Faculty of Science

Semester Based Syllabus (w.e.f. 2018-19)

M.A./M.Sc. MATHEMATICS

Scheme of Examination

Semester	Peper	Marks
First	I -MAT 101 - Algebra – I	100
	II - MAT 102 - Real Analysis	100
	III - MAT 103 - Basic Topology	100
	IV - MAT 104 - Complex Analysis	100
	V - MAT 105 – Hydrodynamics	100
Second	I -MAT 201 - Algebra –II	100
	II - MAT 202 – Functional Analysis I	100
	III - MAT 203 – Measure & integration I	100
	IV - MAT 204 – Classical Mechanics	100
	V - MAT 205 – Mathematical Methods	100
Third	I -MAT 301 – Topology	100
	II - MAT 302 – Advanced Linear Algebra	100
	III - MAT 303 – Differential & Integral Equations	100
	IV - MAT 304 – Differential Geometry of Manifolds	100
	V – MAT 305 Operations Research	100
Fourth	I -MAT 401 – Functional Analysis II	100
	II - MAT 402 – Measure & Integration II	100
	III – MAT 403 – Complex manifolds & Contact manifolds	100
	IV- MAT 404 – Fluid Mechanics	100
	V – Viva Voce + Seminar + Project (Based on Theory Papers)	100
		70+20+10

SEMESTER – I

MAT 101 **ALGEBRA – I**

UNIT I: Action of a group G on a set S, Equivalent formulation as a homomorphism of G to T(S), Examples, Stabilizer (Isotropy) subgroups and Orbit decomposition, Class equation of an action, Its particular cases (left multiplication and conjugation), Conjugacy class equation, Core of a subgroup. Sylow's Theorem I, II and III,

UNIT II: Subnormal and normal series, Zassenhaus's lemma (Statement only)Schreier's refinement theorem, composition series, Jordan – Holder theorem, Chain conditions, Examples, Internal and External direct products and their relationship, Indecomposability. p–groups, Examples and applications, Groups of order pq.

UNIT III: Commutators, Solvable groups, Solvability of subgroups, factor groups and of finite p – groups, Examples, Lower and upper central series, Nilpotent groups and their equivalent characterizations.

UNIT IV: Factorization theory in commutative domains, Prime and irreducible elements, G.C.D., Euclidean domains, Maximal and prime ideals, Principal ideal domains, Unique factorization domains, Examples and counter examples, Chinese remainder theorem for rings and PID's, Polynomial rings over domains, Eisenstein's irreducibility criterion, Unique factorization in polynomial rings over UFD's.

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, Hindustan Publishing Co, New Delhi, 1984.

4. Ramji Lal, Algebra, Vols. I & II, Shail Publications, Allahabad, 2002.

MAT 102 **REAL ANALYSIS**

UNIT I: Definition and existence of Riemann – Stieltjes integral, Conditions for R–S integrability. Properties of the R-S integral, R-S integrability of functions of a function Integration and differentiation, Fundamental theorem of Calculus.

Unit II: Series of arbitrary terms. Convergence, divergence and oscillation, Absolute Convergence, Abel's and Dirichilet's tests. Multiplication of series. Rearrangements of terms of a series, Riemann's theorem and sum of series, Sequences and series of functions.

Unit III: Pointwise and uniform convergence, Cauchy's criterion for uniform convergence, uniform convergence and continuity, uniform convergence and Riemann-Stieltjies integration, Uniform convergence and differentiation, Weierstrass approximation theorem, Power series. Uniqueness theorem for power series, Abel's and Tauber's theorems.

Unit IV: Functions of Several Variables, Linear transformations, Derivatives in an open subset of R^n Jacobian matrix and Jacobians, Chain rule and its matrix form, Interchange of order of differentiation, Derivatives of higher orders Taylor's theorem, Inverse function theorem, Implicit function theorem, Extremum problems with constraints, Lagranges multiplier method.

Books Recommended:

1- Walter Rudin, Principle of Mathematical Analysis (3rd edition) McGraw- Hill Kogakusha, 1976 International Student Edition.

2- T.M. Apostol, Mathematical Analysis, Narosa Publishing House, New Delhi, 1985.

3- S Lang, Analysis I and II, Addision-Wesley Pub. Co. 1969

MAT 103 BASIC TOPOLOGY

UNIT I: Definition and Examples of Metric spaces, Equivalent metrics, characterization of open sets in terms of open spheres, characterization of closed sets in terms of closed spheres, Countability of a metric space, Continuity of functions, Properties of continuous functions, Homeomorphisms.

UNIT II: Connectedness in metric spaces, Connected sets in the real line, Continuity and connectedness, Compactness, closed subset of a compact space, compact subset of a metric space, Continuity and compactness.

Unit III: Definition and examples of topological spaces. Closed sets. Closure. Dense sets. Neighborhoods, interior, exterior, and boundary. Accumulation points and derived sets. Bases and sub-bases. Subspaces and relative topology. Alternative methods of defining a topology in terms of Kuratowski closure operator and neighborhood systems.

Unit IV: Continuous functions and homeomorphism. First and second countable space. Lindelof spaces. Separable spaces. The separation axioms T_0, T_1, T_2, T_3, $T_{3\frac{1}{2}}$, T_4; their characterizations and basic properties. Urysohn's lemma, Tietze extension theorem.

Books Recommended:

1. J.L. Kelley, General Topology, Van Nostrand 1995.

2. K.D. Joshi, Introduction to General Topology, Wiley Eastern,1983.

3. James R. Munkres, Topology, 2nd Edition, Pearson Internationl, 2000.

4. J. Dugundji, Topology, Prentice-Hall of India, 1966.

MAT 104 COMPLEX ANALYSIS

UNIT I: Analytic continuation, uniqueness of analytic continuation, Natural Boundary, complete analytic functions , Power series method of Analytic continuation, Schwarz's Lemma, Inverse function theorem, Schwarz's reflection principle, Reflection across analytic arcs.

UNIT II: Residue at infinity, Cauchy's Residue theorem, Contour integration: Integral of the type $\int_{\alpha}^{2\pi+\alpha} [f(cos\theta, sin]\theta) d\theta$, Integral of the $type \int_{-\infty}^{+\infty} [f(x])dx$, Integral of the $type \int_{-\infty}^{+\infty} [g(x])cosmxdx$, Singularities on the real axis, Integrals involving branch points, Jordan's Lemma.

UNIT III: The Riemann mapping theorem, Behavior at the boundary, Picard' theorem, Borel theorem, Infinite Products, Jensen's formula, Poission –Jenson formula, Borel Cartheodory theorem.

UNIT IV: Entire Functions with Rational Values, The Phragmen-Lindelof and Hadamard Theorems, Meromorphic Functions, Mittag-Leffler Theorem, Weierstrass factorization theorem, Gama functions.

Books Recommended:

1. Serge lang, Complex Analysis, Fourth edition, Springer. (Chapters vii, ix-xii).

2. J. Bak and D.J. Newman, Complex Analysis, Springer.

3. J.B. Conway, Complex Analysis, Springer.

MAT 105 HYDRODYNAMICS

UNIT I: Equation of continuity, Boundary surfaces, streamlines, Velocity potential, Irrotational and rotational motions, Vortex lines, Euler's Equation of motion, Bernoulli's theorem, Impulsive actions.

UNIT II: Motion in two-dimensions, Conjugate functions, Source, sink, doublets and their images, Conformal mapping, Circle Theorem.

UNIT III: Two- dimensional irrotational motion produced by the motion of circular cylinder in an infinite mass of liquid, theorem of Blasius, Motion of Eliptic Cylinder.

UNIT IV: Motion of a sphere through a liquid at rest at infinity. Liquid streaming past a fixed sphere, Equation of motion of a sphere. Concentric Spheres.

Books Recommended:

1. W.H. Besant and A.S. Ramsey, A Treatise on Hydrodynamics, CBS Pub. Delhi, 1988.

2. S.W. Yuan, foundations of Fluid Dynamics, Prentice-Hall of India, 1988.

SEMESTER – II

MAT 201 ALGEBRA – II

UNIT I: Modules over a ring Endomorphism ring of an abelian group. R-Module structure on an abelian group M as a ring homomorphism form R to End M, Submodules, Direct summands, Homomorphism, Factor modules, Correspondence theorem, Isomorphism theorems, Exact sequences, Five lemma, Products, Coproducts and their universal property, External and internal direct sums.

UNIT II: 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, Baer's characterization,

UNIT III: Noetherian modules and rings, Equivalent characterizations, Submodules and factors of noetherian modules, Characteristic of a field, Prime subfields, Field extension, Finite extensions, Algebraic and transcendental extensions. Factorization of polynomials in extension fields, Splitting fields and their uniqueness.

UNIT IV: Separable field extensions, Perfect fields, Separability over fields of prime characteristic, Transitivity of separability, Automorphisms of fields, Dedekind's theorem, Fixed fields, Normal extensions, Splitting fields and normality, Normal closures, Galois extensions, extensions, Fundamental theorem of Galois theory.

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 Ltd., New Delhi, 1986.

5. T.W. Hungerford, Algebra, Springer (India) Pvt. Ltd., New Delhi, 2004.

6. Ramji Lal, Algebra, Vol. 2, Shail Publishing House, Allahabad, 2002.

MAT: 202 FUNCTIONAL ANALYSIS I

UNIT I: Normed linear spaces, Banach spaces, their examples including R^n , C^n , l_p^n , l_p , C[a,b] and topological properties, Holder's and Minkowski's inqualities, Subspaces, Quotient spaces of normed linear spaces and its completeness.

UNIT II: Continuous linear transformations, Spaces of bounded transformations, Continuous linear functional, Hahn Banach theorems(separation and extension), strict convexity and uniqueness of Hahn Banach extension , Banach Steinhous theorem, Uniform boundedness principle.

UNIT III: Closed graph theorem, Projection, Open mapping theorem, Bounded inverse theorem, Finite dimensional normed lnear spaces, Compactness, Equivalent norms, Bolzano Weistrass property.

UNIT IV: Duals of R^n , C^n ,l_p^n , l_p , C[a,b], weak and $weak^*$ convergence, Embedding and reflexivity, Uniform convexity and Milman theorem.

Books Recommended:

1.G.F.Simmons, Introduction to Topology and Modern Analysis, McGraw Hill, 1963

2.S.Ponnusamy, Foundation of Functional Analysis, Narosa Publishing House, New Delhi, 2002.

3.B.V.Limaye,Functional Analysis,New Age Int. Publisher ,Third Edition.

MAT 203 MEASURE AND INTEGRATION – I

UNIT I: Lebesgue outer and inner measure, Lebesgue measure on R, translation invariance of Lebesgue measure, existence of a non-measuable set, characterizations of Lebesgue measurable sets, Borel sets, Cantor-Lebesgure function.

UNIT II: Measurable functions on a measure space and their properties, Borel measurable functions, simple functions and their integrals, Lebesgue integral on R and its properties, Riemann and Lebesgue integrals.

UNIT III: Integral of non negative measureable function and of unbounded functions, Bounded convergence theorem, Fatou's lemma, Monotone convergence theorem, Lebesgue dominated convergence theorem.

UNIT IV: The L^p-space. Convex functions. Jensen's inequality, Holder and Minkowski inequalities, Completeness of L^p, Convergence in measure, Almost uniform convergence.

Books Recommended:

1- H.L. Royden and P.M. Fitzpatrick, Real Analysis, (Fourth edition), P.H.I, 2010.

2- P.R. Halmos, Measure Theory, Grand Text Mathematics, 14, Springer, 1994.

3- I.K. Rana, An Introduction to Measure and Integration, Narosa Publishing House, New Delhi, 2005.

4- E. Hewit and K. Stromberg, Real and Abstract Analysis, Springer, 1975.

MAT 204 CLASSICAL MECHANICS

UNIT I: The linear momentum and the angular momentum of a rigid body in terms of inertia constants, kinetic energy of a rigid body, equations of motion, examples on the motion of a sphere on horizontal and on inclined planes. Euler's equations of motion, motion under no forces, Eulerian angles and the geometrical equations of Euler.

UNIT II: Generalized co-ordinates, geometrical equations, holonomic and non-holonomic systems, configuration space, Lagrange's equations using D' Alembet's Principle for a holonomic conservative system, deduction of equation of energy when the geometrical equations do not contain time explicitly, Lagrange's multipliers case, deduction of Euler's dynamical equations from Lagrange's equations.

UNIT III: Theory of small oscillations, Lagrange's method, normal (principal) co-ordinates and the normal modes of oscillation, small oscillations under holonomic constraints,stationary property of normal modes, Lagrange equations for impulsive motion.

UNIT IV: Generalized momentum and the Hamiltonian for a dynamical system, Hamilton's canonical equations of motion, Hamiltonian as a sum of kinetic and potential energies, phase space and Hamilton's Variational principle, the principle of least action, canonical transformations, Hamilton-Jacobi theory, Integrals of Hamilton's equations and Poisson-Brackets, Poisson- Jacobi identity.

Books Recommended:

1. A.S. Ramsey, Dynamics, Part II, CBS Publishers & Distributors, Delhi, 1985.

2. H. Goldstein, Classical Mechanics, Addison-Wesley Publishing Company, London, 1969.

3. K. C. RANA AND P. C. JOAG, Classical Mechanics, Narosa. Pub.

MAT 205 MATHEMATICAL METHODS

UNIT I: (Fourier Series)

Periodic functions, Trigonometric series, Fourier series, Euler formulas, Functions having arbitrary periods, Even and odd functions, Half-range expansions, Determination of Fourier coefficients without integration, Approximation by trigonometric polynomials, Square error.

UNIT II: (Boundary-value problems and Transfoms) Orthogonal and Orthonormal sets of functions, Generalized Fourier series, Sturm-Liouville problems, Examples of Boundary-value problems which are not Sturm-Liouville problems, Definition, Existence and Linearity of Laplace Transform.

UNIT III: (Fourier Transform) Fourier Integrals, Fourier Cosine and Sine Integrals, Inverse Fourier Transform, Fourier Cosine and Sine Transform, Complex form of the Fourier Transform, Linearity of the Fourier Transform.

UNIT IV: Calculus of Variations: Functionals and extremals, Variation and its properties, Euler equations, Cases of several dependent and independent variables, Functionals dependent on higher derivatives, Parametric forms, Simple applications.

Books Recommended:

1. E. Kreyszing, Advanced Engineering Mathematics, Wiley India Pvt. Ltd, 8th Edition, 2001.

2. L. Elsgolts, Differential Equations and Calculus of Variations, Mir Publishers, 1970.

3. A.S. Gupta, Calculus of Variations, Prentice Hall of India, New Delhi, 1999.

4. J.H. Davis, Methods of Applied Mathematics with a MATLAB Overview, Birkhäuser, Inc., Boston, M.A., 2004.

SEMESTER – III

MAT 301 TOPOLOGY

Unit I: Compactness. Basic properties of compactness. Compactness and finite intersection property. Sequential, countable, and B-W compactness. Local compactness. One-point compactification. Connected spaces and their basis properties. Components. Locally connected spaces. Continuity and connectedness.

Unit II: Tychonoff product topology in terms of standard sub-base and its characterizations. Product topology and separation axioms, connected-ness, andcompactness (incl. the Tychonoff's theorem), product spaces.

Unit III: Homotopy of paths, the fundamental group, covering spaces, fundamental group of circle, punctured plane, n-sphere, figure 8 and of surfaces.

Unit IV: Essential and Inessential maps, equivalent conditions, Fundamental theorem of algebra, Vector fields and fixed points, Brouwer fixed point theorem for disc, Homotopy type and Jordan separation Theorem.

Books Recommended:

1. J.K. Kelley, General Topology, Van Nostrand, 1995

2. K.D. Joshi, Introduction to General Topology, Wiley Eastern, 1983.

3. James R. Munkres, Topology, 2nd Edition, Pearson International, 2000.

4. J. Dugundji, Topology, Prentice-Hall of India, 1966.

MAT 302 ADVANCED LINEAR ALGEBRA

UNIT I: Algebraic and geometric multiplicities of eigenvalues, Invariant subspaces, T-conductors and T-annihilators, Minimal polynormials of linear operators and matrices, Characterization of diagonalizability in terms of multiplicities and also in terms of the minimal polynomial, Triangulability, Simultaneous triangulation and diagonalization.

UNIT II: Submodules of finitely generated free modules over a PID, Torsion submodule, Torsion and torsion-free modules, Direct decomposition into T(M) and a free module, p-primary components, Decomposition of p-primary finitely generated torsion modules, Elementary divisors and their uniqueness, Decomposition into invariant factors and uniqueness, Direct sum decomposition of finite abelian groups into cyclic groups and their enumeration.

UNIT III: Reduction of matrices over polynomial rings over a field,Similarity of matrices and F[x]-module structure, Projections, Invariant direct sums, Characterization of diagonalizability in terms of projections, Primary decomposition theorem.

UNIT IV: Diagonalizable and nilpotent parts of a linear operator, Rational canonical form of matrices, Elementary Jordan matrices, Reduction to Jordan canonical form, Semisimple operators, Taylor formula.

Books Recommended:

1. K. Hofmann and R. Kunze, Linear Algebra Prentice Hall of India, New Delhi, 1972.

2. D.S. Dummit and R.M. Foote, Abstract Algebra, John Wiley & Sons, N.Y. 2003.

3. H. Helson, Linear Algebra, Hindustan Book Agency, New Delhi, 1994.

4. N. Jacobson, Basic Algebra, Vol. 1, Hindustan Publishing Co., New Delhi, 1984.

5. N.S. Gopalakrishnan, University Algebra, Wiley Easten, New Delhi, 1986.

6. T.W. Hungerford, Algebra, Springer (India), Pvt. Ltd., 2004.

7. C. Musili, Rings and Modules, Narosa Publishing House, New Delhi, 1994.

MAT 303 DIFFERENTIAL AND INTEGRAL EQUATIONS

UNIT I: Solution of differential equations in ascending and descending power series, Frobenius metod, Hpergeometric Differential equations, Pochhammer symbol, Hypergeometric Function, Solution of Gauss's Hypergeometric differential equation, Differentiation of Hypergeometric functions, Solution of Legendre's and Bessel's differential equation, Legendre's and Bessel's function.

UNIT II: Generating function for P_n (x), Laplace definite integrals for P_n (x), Orthogonal properties of Legendre's polynomials, Recurrence formulae, Beltrami result, Christoffel's expansion and summation formulae, Rodrigue's formula for P_n (x), Generating function for J_n (x) Recurrence formulae for J_n (x), Orthogonality of Bessel's function.

UNIT III: Method of separation of variables: Laplace, Diffusion and Wave equations in Cartesian, cylindrical and spherical polar coordinates, Boundary value problems for transverse vibrations in a string of finite length and heat diffusion in a finite rod, Classification of linear integral equations, Relation between differential and integral equations.

UNIT IV: Fredholm equations of second kind with separable kernels, Fredholm alternative theorem, Eigen values and eigen functions, Method of successive approximation for Fredholm and Volterra equations, Resolvent kernel.

Books Recommended:

1. I.N. Sneddon, Elements of Partial Differential Equations, McGraw-Hill, 1957.

2. T. Amaranath, An Elementary Course in Partial Differential Equations, Narosa Pub. New Delhi.

3. R.P. Kanwal, Linear Integral Equations, Birkhäuser,Inc., Boston, 1997.

4. V.S. Verma,Series solution and special functions, Neelkamal Publication

MAT 304 DIFFERENTIAL GEOMETRY OF MANIFOLDS

UNIT I: Definition and examples of differentiable manifolds. Tangent spaces. Vector fields, Jacobian map Lie derivatives. Exterior algebra. Exterior derivative, Lie groups and Lie algebras.

UNIT II: Riemannian manifolds, Riemannian connections, Curvature tensors, Sectional curvature, Shur's theorem, Projective curvature tensor , Conformal curvature tensor, Conharmonic curvature tensor and Concircular curvature tensor.

UNIT III: Homomorphism and isomorphism. Lie transformation groups, Principle fibre bundle, Linear fame bundle, Associated fibre bundle, Vector bandle, Tangent bundle, Induced bundle, Bundle homomorphism.

UNIT IV: Submanifolds and Hypersurfaces, Normals, Induced connection, Gauss formulas, Weingarten formulae, Lines of curvature, Mean curvature, Generalized Gauss and Minardi-Codazzi's equations.

Books Recommended:

1. R.S. Mishra, A course in tensors with applications to Riemannian Geometry Pothishala (Pvt.) Ltd. 1965.

2. R.S. Mishra, Structures on a differentiable manifold and their applications. Chandrama Prakashan, Allahabad, 1984.

3. B.B. Sinha, An introduction to modern differentrial geometry, Kalyani Publishes, New Delhi, 1982.

MAT 305 OPERATONS RESEARCH

UNIT I: Operations Research and its Scope. Linear Programming- Simplex Method, Dual simplex method, Parametric linear programming, Upper bound technique.

UNIT II: Transformation and Assignment problems, Integer programming,Dynamic Programming.

UNIT III: Network Analysis- Shortest path problem, Minimum squaring problems, Maximum Flow problem, Minimum cost flow problem, Network simplex method ,Game theorem-Two Person, Zero-sum Games. Games with mixed strategies. Graphic solution.

UNIT IV: Non linear programming-one and multi variable unconstrained optimization, Conditions for constrained optimization, Separable programming, Convex programming, Non-convex programming, Linear Goal programming.

Books Recommended:

1. H.A. Taha. Operations Research- An Introduction, Macmillan Publishing Co., Inc., New York.

2. S.S. Rao, Optimization Theory and Applications, Wiley Eastern Ltd., New Delhi.

SEMESTER- IV

MAT 401 FUNCTIONAL ANALYSIS II

UNIT I: Inner product spaces with example, Polarization identity, Scwartz inequality, Parallelogram law, Uniform convexity of norm induced by inner product,Orthonarmal sets, Gram-Schmidt Orthogonalisation.

UNIT II: Hilbert spaces, Bessel's inequality, Riesz-Fisher theorem, orthonormal basis, characterization of orthonormal basis, Fourier series representation and Parsevell's relation, Separable Hilbert paces, Continuity of linear mappings, Projection theorem, Riesz-representation theorem, reflexivity of a Hilbert's space, Unique Hahn extension theorem, weak convergence and weak boundedness.

UNIT III: Unitary operators on a Hilbert spaces, Adjoint of an operator, Self adjoint and normal operators with examples, Characterization and results pertaining to these operators, Positive operator, Shift operator, Projection on a Hilbert's space.

UNIT IV: Finite dimensional spectral theory, Determinant and spectrum of an operator, Spectral theorem, spectral resolution.

Books Recommended:

1. G.F. Simmons, Introduction to Topology and Modern Analysis, McGraw Hill, 1963.

2. S. Ponnusamy, Foundations of Functional Analysis, Narosa Publishing House, New Delhi, 2002.

3.B.V.Limaye, Functional Analysis, New Age Int. Publication.

MAT 402: MEASURE AND INTEGRATION II

UNIT I: Semi algebras, algebras, monotone class, σ- algebras, measure and outer measures, Caratheodory extension process of extending a measure on a semi-algebra to generated σ – algebra, completion of measure space.

UNIT II: Signed measure. Hahn and Jordan decomposition theorems. Absolutely continuous and singular measures. Radon Nikodyn theorem. Lebesgue decomposition. Riesz. Representation theorem, Extension theorem (carathedory).

UNIT III: Product measures, Fubini's theorem, Baire sets, Baire measure, Continuous functions with compact support.

UNIT IV: Regularity of measures on locally compact spaces. Integration of continuous functions with compact support. Reisz-Markoff theorem.

Books Recommended:

1. H.L. Royden, Real Analysis, Macmillan, 4th Edition, 1993.

2. P.R. Halmos, Measure Theory, Van Nostrand, 1950.

3. S.K. Berberian, Measure and Integration, Wiley Eastern, 1981

4. A.E. Taylor, Introduction to Functional Analysis, John Wiley, 1958.

5. G. de Barra, Measure Theory and Integration, Wiley Eastern, 1981.

6. R.G. Bartle, The Elements of Integration, John Wiley, 1966.

7. Inder K. Rana, An Introduction to measure and Integration, narosa Publishing House, 1997.

MAT 403 COMPLEX MANIFOLDS AND CONTACT MANIFOLDS

UNIT I: Almost complex manifolds: Elementary notions ,Nijenuis tensor, Eigen values of F, Integrability conditions, Contravariant and covariant almost analytic vectors fields, F connection.

UNIT II: Almost Hermite manifolds: Definition, Curvature tensor, Linear connection

Kaehler manifolds: Definition, Curvature tensor, Properties of Projective, Conformal, Conharmonic and concircular curvature tensor.

UNIT III: Almost contact manifolds: Definition, Eigen values of F, Lie derivative, Normal contact structure, Particular affine connection, Almost Sasakian manifold.

UNIT IV: Sasakian manifolds: K- contact Riemannian manifold and its properties , Sasakian manifolds and its properties, Properties of Projective, Conformal, Conharmonic and concircular curvature tensor in Sasakian manifolds, Cosymplectic structure.

Books Recommended:

1. R.S. Mishra, A course in tensors with applications to Riemannian Geometry Pothishala (P.vt.) Ltd., 1965.

2. R.S. Mishra, Structures on a differentiable manifold and their applications. Chandrama Prakashan, Allahabad, 1984.

3. B.B. Sinha, An introduction to modern differential geometry, Kalyani Publishers, New Delhi, 1982.

MAT 404 FLUID MECHANICS

UNIT I: Elementary notions of fluid motion: Body forces and surface, Forces nature of stresses, Transformation of stress components, Stress invariants, Principal stresses, Nature of strains, Rates of strain components, Relation between stress and rate of strain components, General displacement of a fluid element, Newton's law of viscosity, Navier-Stokes equation (sketch of proof).

UNIT II: Equation of motion for inviscid fluid, Energy equation, Vortex motion-Helmholtz's vorticity theorem and vorticity equation, Kelvin's circulation Theorem, Mean Potential over a spherical surface, Kelvin's Minimum kinetic energy Theorem, Acyclic irrotational motion.

UNIT III: Wave motion in a gas. Speed of Sound. Equation of motion of a gas. Subsonic, Sonic and Supersonic flows of a gas. Isentropic gas flows.

UNIT IV: Normal and oblique shocks. Plane Poiseuille and Couette flows between two parallel plates. Unsteady flow over a flat plate. Reynold's number.

Books Recommended:

1. L.D. Landau and E.M. Lifshitz, Fluid Mechanics, Butterworth-Heinemann, 2nd Edition, 1987.

2. N. Curle and H.J. Davies, Modern Fluid Dynamics, Vol. I, D. Van Nost. Comp London, 1968.

3. S.W. Yuan, Foundation of Fluid Mechanics, Prentice-Hall, Englewood Cliffs, N.J, 1967.

4. A.S. Ramsey, A. Treatise on Hydrodynamics, Part I, G. Bell and Sons Ltd. 1960.

5. F. Chalton. A text book of fluid dynamics. CBS Publication, New Delhi.