PROF. RAJENDRA SINGH (RAJJU BHAIYA) UNIVERSITY, PRAYAGRAJ

MA/M.Sc. MATHEMATICS

EXAMINATION AND SYLLABUS SCHEME

Annexure-18

(Credit & Grading System)

Course Code		Course Title	T/P	Credits	Evaluation (MM=100)		
					Internal		External
					CIE	Practical	ETE
Semester-I							
MAT-501	Core	ALGEBRA-I	T	5	25	-	75
MAT-502	Core	ANALYSIS	T	5	25	-	75
MAT-503	Core	ORDINARY DIFFERENTIAL EQUATIONS	T	5	25	-	75
MAT-551	Elective (select any one)	MATHEMATICAL METHODS	T	5	25	-	75
MAT-552		DIFFERENTIAL GEOMETRY	T	5	25	-	75
MAT-531	Core	FIELD WORK/MINOR PROJECT/PRACTICAL	P	4	-	100	-
Semester-II							
MAT-504	Core	TOPOLOGY	T	5	25	-	75
MAT-505	Core	TENSORS AND RIEMANNIAN GEOMETRY	T	5	25	-	75
MAT-506	Core	PARTIAL DIFFERENTIAL EQUATIONS AND INTEGRAL EQUATIONS	T	5	25	-	75
MAT-507	Core	CLASSICAL MECHANICS	T	5	25	-	75
MAT-532	Core	FIELD WORK/MINOR PROJECT/PRACTICAL	P	4	-	100	-
Semester-III							
MAT-601	Core	ALGEBRA-II	T	5	25	-	75
MAT-602	Core	MEASURE AND INTEGRATION	T	5	25	-	75
MAT-603	Core	FUNCATIONAL ANALYSIS	T	5	25	-	75
MAT-651	Elective (select any one)	DIFFERENTIAL GEOMETRY OF MANIFOLDS	T	5	25	-	75
MAT-652		HYDRODYNAMICS	T	5	25	-	75
MAT-631	Core	FIELD WORK/MINOR PROJECT/PRACTICAL	P	4	-	100	-
Semester-IV							
MAT-604	Core	WAVELETS	T	5	25	-	75
MAT-605	Core	FLUID MECHANICS	T	5	25	-	75
MAT-653	Elective (select any one)	NUMBER THEORY	T	5	25	-	75
MAT-654		ALEGEBRAIC TOPOLOGY	T	5	25	-	75
MAT-655		CRYPTOGRAPHY	T	5	25	-	75
MAT-656		ADVANCED LINEAR ALGEBRA	T	5	25	-	75
MAT-657	Elective (select any one)	OPERATION RESEARCH	T	5	25	-	75
MAT-658		SPECIAL FUNCTION	T	5	25	-	75
MAT-659		FINSLER GEOMETRY	T	5	25	-	75
MAT-660		BIO-MATHEMATICS	T	5	25	-	75
MAT-632	Core	FIELD WORK/MINOR PROJECT/PRACTICAL	P	4	-	100	-

There is:

CIE: Continuous Internal Evaluation.

Practical: 100% Internal

ETE: End Term Examination (University Examination).

ALLAHABAD STATE UNIVERSITY
RECOMMENDED SYLLABUS OF MATHEMATICS
FOR MA.A/M.Sc. CLASSES
(w.e.f. 2017-18 Onwards)

M.A./M.Sc. Semester- I

PAPER-1 : ALGEBRA I **M.M:100**

UNIT 1: Subnormal and normal series, Zassenhaus' lemma, Scherer's refinement theorem, Composition series, Jordan-Holder's theorem, Chain Conditions, Examples, Internal and external directed products and their relationship, Indecomposability.

UNIT 2: 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, Particularization to translation and conjugation, Conjugacy class equation.

UNIT 3: Sylow subgrous, sylow's Theorem I, II and III, p-groups, Examples and applications, Groups of order pq, Direct and inverse images of Sylow subgroups.

UNIT 4: Commutators, Solvable groups, Solvability of subgroups and factor groups and of finite p-groups, Examples, Lower and upper central series, Nilpotent groups and their equivalent characterizations.

UNIT 5: Factorization theory in commutative domains, Prime and irreducible elements, G.C.D., Euclidean domains, Maximal and prime ideals, Principal ideal domains, Divisor chain condition Unique factorization domains, Examples and counter-examples, Chinese remainder theorem for rings and PID's.

Books Recommended:

1. D.S. Dummit and R.M. Foote, Abstract Algebra, John Wiley, N.Y., 2003.
2. N.S. Gopalkrishnan, University Algebra, Wiley Eastern, New Delhi, 1986
3. N.Jacobson, Basic Algeba, Vol. I, Hindustan Publishing Co. New Delhi, 1984.
4. I.N. Herstein, Topics in Algebra, Wiley India Pvt. Ltd. 2006.
5. T.W. Hungerford, Algebra, Springer (India) Pvt. Ltd. New Delhi, 2004
6. Ramji Lal, Algebra, Vols. I & II, Shail Publications, Allahabad, 2002.

PAPER :2 ANALYSIS M.M:100

UNIT 1: Riemann integral, Integrability of continuous and monotonic functions fundamental theorem of integral calculus, Mean value theorems of intergral calculus.

UNIT 2: Definition and examples of metric spaces, Neighbourhoods, Interior points, Limit points, Open and closes sets, Subspaces, Convergent and Cauchy sequences, Completeness, Cantor's intersection theorem.

UNIT 3: Maximum modulus theorem, minimum modulus theorem, Schwarz Lemma, Hadamard's three circle theorem, inverse function theorem, Function spaces, Hurwitz's theorem, Infinite products, Weirestrass factorization theorem, Mittag-Leffler's theorem.

UNIT 4 : Gamma functions and its properties, Riemann's Zeta function, Analytic continuation, Uniqueness of direct Analytic continuation, Power series method of Analytic continuation, Harmonic functions on a disk, Harneck's inequality and theorem.

UNIT 5: Canonical Products, Poison formula Jensen's formula, Poison Jensen's Formula, Hadamard's three circle theorem as conversely theorem, Hadamal's three circle theorem as convexity theorem, Hadamard's factorization theorem, Order of an entire function.

Books Recommended:

1. Walter Rudin, Principles of Mathematical Analysis, Mc Graw Hill Publication.
2. Goldberg, Real Analysis.
3. J.V. Deshpande, Complex Analysis.
4. E.C. Titchmarsh, Theory of Functions .
5. John B. Conway, Functions of one complex variable .

PAPER-3: ORDINARY DIFFERENTIAL EQUATIONS M.M:100

UNIT 1: Solution of 2nd order differential equations with variable coefficients including method of variation of parameters.

Statement only Existence theorem of 1st order equation, Statement of existence theorems for system of 1st order equations and for nth order differential equations, Wronskian.

UNIT 2: Method of series solution of 2nd order differential equations with particular reference to legendre, Bessel and Gauss, Simultaneous differential equations and total differential equations.

UNIT 3: Linear independence and Wronskians, General solutions covering all solutions for homogeneous and non-homogeneous linear systems, Abel's formula, Method of variation of parameters for particular solutions, Linear systems with constant coefficients, Matrix methods, Different cases involving diagonalizable and non-diagonalizable coefficient matrices, Real solutions of systems with complex eigen values.

UNIT 4: Convergence of real power series, Radius and interval of convergence, Ordinary and singular points, Power series solutions, Frobenius's generalized power series method, Indicial equation, Different cases involving roots of the indicial equation, Regular and logarithmic solutions near regular singular points.

UNIT 5: Legendre's equation, Solution by power series method, Polynomial solution, Legendre polynomial, Rodrigues' formula, Generating function, Recurrence relations, Orthogonality relations, Fourier-Legendre expansion, Bessel's equation, Bessel functions of I and II kind, Recurrence relations, Bessel functions of half-integral orders, Sturm comparison theorem, Zeros of Bessel fuctions, Orthogonality relations, Generating function, Fourier-Bessel expansions.

Books Recommended:

1. B. Rai, D.P. Choudhury and H.I. Freedman, A Course in Ordinary Differential Equations, Narosa Publishing House, New Delhi, 2002.

2. E.A. Coddington, An Introduction to Ordinary Differential Equations, Prentice Hall on India, New Delhi, 1968.

3. Raisinghania, Advanced Differential Equations.

4. G.F. Simmons' Differential Equations, TMH.

5. P. Hartman, Ordinary Differential Equations, Jhon Wiley.

PAPER- 4: MATHEMATICAL METHODS M.M: 100

Unit 1: 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 2: 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 3: The Inversion formula, First Shifting Theorem, Laplace Transform of the derivatives and of the Integrals of a function, Derivatives and integrals of Transforms, Convolution Products and application to the Initial Value Problems.

Unit 4: 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 5: 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. Kreyszig, Advanced Engineering Mathematics, Wiley India Pvt. Ltd. 8th Edition, 2001.
2. A.D. Polyanin and A.V. Manzhirov, Handbook of Integral Equations, CRC Press, 2nd edition, 2008.
3. L. Elsgolts, Differential Equations and Calculus of Variations, Mir Publishers, 1970.
4. A. S. Gupta Calculus of Variations, Prentice Hall of India, New Delhi, 1999.
5. Francis B. Hilderbrand, Methods of Applied Mathematics.

PAPER-5; DIFFERENTIAL GEOMETRY **M.M :100**

Unit 1: Curves in space R^3, Parameterized curves, Regular curves, Helices, Arc length, Reparametrization (by arc length), Tangent, Principal normal, Binormal, Osculating plane, Normal plane, Rectifying plane, Curvature and torsion of smooth curves, Frenet-Serret formulae, Frenet approximation of a space curve.

Unit 2: Osculating circle, Osculating sphere, Spherical indicatrices, Involutes and evolutes, Intrinsic equations of space curves, Isometries of R^3, Fundamental theorem of space curves, Surfaces in R^3, Regular surface, Co-ordinate neighborhoods, Parameterized surfaces, Charge of parameters, Level sets of smooth functions on R^3, Surfaces of revolution, Tangent vectors, Tangent plane, Differential of a map.

Unit 3: Normal fields and orientability of surfaces, Angle between two intersecting curves on a surface, Gauss map and its properties, Weingarten map, Second and third fundamental forms, Classification of points on a surface.

Unit 4: Curvature of curves on surfaces, Normal curvature, Meusnier theorem, Principal curvatures, Geometric interpretation of principal curvatures, Euler theorem, Mean curvature, Lines of curvature, Umbilical points, Minimal surfaces, Definition and examples, Gaussian curvature, Intrinsic formulae for the Gaussian curvature, Isometries of surfaces, Gauss Theorem Egregium (Statement only).

Unit 5: Christoffel symblos, Gauss formulae, Weingarten formulae, Gauss equations, Codazzi-Mainardi equations, Curvature tensor, Geodesics, Geodesics on a surfaces of revolution, Geodesic curvature of a curve, Gauss-Bonnet Theorem (Statement only).

Books Recommended:

1. M.P. Do carmo, Differential Geometry of curves and surface, Prentice-Hall, Inc.
2. B.O' Neill, Elementary Differential Geometry, Academic press, 1997,
3. A Pressley, Elementary Differential Geometry, Springer (Undergraduate Mathematics Series) 2001
4. J.A. Thorpe, Elementary Topics in Differential Geometry, Springer (Undergraduate Texts in Mathematics), 1979.
5. D. Somasundaram, Differential Geometry, A first Course, Narosa Publishing House, New Delhi, 2005.

M.A./M.SC. SEMESTER-II

PAPER -I : TOPOLOGY **M.M:100**

Unit 1: Topological spaces and examples, Metric topology, Open sets, Closes sets, Closure, Dense Sets, Neighborhoods, Interior, Exterior Boundary, Accumulation and Limit points, Derived sets, Bases and Sub-bases, Subspaces and Relative Topology.

Unit 2: Continuous maps, Open and closed maps Homeomorphisms, Topological property, Product spaces, Projection maps, Quotient space and Quotient map, First and second Countable spaces, Lindelof spaces, Separable spaces.

Unit 3: The Separation axioms T_0, T_1, T_2, Regular, T_3, Completely regular, $T_{3\frac{1}{2}}$, T_4 Spaces, Their characterizations and basic properties, Urysohn's Lemma, Tietze Extension theorem, Urysohn's Metrization theorem.

Unit 4 : Compactness, Basic properties of Compactness, Tychonoff theorem, Compactness and finite intersection property, Sequential and Countable Compactness, Local Compactness.

Unit 5 : Connectedness, and Basic properties of Connected spaces, Connectedness of real line, Components, Locally connected spaces, Path connected spaces, Local path connectedness, Path components.

Books Recommended :

1. J.R. Munkres, Topology- A First Course.
2. G.F. Simmons, Introduction to Topology and Modern Analysis.
3. K.D. Joshi, Introduction to General Topology.
4. J.L. Kelley, General Topology.

PAPER-2 : TENSORS AND RIEMANNIAN GEOMETRY M.M.-100

Unit 1 : n-dimensional real vector space, Contravariant vectors, Dual vector space, Covariant vectors, Tensor product, Second order tensors, Tensors of type (r,s), Symmetry and skew symmetry of tensors, Fundamental algebraic, Contraction, Inner product, Quotient law of tensors.

Unit 2 : Differentiable manifolds of dimension n, Tangent spaces, Transformation of coordinates, Transformation laws for contra variant (tangent), Convariant (cotangent) vectors and tensors of higher order, Connection, Covariant differentiation and curvature tensor, Parallelism.

Unit 3 : Riemannian metric, Christoffel symbols, Curvature tensor with respect to Christoffel symbols, Differential operators, Geodesics, Riemann curvature tensor.

Unit 4 : Lie derivative, Lie derivatives of scalars, vectors, tensors and linear connection, commutation formulae for Lie differential operator and covariant differential operator.

Unit 5 : Motion, Affine motion, Projective motion in a Riemannian space, Curvature collineation, Conformal and homothetic transformations.

Books Recommended :

1. R.S. Mishra, A Course in Tensors with Application to Riemannian Geometry, Pothishala Pvt. Ltd., Allahabad, 1965.
2. K. Yano, The Theory of Lie Derivatives and its Applications, North-Holland Publishing Company, Amsterdam, 1957.
3. C.E. Weatherburn, An Introduction to Riemannian Geometry and the Tensor Calculus, Cambridge University Press, 2008.
4. Matthew S. Smith, Principles and Applications of Tensor Analysis, W. Sons Indianapolis, 1963.

PAPER-3 : PARTIAL DIFFERENTIAL EQUATIONS AND INTEGRAL EQUATIONS

M.M:100

Unit 1 : Formation of P.D.E.'s, First order P.D.E's, Classification of first order P.D.E.'s Complete, General and singular integrals, Lagrange's or quasi- linear equations, Integral surfaces through a given curve, Orthogonal surfaces to a given system of surfaces, Characteristic curves.

Unit 2 : Pfaffian differential equations, Compatible systems, Charpit's method, Jacobi's Method.

Unit 3 : Linear equations with constant coefficients, Reduction to canonical forms, Classification of second order P.D.E.'s, Monge's method.

Unit 4 : 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 Lntegral Equations, Relation between Differential and Integral equations.

Unit 5 : Fredholm equations of second kind with separable kernels, Fredholm alternative theorem, Eigen values and eigen funcions, Method of successive approximation for Fredhol and Volterra equations, Resolvent kernel.

Books Recommended:

1. I.N. Sneddon, Elements of Partial Differential Equations, McGraw-Hill, 1957.
2. T. Amarnath, An Elementary Course in Partial Differential Equations, Narosa Publishing House, New Delhi, 2005.
3. R.P. Kanwal, Linear Integral Equations, Birkhauser, Inc. Boston, MA, 1997.

PAPER-4 : CLASSICAL MECHANICS M.M:100

Unit 1 : The momentum of a system of particles, Linear and angular momentum, Rate of change of momentum and the equations of motion for a system particles, Principles of linear and angular momentum, Motion of the center of mass of a system, Theorems on the rate of change of angular momentum about different points, with special reference to the center of mass, Kinetic energy of a system of particles in terms of the motion relative to the center of mass of the system.

Unit 2 : Rigid bodies as a system of particles, General displacement of a rigid body, Displacement of a rigid body about one of its points and the concept of angular velocity, Computation of the angular velocity of a rigid body in terms of the velocities of two particles of the system chosen appropriately, Kinematical examples.

Unit 3 : 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, Invariable line and invariable cone, Theorems of Poinsot and Sylvester, Eulerian angles and the geometrical equations of Euler.

Unit 4 : Generalized co-ordinates, Geometrical equations, Holonomic and non-holoromic systems, Configuration space, Lagrange's equations using D' Alembert's principle for a holonomic conservative system, Deduction of equation of energy when the geometrical equations do not contain time t

explicitly, Lagrange's multipliers case, Deduction of Euler's dynamical equations from Lagrange's equations.

Unit 5 : 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, 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.

Books Recommended:

1. E.A. Milne, Vectorial Mechanics, Methuen & Co. Ltd., London, 1965.
2. A.S. Ramsey, Dynamics, Part II, CBS Publishers & Distributors, Delhi, 1985.
3. H. Goldstein, Classical Mechanics, Addison-Wesley Publishing Company, London, 1969.
4. L.A. Pars, A Treatise on Analytical Dynamics, Heinemann, London, 1968.
5. N. Kumar, Generalized Motion of Rigid Body, Narosa Publishing House, New Delhi, 2004.

PAPER-5 : PROJECT WORK AND VIVA-VOCE. M.M:100

M.A./M.Sc Semester III

PAPER-1 : ALGEBRA II MM:100

Unit 1 : Modules - Definition and examples, Simple modules, Submodules, Module Homomorphisms, Quotient modules, Direct sum of modules, Exact sequences, Short exact sequence, Split exact sequences, Torsion free and torsion modules.

Unit 2 : Free modules - Definition and examples, Modules over division rings are free modules, Free modules over PID's, Invariant factor theorem for submodules.

Unit 3 : Finitely generated modules over PID, Chain of invariant ideals, Fundamental structure theorem for finitely generated module over a PID.

Unit 4 : Projective and injective modules, Bare's characterization, Divisible groups, Existence of enough injectives.

Unit 5 : Noetherian modules and rings, Equivalent characterizations, Submodules and factors of noetherian modules, Hilbert basis theorem (statement only). Characteristic of a field, Prime subfields, Field extensions, Finite extensions, Simple extensions, Algebraic and transcendental extensions.

Books Recommended:

1. D.S. Dommit R.M. Foote, Abstract of Algebra, John Wiley, Newyork, 2003.
2. F.W. Anderson and K.R. Fuller, Rings and Categories of Modules, Springer, Newyork, 1977.
3. N.S. Gopala krishnan, University Algebra, Wiley Estern Ltd. New Delhi
4. Serge Lang, Algebra, Addison Wesley.
5. V. Sahai and Bist, Algebra, Narosa.

PAPER-2 : MEASURE AND INTEGRATION M.M : 100

Unit 1 : Countable and uncountable sets, Cardinality and cardinal arithmetic, Schroder-Bernstein theorem, $a < 2^a$, 2^{N_0} the Cantor's ternary set and its properties.

Unit 2 : 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 a measure space.

Unit 3 : Borel sets, Lebesgue outer measure and Lebesgue measure on R, Translation invariance of Lebesgue measure, Existence of a non-measurable set, Characterizations of Lebesgue measurable sets, Cantor-Lebesgue function.

Unit 4 : Measurable functions on a measure space and their properties, Borel and Lebesgue measurable functions, Simple functions and their integrals, Littlewood's three principle (statement only), Lebesgue integral on R and its properties, Comparison of Riemmann integal and Lebesgue integral.

Unit 5 : Convergence of Lebesgue integral, Bounded convergence theorem, Fatou's lemma, Lebesgue monotone convergence theorem, Lebesgue dominated convergence theorem, Minkowski's and Holder's inequaleties Riesz-Fischer theorem (statement only).

Books Recommended :

1. H.L. Royden and P.M. Fitzpatrick, Real Analysis, (Fourth edition), Prentice Hall of India, 2010.
2. P.R. Halmos, Measure Theory, Grand Text Mathematics, 14, Springer, 1994.
3. K.R. Parthasarathy, Introduction to Probability and Measure, TRIM 33, Hindustan Book Agency, New Delhi, 2005.
4. I.K. Rana, An Introduction to Measure and Integration, (Second Edition), Narosa Publishing House, New Delhi, 2005.
5. H.L. Royden, Real Analysis, Prentice Hall of India.

PAPER-3 : FUNCTIONAL ANALYSIS MM : 100

Unit 1 : Normed Linear Space, Examples and its topological properties Banach Space, Finite Dimensional Normed Linear Space, Compactness and Finite dimension, Continuity and Convergence, Continuity of a Linear Map, Norm of a Continuous Linear Map, Isometric Isomorphism.

Unit 2 : Dual Space, Natural Embedding of a Normed Linear Space in its second Dual Space, Weak Topology, Hahn-Banach theorem, Open Mapping Theorem, Closed Graph Theorem, Uniform Boundedness Principle, Conjugate of an operator.

Unit 3 : Hilbert space, Its dual, Schwarz's inequality, Orthogonal complement of a set, Orthonormal set, Complete orthonormal set, Bessel's inequality, Fourier's expansion, Parseval's equation, Gram Schmidt orthogonalisation process, Adjoint of an operator.

Unit 4 : Self Adjoint operators, Normal operators, Unitary Operators, Projection on a Linear Space, Banach Space and Hilbert Space, Spectral Theorem.

Unit 5 : Banach Algebra, Spectrum, Spectral Radius, Compact Operator, Spectrum of a Compact operator.

Books Recommended :

1. G.F. Simmons, Introduction to Topology and Modern Analysis, Mc Graw Hill, 1963.
2. S. Ponnusamy, Foundations of Functional Analysis, Narosa Publishing House, New Delhi, 2002.
3. I.J. Maddox, Elements of Functional Analysis, Universal Book Stall, New Delhi.

PAPER-4 : DIFFERENTIAL GEOMETRY OF MANIFOLDS **MM : 100**

Unit 1 : Topological Manifolds, Compatible charts, Differentable manifolds, Smooth manifolds, Examples, Smooth maps and diffeomorphisms, Definition of a Lie group and some examples, derivatives of smooth maps.

Unit 2 : Tangent and cotangent spaces to a manifold, Immersions and submersions, Submanifolds, Vector fields, Algebra of vector fields, @-related vector fields, Left and right invariant vector fields on Lie groups.

Unit 3 : Integral curves of smooth vector Fields, flow of a vector field, Complete vector fields, Distributions, Tensor fields on manifolds, r-forms, Exterior product, Exterior differentiation.

Unit 4 : Affine connections (covariant differentiation) on a smooth manifold, Torsion and curvature tensors of an affine connection, Reimannian metrics, Riemannian manifolds, submanifolds, Local isometry and isometry, Levi-Civita connection, Fundamental Theorem of Riemannian Geometry.

Unit 5 : Riemannian curvature tensor, Identities satisfied by Riemannian curvature tensor, Ricci tensor, Scalar curvature, Sectional curvature of Riemannian manifolds, Manifolds of constant curvature, Schur's Theorem, Gradient vector fields, Divergence of a vector field, Einstein manifolds.

Books Recommended :

1. S. Kumaresan, A Course in Differential Geometry and Lie Groups, Hindustan Book Agency, New Delhi, 2002.
2. M. Spivak, A Comprehensive Introduction to Differential Geometry, Vols. 1-5, Publish or Perish, Inc., Houston, 1999.
3. W.M. Boothby, An Introduction to differentiable Manifolds and Riemannian Geometry, Academic Press, revised, 2003.
4. Y. Matsushima, Differentiable Manifolds.

PAPER-5 : HYDRODYNAMICS MM : 100

Unit 1 : Equation of Continuity, Boundry Surfaces, Streamlines, Irrotational and Rotational motions, Vortex lines, Euler's equation of motion, Bernoulli's theorem, Impulsive actions.

Unit 2 : Motion in two-dimensions, Conjugate functions, Source, Sink, Doublets and their images, Conformal mapping, Two-dimensional irrotational motion produced by the motion of circular cylinder in an infinite mass of liquid, Theorem of Blasius.

Unit 3 : Motion of a sphere through a liquid at rest at infinity, Liquid streaming part a fixed sphere, Equation of motion of a sphere.

Unit 4 : Stress components in real fluid, Equilibrium equation in stress components, Transformation of stress components, Principal stres, Nature of strains, Transformation of rate of strain, Navier-Stokes equation of motion.

Unit 5 : Vortex Motion, Properties of vortex filament motion due to rectilinear vortex and a system of vortices motion of a vortex filament due to the influence of others, Ranking vortex.

Books Recommended :

1. W.H. Besant and A.S. Ramsey, A Treatise on Hydrodynomics, CBS Publishers and Distributors, Delhi 1988.
2. S.W. Yuan, Foundations of Fluid dynamics, Prentice Hall of India, 1988.

M.A./M.Sc. Semester-IV

PAPER-1 : WAVELETS MM:100

Unit 1 : The discrete Fourier transform and the inverse discrete Fourier transform, Their basic properties and computations, The fast Fourier transform, The discrete cosine transform and the fast cosine transform.

Unit 2 : Construction of wavelets on Z_N, First stage and by iteration, The Haar system, Shannon wavelets, Daubechies' D6 wavelets on Z_N.

Description of $l^2(Z)$. L^2 $[-\pi, \pi]$, L^2 (R), Their orthonormal bases, Fourier transform and convolution on l^2 (Z), wavelets on Z, Haar wavelets on Z, Daubechies' D6 wavelets for l^2 (Z).

Unit 3 : Orthonormal bases generated by a single function in L^2 (R), Fourier transform and inverse Fourier transform of a function f in L^1 (R) / L^2(R), Parseval's relation, Plancherel's formula, Orthonormal wavelets in L^2 (R), Balian-Low theorem.

Unit 4 : Multi-resolution analysis and MRA wavelets, certain function in L^2 (R) for which $\{\psi_{j,k}\}$ does not form an orthonormal system, compactly supported wavel;ets, Band-limited wavelets.

Unit 5 : Franklin wavelets on R, Dimension function, Characterization of MRA wavelets (Sketch of the proof), Minimally Supported Wavelets, Wavelet sets, Characterization of two-interval wavelet sets, Shannon wavelet, Journe's wavelet, Decomposition and reconstruction algorithms of Wavelets.

Books Recommended :

1. Michael W. Frazier, An Introduction to Wavelets through Linear

Algebra, Springer-Verlag, 1999.

2. Eugenio Hernandez and Guido Weiss, A First Course on Wavelets, CRC Press, 1996.
3. C.K. Chui, An Introduction to Wavelets, Academic Press, 1992.

PAPER-2 : FLUID MECHANICS MM:100

Unit 1 : 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, Viscosity, Equation of continuity, Newton's law of viscosity, Navier-Stokes equation of motion.

Unit 2 : 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 3 : Two dimensional irrotational motion, Complex velocity potential, Concept of line vortices, Vortex rows and the Karman vortex street, Milne-Thomson Circle Theorem, Complex potential for a uniform flow past a circular cylinder, Streaming and circulation about a fixed circular cylinder, Blasius Theorem, Kutta - Jouko-wski theoterm, Sources, Sinks, Doublets and their images in two dimension.

Unit 4 : Three dimensional irrigational flow, Axisymmetric flow, Stokes

stream function, Axisymmetric potential flow, Butler's sphere theorem, Liquid streaming past a stationary sphere, Uniform motion of a sphere in a liquid at rest at infinity, Concentric spheres (Problem of Initial motion).

Unit 5 : Gravity waves, Surface waves on the infinite free surface of liquids, Waves at the interface between finitely and infinitely deep liquids.

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. 1, D. Van Nostrand Comp. Ltd., London, 1968.
3. S. W. Yuan, Foundations of Fluid Mechanics, Prentice-Hall, Englewood Cliffs, NJ, 1967.

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

5- Frant Chorlton, Text Book of Fluid Dynamics, C.B.S. Publishers, Delhi, 1985.

PAPER-3: Any one of the following papers:

PAPER -3(a) : NUMBER THEORY M.M:100

Unit 1: Principal of mathematical induction, Least common multiple, Greatest common divisor, Euclidean algorithm, Prime numbers, Unique Factorization Theorem.

Unit 2: Operations of congruences, Residue sets mod m, Euler's theorem, Order of a mod m, Linear congruences, The theorems of Fermat and Wilson, The Chinese Reminder theorem, Polynomial congruences.

Unit 3: Primitive roots, Indices, quardratic residuce mod m, Euler's criterion, The Legendre sybmol, The law of quadratic reciprocity The Jacobi symbol.

Unit 4: Multiplicative Arithmetic functions, τ and σ functions, Mobius function, Euler's function, The inversion farmula.

Unit 5: Linear Diophantine equations, equations of the form $x^2+y^2=Z^2$, Related equations, Representation of a number by sum of two of four squares.

Book Recommended:

Burton D.M.: Elementary Number Theory, Universal Book stall, New Delhi.

PAPER-3(b) : ALGEBRAIC TOPOLOGY MM:100

UNIT-1 Attaching spaces, Spheres, real and complex projective spaces and generalized torus as attaching spaces, Hopf map, CW-complexes and cellular maps.

UNIT-2: Homotopic maps, Relative homotopy, Homotopy type, Space of paths and loops, Fundamental group, Simply connected space, Calculation of fundamental group of the circle, Fundamental group of product of spaces, Contractible spaces, Example of a space having non-abelian homotopy group, Inessential maps.

UNIT-3: Singular simplices and complexes, Singular homology groups, Relative homology groups, Verification of Eilenberg-Steenrod axims, Mayer-Vietories sequence, Homology of complexes, Computation of homology groups of spheres, Torus, real and complex projective spaces, relation between homotopy and homology groups, Fundamental Theorem of Algebra.

UNIT-4: Compact-open topology, Exponential law, Higher homotopy groups of a space, Homotopy exact sequence of a pair of spaces (sketch of the proof), Poincare- Hurewicz Theorem.

UNIT-5 : Homotopy extension property, Weak homotopy type, Whitehead theorem, Cellular approximation theorem, Milnor's theorem (every topological space is weak homotopy type of a CW-complex), Eilenberg-MacLane space, Homotopy lifting property, Fibre spaces and covering spaces, Homotopy exact sequence of a fibre space, and its applications in simple computations of homotopy

groups.

Books Recommended :

1. J.J. Rotman, An Introduction to Algebraic Topology, Springer-Verlag, 1988.
2. E.H. Spanier, Algebraic Topology, McGraw Hill, 1966.
3. W.S. Massey, Algebraic Topology-An Introduction, Springer-Verlag, 1988.
4. G.E. Bredon, Topology and Geometry, Springer-Verlag, New York, 1993.

PAPER -3 (c) : CRYPTOGRAPHY M.M:100

Unit 1 : Introduction, classical cryptography Secret key Encryption : Perfect secrecy-One time pads, stream ciphers and the Data Encryption Standard (DES), The Adavanced encryption stnadard (AES)

Unit 2 : Public key Encryption : Factoring and the RSA Encryption, Discrebe log. Diffie-Hellman key Exhange, ELG amal enoryption.

Unit 3 : Digital Signatures, One time sigratures, Rabin and ELG amal signatures schemes, Digital Signature standard (DSS).

Unit 4 : Hashing : Motivation and application, Cryptographically, Secure

Hashing, Message Authentication Codes (HMAC), Network Security, Secure Socket Layes (SSL) L Psec.

Unit 5 : Secret sharing, Definition, shamir's Threshold scheme, Visual secret sharing schemes.

Book Recommended

D.R. Stinson, Cryptography : Theory and Practice, CRC Press, 1995.

PAPER-3 (d) : ADVANCED LINEAR ALGEBRA MM:100

Unit 1 : Algebraic and geometric multiplicities of eigenvalues, Invariant subspaces, T-conductors and T-annihilators, Minimal polynomials 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 2 : 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 uniquencess, Direct sum decomposition of finite abelian groups into cyclic groups and their enumeration.

Unit 3 : 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 4 : 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.

Unit 5 : Positive definite matrices and polar decomposition, QR, LU and Cholesky decompositions of matrics, Singular value decomposition.

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, Absract 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 Eastern, New Delhi, 1986.

PAPER-4 : Any one of the following papers **MM:100**

PAPER-4(a) : OPERATION RESEARCH

Unit 1 : History and development of operations Research, Operation Research and its scope, Necessity of Operation Research in Industry and Management, Markovian and No-Markovian queues Queuing theory and its operating characteristic queuing model-M/M/1. M/M/K. Genral equations of the models, Theory of simulation, Monte Carlo method application to the problems of replacement and maintenance inventory, Queuing and financial problems.

Unit 2 : Simplex method: Theory of the simplex Method, Duality and Sensitivity Analysis. Other Algorithms for Linear Programming, Dual Simplex Method, Integer programming-Branch and Bound technique. Concept of cutting plane. Gomory's all integer cutting plane method. Applications to Industrial Problems:-Optimal product mix and activity levels, Petroleum Refinery Operations Blending Problems, Economic interpretation of dual linear programming problems. Input-output analysis.

Unit 3 : Transportation and Assignment Problems.

Unit 4 : New York Analysis: Shortest Path Problem, Minimum Spanning Tree Problem. Maximum Flow Problem, Minimum Cost Flow Problem, Network simplex Method, Project Planning and Control with PERT-CPM.

Unit 5 : Non-linear Programming: One and Multi-Unconstrained Optimization, Fuhn-Tucker conditions for Constrained Optimization, Quadratic Programming, Separable Programming, Convex Programming, Non-convex Programming.

Books Recommended :

1. Kanti Swarup P.K. Gupta and Manmohan : Operation Research, S. Chand and Co.
2. H.A. Taha. Operations Research-An introduction, Macmillan Publishing Co.Inc., New York.
3. P.K. Gupta and D.S. Hira : Operations Research-An Introduction, S.Chand and Co.

PAPER-4 (b) : SPECIAL FUNCTION MM:100

Unit 1 : The Gamma Functions : Analytic Character, Tannery's therorem, Euler's limit formula, Duplication formula, Eulerian integral of the first kind, Euler's Constant, Canonical product, Asymptotic expansions, Watson's lemma, Asymptotic expansion of r(z) and its range of validity, Asymptotic behavior of /r(x+iy)/, Hankel's contour integral.

Unit 2 : The Hypergeometric Functions: Solution of homogeneous linear differential equation of order two near an ordinary point and near a regular singularity, Convergence of the series solution near a regular singularity, Solutions valid for large value of/z/, Solution when the exponent diference is an integer or zero, second-order differential equation with three regular sigularity, Hypergeometric equation and its solution, Generalized hypergeometric equation.

Unit 3 : Integral representation of F(a,b,c,z), Value of F(a,b,c;i) when R1(c-a-b)>o, Analytical continuation of f(a,bc;c;za), Barnes's contour integral

for F(a,b;c;z), Behavior between continuous hypergeometric functions, Hypergeometric function, Confluent hypergeometric fuuction, Confluent hypergeometric function,F1 (; ;zaaao), Asymptotic expansion, Asymptotic expansion of 1F1 (; ; z).

Unit 4 : Integral for the Legendre Polynomials, Generating function, Recurrence formulae, Integral of a product of Legendre polynomial, Complete Solution of Legendre's equation when n is an integer,

Unit 5 : Bessel's Function, Bessel's differential equation and its series solution, Recurrence formulae for $J_n(z)$ Schlaflis contour integral for Jn(z), Generating functions for $J_n(z)$, Solution of Bessel's equation by Complex integrals, Hanket function, Connection between the Bessel and Hanket functions, Complete solution of Bessel's equation, Bessel function of the second kind, Series for $Y_n(z)$, Asymptotic expansion of the Bessel's functions, Neumann polynomials, Neumann's expansion theorem.

Book Recommended :

1. N.N. Lebedev, Special Functions and Their applications.
2. A.Chakrabarti, Elements of Ordinary Differential Equations and Special Functions.

PAPER-4 (c) :FINSLER GEOMETRY **M.M:100**

Unit 1 : Line elements, Finsler space, Minkowskian space, Tangent space, Indicatrix, Metric Tensor, Dual tangent space, Hamiltonian function,

Angle between two vectors, Generalized Christoffel symbols, Geodesics.

Unit 2 : δ-derivative, Partial δ-derivative, Fudamental postulates of E. Cartan, Different deductions, Cartan's two processes of convariant differentiation, Berwald connection parameters, Berwald's convariant differentiation.

Unit 3 : Commutation formuae resulting from, Cartan's convariant differentiation, Cartan curvature tensor, Commutation formulae resulting from Berwald's covariant differentiation, Berwald curvature tensor, Generalization of Bianchi identities, Space of scalar curvature, Space of constant curvature, Generalization of Schur's theorem, Recurrent spaces, Symmetric spaces.

Unit 4 : Projective change, Projective invariants, Projective change of Berwald's connection parameters, Projective deviation tensor, Generalized Weyl's projective curvature tensor, Projective connection parameters, Projectively flat spaces, Szabo Theorme.

Unit 5 : Infinitesimal transformations, Lie derivative of scalars, vectors and tensors, Lie derivative of connection parameters of Cartan and Berwald, Motion, Affine motion and Projective motion.

Books Recommended :

1. H. Rund, The Differential Geometry of Finsler Spaces, Springer-Verlag, Berlin, 1959.
2. M. Matsumoto, Foundations of Finsler Geometry and Special Finsler Spaces, Kaisheisha Press, Otsu, 1986.
3. P. L. Antonelli (ed.), Handbook of Finsler Geometry, Kluwer Academic Publishers, Dordrecht, The Netherlands, 2003.

PAPER-4 (d) :BIO-MATHEMATICS **M.M:100**

Unit-1 Continuous Population Models for single species : Continuous Growth Models, Insect Out break Model Spruce Budworm, Delay Models, Linear Analysis of Delay Population Models, Periodic solutions.

Unit-2 Delay Models in Physiology; I Dynamic Diseases, Harvesting a single Natural Population, Population Model with Age Distribution, Simple Discrete Models.

Unit-3 Continuous Models for Interacting Population: Interaction between species : Two species models, Definition of stability, Community matrix approach, Qualitative behavior of the community matrix, Completion: Lokta-Volterra models, Extension to Lotka-Volterra models, Competition in filed experiments, Competition for speace, Models for Mutualism.

Unit-4 Predator: Prey interaction: Lotka-Volterra Models, Dynamic of the simple Lotka-Volterra models, Role of density dependent in the Prey Classic laboratory experiment on predators, predation in natural system, Some predator-prey models.

Unit-5 Historical asides of Epidemics, Simple Epidemic models and practical application, Modeling venereal diseases

AIDS: Modeling the transmission dynamics of the HIV.

Books Recommended:

1. Mathematical Biology : J.D. Murrey.

2. Population Biology: Alam Hastings Concepts and Models, Springer

PAPER-5: Project Work and Viva-Voce. **M.M: 100**