian graphs, Planer Graphs, Discrete Graphs, Trees, Permutation and Combinations, Pigenhole principle of inclusion and Exclusion, Derangements.

Books:

1. J. P. Trembley and R. Manohar: Discrete Mathematical Structure with Applications to Computer Science, McGraw-Hill Book Co., 1997.
2. J. I. Gersting: Mathematical Structures of Computer Science (3rd Edition), Computer Science Press, New York.
3. Seymour Lepschutz: Finite Mathematics (International Edition 1983), McGraw-Hill Book Co., New York.
4. S. Wutala: Discrete Mathematics A United Approach, McGraw-Hill Book Company.
5. G. L. Lin: Elements of Discrete Mathematics, McGraw-Hill Book Company.

4. Mathematical Programming

Part – A: Feasible, Basic feasible and optimal solutions, Extreme points, Some basic properties of convex sets, convex and concave functions, Simple method, Big-M Method, Two Phase method, Degencracy, Alternative optima, unbounded and infeasible solutions, Definition of dual problem, Relationship between the optimal primal and dual solutions, Economic Interpretation of Duality, Dual Simplex Method, Primal – Dual Computations.

Part – B: Formulation of Transportation Problem (T.P.), Special features of T.P., Methods of selection of an initial basic feasible solution to a T.P., Optimal solution of T.P., Formulation of Assignment Problem (A.P.) and Hungarian method of solution, Optimal solution of Two- person, zero sum games, Solution of Mixed strategy games.

Books:

1. H.A. Taha: Operation Research – An Introduction, Macmillan Publishing Co. Inc., New York.
2. S.C. Rao: Optimization Theory and Applications, Wiley Eastern Ltd., New Delhi.

SYLLABUS

M.A./M./Sc. IVth SEMESTER

INTEGRATION THEORY : MMM-X002

UNIT-1: Measure and Outer Measure

Set functions, Measurable space (finite, σ-finite and complete measure spaces), Measure outer measure, measurability, extension theorems including Cosatheodary Theorem, Competun theorem.

UNIT-2: Measurable Functions and Integration

Measurable functions (definitions examples and core results), Integration, (definition, examples and core results), Fatous Lemma, Monotone convergence theorems and Dominated convergence theorem, Lebesgue - Stiellges integral.

UNIT-3: Signed Measure

Signed measure, Hahn decomposition theorem, mutually singular measure, Radon measure, Radon Nikodym theorem, Lebesgue decomposition theorem, Reisz representation theorem on L^p-spaces.

UNIT-4: Inner Measure and Product Measure

Inner measure, Carotheodery outer measure space, Product measures, integration on product measures, Fubini's theorem.

Books Recommended:

1. H.L. Royden: Real Analysis, Macmillan, 1993.
2. D. Bor:

Reference Books:

1. Inder .K. Rana: An Introduction to Measure and Integration, Narosa, 1997.
2.