आज दिनांक 21.10..2011 को विश्वविद्यालय परिसर में निम्न विषय की पाठ्यक्रम समिति की एक आवश्यक बैठक हुई, जिसमें निम्न प्राध्यापकगण उपस्थित हुए :–

Date :- 21.10.2011 Subject :- Mathematics Committee Place :- Committee Hall

1. Prof. S. K. Vaish
2. Dr. P. K. Shukla
3. Dr. Updesh Kumar
4. Dr. Satishchandra
5. Dr. Sanjeev Kumar Saxena

RECOMMENDED UNIFIED SYLLABUS OF MATHEMATICS

For B.A./B.Sc. Classes

(From 2011-12 onwards)

B.A./B.Sc. I

Paper I : ALGEBRA and TRIGONOMETRY M.M. : 33/65

Algebra

Unit 1. Sequence and its convergence (basic idea), Convergence of infinite series, Comparison test, ratio test, root test, Raabe's test, Logarithmic ratio test, Cauchy's condensation test, DeMorgan and Bertrand test and higher logarithmic ratio test. Alternating series, Leibnitz test, Absolute and conditional convergence, Congruence modulo m relation, Equivalence relations and partitions.

Unit 2. Definition of a group with examples and simple properties, Permutation groups, Subgroups, Centre and normalizer, Cyclic groups, Coset decomposition, Lagrange's theorem and its consequences.

Unit 3. Homomorphism and isomorphism, Cayley's theorem, Normal subgroups, Quotient group, Fundamental theorem of homomorphism, Conjugacy relation, Class equation, Direct product.

Unit 4. Introduction to rings, subrings, integral domains and fields, Characteristic of a ring, Homomorphism of rings, Ideals, Quotient rings.

Trigonometry

Unit 5. Complex functions and separation into real and imaginary parts, Exponential, direct and inverse trigonometric and hyperbolic functions, logarithmic function, Gregory's series, Summation of series.

Paper II: CALCULUS M.M. : 33/65

Differential Calculus

Unit 1. ε–δ definition of the limit of a function, Continuous functions and classification of discontinuities, Differentiability, Chain rule of differentiability, Rolle's theorem, First and second mean value theorems, Taylor's theorems with Lagrange's and Cauchy's forms of remainder, Successive differentiation and Leibnitz's theorem.

Unit 2. Expansion of functions (in Taylor's and Maclaurin's series), Indeterminate forms, Partial differentiation and Euler's theorem, Jacobians.

Unit 3. Maxima and Minima (for functions of two variables), Tangents and normals (polar form only), Curvature, Envelopes and evolutes.

Unit 4(*a*). Asymptotes, Tests for concavity and convexity, Points of inflexion, Multiple points, Tracing of curves in Cartesian and polar co-ordinates.

Integral Calculus

Unit 4(*b*). Reduction formulae, Beta and Gamma functions.

Unit 5. Qudrature, Rectification, Volumes and surfaces of solids of revolution, Pappus theorem, Double and triple integrals, Change of order of integration, Dirichlet's and Liouville's integral formulae.

Paper III : GEOMETRY and VECTOR CALCULUS M.M. : 34/70

Geometry

Unit 1. General equation of second degree, Tracing of conics, System of conics, Confocal conics, Polar equation of a conic and its properties.

Unit 2. Three dimensional system of co-ordinates, Projection and direction cosines, Plane, Straight line.

Unit 3. Sphere, cone and cylinder.

Unit 4. Central conicoids, Reduction of general equation of second degree, Tangent plane and normal to a conicoid, Pole and polar, Conjugate diameters, Generating lines, Plane sections.

Vector Calculus

Unit 5. Vector differentiation and integration, Gradient, divergence and curl and their properties, Line integrals, Theorems of Gauss, Green and Stokes and problems based on these.

B.A./B.Sc. II

(From 2012-13 onwards)

Paper I : LINEAR ALGEBRA and MATRICES M.M. : 33/65

Linear Algebra

Unit 1. Vector spaces and their elementary properties, Subspaces, Linear dependence and independence, Basis and dimension, Direct sum, Quotient space.

Unit 2. Linear transformations and their algebra, Range and null space, Rank and nullity, Matrix representation of linear transformations, Change of basis.

Unit 3. Linear functionals, Dual space, Bi-dual space, Natural isomorphism, Annihilators, Bilinear and quadratic forms, Inner product spaces, Cauchy-Schwarz's inequality, Bessel's inequality and orthogonality.

Matrices

Unit 4. Symmetric and skew-symmetric matrices, Hermitian and skew-Hermitian matrices, Orthogonal and unitary matrices, Triangular and diagonal matrices, Rank of a matrix, Elementary transformations, Echelon and normal forms, Inverse of a matrix by elementary transformations.

Unit 5. Characteristic equation, Eigen values and eigen vectors of a matrix, Cayley-Hamilton's theorem and its use in finding inverse of a matrix, Application of matrices to solve a system of linear (both homogeneous and non-homogeneous) equations, Consistency and general solution, Diagonalization of square matrices with distinct eigen values, Quadratic forms.

Paper II : DIFFERENTIAL EQUATIONS and INTEGRAL TRANSFORMS

M.M. : 33/65

Differential Equations

Unit 1. Formation of a differential equation (D.E.), Degree, order and solution of a D.E., Equations of first order and first degree : Separation of variables method, Solution of homogeneous equations, linear equations and exact equations, Linear differential equations with constant coefficients, Homogeneous linear differential equations,

Unit 2. Differential equations of the first order but not of the first degree, Clairaut's equations and singular solutions, Orthogonal trajectories, Simultaneous linear differential equations with constant coefficients, Linear differential equations of the second order (including the method of variation of parameters),

Unit 3. Series solutions of second order differential equations, Legendre and Bessel functions (P_n and J_n only) and their properties.

Order, degree and formation of partial differential equations, Partial differential equations of the first order, Lagrange's equations, Charpit's general method, Linear partial differential equations with constant coefficients.

Unit 4(*i*). Partial differential equations of the second order, Monge's method.

Integral Transforms

Unit 4(*ii*). The concept of transform, Integral transforms and kernel, Linearity property of transforms, Laplace transform, Inverse Laplace transform, Convolution theorem, Applications of Laplace transform to solve ordinary differential equations.

Unit 5. Fourier transforms (finite and infinite), Fourier integral, Applications of Fourier transform to boundary value problems, Fourier series.

Paper III : MECHANICS

Dynamics M.M. : 34/70

Unit 1. Velocity and acceleration along radial and transverse directions, and along tangential and normal directions, Simple harmonic motion, Motion under other laws of forces, Earth attraction, Elastic strings.

Unit 2. Motion in resisting medium, Constrained motion (circular and cycloidal only).

Unit 3. Motion on smooth and rough plane curves, Rocket motion, Central orbits and Kepler's law, Motion of a particle in three dimensions.

Statics

Unit 4. Common catenary, Centre of gravity, Stable and unstable equilibrium, Virtual work.

Unit 5. Forces in three dimensions, Poinsot's central axis, Wrenches, Null line and null plane.

B.A./B.Sc. III

(From 2013-14 onwards)

Paper I : REAL ANALYSIS M.M. : 36/75

Unit 1. Axiomatic study of real numbers, Completeness property in R, Archimedean property, Countable and uncountable sets, Neighbourhood, Interior points, Limit points, Open and closed sets, Derived sets, Dense sets, Perfect sets, Bolzano-Weierstrass theorem.

Unit 2. Sequences of real numbers, Subsequences, Bounded and monotonic sequences, Convergent sequences, Cauchy's theorems on limit, Cauchy sequence, Cauchy's general principle of convergence, Uniform convergence of sequences and series of functions, Weierstrass M-test, Abel's and Dirichlet's tests.

Unit 3. Sequential continuity, Boundeness and intermediate value properties of continuous functions, Uniform continuity, Meaning of sign of derivative, Darboux theorem.

Limit and continuity of functions of two variables, Taylor's theorem for functions of two variables, Maxima and minima of functions of three variables, Lagrange's method of undetermined multipliers.

Unit 4. Riemann integral, Integrability of continuous and monotonic functions, Fundamental theorem of integral calculus, Mean value theorems of integral calculus, Improper integrals and their convergence, Comparison test, μ-test, Abel's test, Dirichlet's test, Integral as a function of a parameter and its differentiability and integrability.

Unit 5. Definition and examples of metric spaces, Neighbourhoods, Interior points, Limit points, Open and closed sets, Subspaces, Convergent and Cauchy sequences, Completeness, Cantor's intersection theorem.

Paper II : COMPLEX ANALYSIS M.M. : 36/75

Unit 1. Functions of a complex variable, Concepts of limit, continuity and differentiability of complex functions, Analytic functions, Cauchy-Riemann equations (Cartesian and polar form), Harmonic functions, Orthogonal system, Power series as an analytic function.

Unit 2. Elementary functions, Mapping by elementary functions, Linear and bilinear transformations, Fixed points, Cross ratio, Inverse points and critical points, Conformal transformations.

Unit 3. Complex Integration, Line integral, Cauchy's fundamental theorem, Cauchy's integral formula, Morera's theorem, Liouville theorem, Maximum Modulus theorem, Taylor and Laurent series.

Unit 4. Singularities and zeros of an analytic function, Rouche's theorem, Fundamental theorem of algebra, Analytic continuation.

Unit 5. Residue theorem and its applications to the evaluation of definite integrals, Argument principle.

Paper III : NUMERICAL ANALYSIS and PROGRAMMING IN *C*

Numerical Analysis M.M. : 36/75

Unit 1. Shift operator, Forward and backward difference operators and their relationships, Fundamental theorem of difference calculus, Interpolation, Newton-Gregory's forward and backward interpolation formulae.

Unit 2. Divided differences, Newton's divided difference formula, Lagrange's interpolation formula, Central differences, Formulae based on central differences : Gauss, Striling's, Bessel's and Everett's interpolation formulae, Numerical differentiation.

Unit 3. Numerical integration, General quadrature formula, Trapezoidal and Simpson's rules, Weddle's rule, Cote's formula, Numerical solution of first order differential equations : Euler's method, Picard's method, Runge-Kutta method and Milne's method, Numerical solution of linear, homogeneous and simultaneous difference equations, Generating function method.

Unit 4. Solution of transcendental and polynomial equations by iteration, bisection, Regula-Falsi and Newton-Raphson methods, Algebraic eigen value problems : Power method, Jacobi's method, Given's method, Householder's method and Q-R method, Approximation : Different types of approximations, Least square polynomial approximation, Polynomial approximation using orthogonal polynomials, Legendre approximation, Approximation with trigonometric functions, exponential functions, rational functions, Chebyshev polynomials.

Programming in C

Unit 5. Programmer's model of computer, Algorithms, Data type, Arithmetic and input/out instruction, Decisions, Control structures, Decision statements, Logical and conditional operators, Loop case control structures, Functions, Recursion, Preprocessors, Arrays, Puppetting of strings Structures, Pointers, File formatting.

OPTIONAL PAPER

Any one of the following papers : M.M. : 42/75

Paper IV(*a*) : NUMBER THEORY and CRYPTOGRAPHY

Unit 1. Divisibility : gcd, lcm, prime numbers, fundamental theorem of arithmetic, perfect numbers, floor and ceiling functions, Congruence : properties, complete and reduced residue systems, Fermat's theorem, Euler functions, Chinese remaineder theorem.

Unit 2. Primality testing and factorization algorithms, Pseudo-primes, Fermat's pseudo-primes, Pollard's rho method for factorization.

Unit 3. Introduction to cryptography : Attacks, services and mechanisms, Security services, Conventional encryption - Classical techniques : Model, Stegnanography, Classical encryption technique, Modern techniques : DES, cryptanalysis, block cipher principles and design, Key distribution problem, Random number generation.

Unit 4. Hash functions, Public key cryptography, Diffie-Hellmann key exchange, Discrete logarithm-based crypto-systems, RSA crypto-system, Signature schemes, Digital signature standard (DSA), RSA signature schemes, Knapsack problem.

Unit 5. Elliptic curve cryptography : Introduction to elliptic curves, Group structure, Rational points on elliptic curves, Elliptic curve cryptography, Applications in cryptography and factorization, Known attacks.

Paper IV(*b*) : LINEAR PROGRAMMING

Unit 1. Linear programming problems, Statement and formation of general linear programming problems, Graphical method, Slack, and surplus variables, Standard and matrix forms of linear programming problem, Basic feasible solution.

Unit 2. Convex sets, Fundamental theorem of linear programming, Simplex method, Artificial variables, Big-*M* method, Two phase method.

Unit 3. Resolution of degeneracy, Revised simplex method, Sensitivity Analysis.

Unit 4. Duality in linear programming problems, Dual simplex method, Primal-dual method Integer programming.

Unit 5. Transportation problems, Assignment problems.

Paper IV(*c*) : DIFFERENTIAL GEOMETRY and TENSOR ANALYSIS

Differential Geometry

Unit 1. Local theory of curves- Space curves, Examples, Plane curves, tangent and normal and binormal, Osculating plane, normal plane and rectifying plane, Helices, Serret-Frenet apparatus, contact between curve and surfaces, tangent surfaces, involutes and evolutes of curves, Intrinsic equations, fundamental existence theorem for space curves, Local theory of surfaces- Parametric patches on surface curve of a surface, surfaces of revolutions, Helicoids, metric-first fundamental form and arc length.

Unit 2. Local theory of surfaces (Contd.), Direction coefficients, families of curves, intrinsic properties, geodesics, canonical geodesic equations, normal properties of geodesics, geodesics curvature, geodesics polars, Gauss-Bonnet theorem, Gaussian curvature, normal curvature, Meusneir's theorem, mean curvature, Gaussian curvature, umbilic points, lines of curvature, Rodrigue's formula, Euler's theorem.

Unit 3. The fundamental equation of surface theory – The equation of Gauss, the equation of Weingarten, the Mainardi-Codazzi equation, Tensor algebra : Vector spaces, the dual spaces, tensor product of vector spaces, transformation formulae, contraction, special tensor, inner product, associated tensor.

Unit 4. Differential Manifold-examples, tangent vectors, connexions, covariant differentiation. Elements of general Riemannian geometry-Riemannian metric, the fundamental theorem of local Riemannian Geometry, Differential parameters, curvature tensor, Geodesics, geodesics curvature, geometrical interpretation of the curvature tensor and special Riemannian spaces.

Tensor Analysis

Unit 5. Contravariant and covariant vectors and tensors, Mixed tensors, Symmetric and skew-symmetric tensors, Algebra of tensors, Contraction and inner product, Quotient theorem, Reciprocal tensors, Christoffel's symbols, Covariant differentiation, Gradient, divergence and curl in tensor notation.

Paper IV(*d*) : PRINCIPLES OF COMPUTER SCIENCE

Unit 1. Data Storage - Storage of bits, main memory, mass storage, Information of storage, The binary system, Storing integers, stroring fractions, communication errors.

Data Manipulations - The central processing unit, The stored program concept, Programme execution, Other Architectures, arithmetic/logic instructions, Computer – peripheral communication.

Unit 2. Operating System and Network – The evolution of operating system, Operating system architecture, Coordinating the machine's activates, Handling competition among process, networks, network protocol.

Unit 3. Algorithms - The concept of an algorithm, Algorithm representation, Algorithm, Discovery, Iterative structure, Recursive structures, Efficiency and correctness, (algorithm to be implemented in C++).

Unit 4. Programming Languages - Historical perspective, Traditional programming Concepts, Program units, Languages implementation, Parallel computing, Declarative computing.

Unit 5. Software Engineering - The software engineering discipline, The software life cycle, Modularity, Development, Tools and techniques, Documentation, Software ownership and liability. **Data Structures -** Array, Lists, Stack, Queues, Trees, Customised data types, Object-oriented.

Paper IV(*e*) : DISCRETE MATHEMATICS

Unit 1. Propositional Logic - Proposition logic, basic logic, logical connectives, truth tables, tautologies, contradiction, normal forms (conjunctive and disjunctive), modus ponens and modus tollens, validity, predicate logic, universal and existential quantification.

Method of Proof - Mathematical induction, proof by implication, converse, inverse, contrapositive, negation, and contradiction, direct proof by using truth table, proof by counter example.

Unit 2. Relation - Definition, types of relation, composition of relations, domain and range of a relation, pictorial representation of relation, properties of relation, partial ordering relation.

Posets, Hasse Diagram and Lattices - Introduction, ordered set, Hasse diagram of partially ordered set, isomorphic ordered set, well ordered set, properties of lattices, and complemented lattices.

Boolean Algebra - Basic definitions, Sum of products and product of sums, Logic gates and Karnaugh maps.

Unit 3. Graphs - Simple graph, multi graph, graph terminology, representation of graphs, Bipartite, regular, planar and connected graphs, connected components in a graph, Euler graphs, Hamiltonian path and circuits, Graph colouring, chromatic number, isomorphism and homomorphism of graphs.

Tree - Definition, Rooted tree, properties of trees, binary search tree, tree traversal.

Unit 4. Combinatorics - Basics of counting, permutations, combinations, inclusion-exclusion, recurrence relations (n^{th} order recurrence relation with constant coefficients, Homogeneous recurrence relations, Inhomogeneous recurrence relations), generating function (closed form expression, properties of G.F., solution of recurrence relation using, G.F, solution of combinatorial problem using G.F.).

Unit 5. Finite Automata - Basic concepts of automation theory, Deterministic finite automation (DFA), transition function, transition table, Non deterministic finite automata (NDFA), Mealy and Moore machine, Minimization of finite automation.

Paper IV(*f*) : MATHEMATICAL STATISTICS

Probability Theory

Unit 1. Three definitions of probability (Mathematical, Empirical & axiomatic). Dependent, independent and compound events.

Addition and multiplication theorems of probability, conditional probability. Bionomial and multinomial theorems of probability, Baye's theorem, Mathematical expectation and its properties, Moment generating functions (m.g.f.) and cumulants.

Distributions

Unit 2. Discrete distributions – Binomial & Poisson distributions and their properties.

Continuous distributions – Distribution function, Probability density function (Pdf), Cauchy's distribution, rectangular distribution, exponential distribution, Beta, Gamma Normal distributions and their properties.

Fitting of the Curves by method of least square – Straight line, parabola and exponential curves.

Correlation and Regression

Unit 3. Bivariate population, Meaning of correlation & regression. Coefficient of Correlation, rank correlation, lines of regression. Properties of regression coefficients, Partial and multiple correlation and their simple Properties.

Sampling Theory

Unit 4. Types of population, Parameters & Statistics, Null Hypothesis, Level of Significance, critical region. Procedure for testing Hypothesis. Type I & Type II error, χ^2- distribution and its properties.

Unit 5. Simple and random sampling. Test of significance for large samples. Sampling distribution of Mean. Standard error, Test of significance based on χ^2. Test of significance based on t,F & Z distribution, ANOVA.

REVISED SYLLABUS OF M.A./M.SC. (PREVIOUS) AND M.A./M.SC.(FINAL) MATHEMATICS EFFECTIVE FROM SESSION 2005-2006

Note:

1. Each paper will carry 100 marks
2. Five periods in a week shall be allotted to each paper.
3. Equal weightage shall be given to each section of a paper if the paper contains more than one section.
4. Five questions are to be attempted out of ten questions in each paper.
5. In paper II analysis (Real & Complex) of M.A./M.Sc. Previous five questions are to be attempted selecting, at least two questions from each section.

M.Sc.(Previous) (W.E.F. 2005-2006)

1. Advanced Algebra
2. Analysis (Real & Complex)
3. Differential Equations
4. Advanced Fluid Dynamics
5. Advanced Discrete Mathematics

M.Sc.(Final) (W.E.F. 2006-2007)

Compulsory

1. Partial Differential Equations and Their Numerical solutions.
2. Operations Research
3. Topology

Optional (Any two Papers) Fourth & fifth papers

1. Functional Analysis
2. Mathematical Statistics
3. Programming in C: Theory and Practical (only for regular students)
4. Difference Equations
5. Integral Equations and Boundary Value Problems.
6. Solar Megneto Hydrodynamics
7. Information Theory

8. Fuzzy Sets and Their Applications
9. Differential Geometry of Manifolds
10. Wavelets
11. Biomechanics
12. Plasma Dynamics
13. General Relativity & Cosmology
14. Dissertation may be opted as one of the optional paper only for regular students who have obtained at least 60% Marks in M.Sc. Previous.

DETAILS OF SYLLABI

M.A./M.SC. MATHEMATICS (PREVIOUS)

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

ADVANCED ALGEBRA

Groups- Normal and Subnormal Series, Composition Series, Jordan-Holder theorem, Solvable groups, Nilpotent groups.

Ring theory- Ring homomorphism. Ideals and Quotient Rings. Field of Quotients of an Integral Domain. Euclidean Rings. Polynomial Rings. Polynomials over the Rational Field. The Eisenstien Criterion. Polynomial Rings over Commutative Rings. Unique factorization domain. R unique factorisation domain implies so i & R $[x_1, x_2 .... x_n]$.

Definition and examples of vector spaces. Subspaces, Sum and direct sum of subspaces. Linear span. Linear dependence, independence and their basic properties. Basis, Finite dimensional vector spaces. Existence theorem for bases. Invariance of the number of elements of a basis set. Dimension, Existence of complementary subspace of a finite dimensional vector space. Dimension of sums of subspaces. Quotient space and its dimension. Linear transformations and their representation as matrices. The Algebra of linear transformations. The rank nullity theorem. Change of basis. Dual space. Bidual space and natural isomorphism. Adjoint of a linear transformation. Eigenvalues and eigenvectors of a linear transformation. Diagonalisation. Annihilator of a subspace. Bilinear, Quadratic and Hermitian forms.

Inner Product spaces-Cauchy- Schwarz inequality. Orthogonal vectors. Orthogonal Complements. Orthonormal sets and bases. Bessel's inequality for finite dimensional spaces. Gram-Schmidt Orthogonalization process.

Canonical Forms-Similarity of linear transformations. Invariant subspaces. Reduction to triangular forms. Nilpotent transformations. Index of nilpotency. Invariants of a nilpotent trasformation. The primary decomposition theorem. Jordan blocks and Jordan forms.

Modules, Submodules, Quotient modules, Homomorphism and Isomorphisms theorem.

Cyclic modules, Simple modules. Semi-simple modules. Schuler's lemma. Free modules. Field theory-Extension fields, Algebraic and transcendental extensions. Separable and inseparable extensions. Normal extensions. Perfect fields. Finite fields. Primitive elements. Algebraically closed fields. Automorphisms of extensions. Galois extensions. Fundamental theorem of Galois theory. Solution of polynomial equations by radicals. Insolvability of the general equation of degree 5 by radicals.

References

1. I.N, Herstein, Topics in Algebra, Wiley Eastern Ltd., New Delhi, 1975.
2. P.B. Bhattacharya, S.K. Jain and S.R. Nagpaul, Basic Abstract Algebra (2nd Edition), Cambridge University Press, Indian Edition, 1997.
3. M. Artin, Algebra, Prentice-Hall of India, 1991.
4. P.M. Cohn, Algebra, Vols. I, II & III, John Wiley & Sons, 1982, 1989, 1991.
5. N. Jacobson, Basic Algebra, Vols. I & II, WH. Freeman, 1980 (also published by Hindustan Publishing Company).
6. S. Lang, Algebra, 3rd edition, Addison-Wesley- 1993.
7. I.S. Luther and I.B.S. Passi, Algebra, Vol. I-Groups, Vol. II-Rings, Narosa Publishing House (Vol. 1-1996. Vol. II-1999).
8. D.S. Malik, J.N. Mordeson, and M.K. Sen, Fundamentals of Abstract Algebra, Mc Graw-Hill, International Edition, 1997.
9. K.B. Datta, Matrix and Linear Algebra, Prentice Hall of India Pvt. Ltd.,

New Delhi, 2000.

10. S.K. Jain, A, Gunawardena and P.B. Bhattacharya, Basic Linear Algebra with MATLAB, Key College Publishing (Springer-Verlag), 2001.
11. S. Kumaresan, Linear Algebra, A Geometric Approach, Prentice-Hall of India, 2000.
12. Vivek Sahai and Vikas Bist, Algebra, Narosa Publishing House, 1999.
13. I. Stewart, Galois Theory, 2nd edition, Chapman and Hall, 1989.
14. J.P. Escofier, Galois theory, GTM Vol. 204, Springer, 2001.
15. T.Y. Lam, Lectures on Modules and Rings, GTM Vol. 189, Springer-Verlag, 1999.
16. D.S. Passman, A Course in Ring Theory, Wadsworth and Brooks/Cole Advanced Books and Softwares, California, 1991.

M.A./M.SC. MATHEMATICS (PREVIOUS)

PAPER-II **M.M. : 100**

ANALYSIS (REAL & COMPLEX)

MM 50

Section A: Real Analysis

Definition and existence of Riemann-Stielijes integral, Properties of the Integral, Integration and differentiation, the fundamental theorem of calculus.

Rearrangements of terms of a series, Riemann's theorem.

Sequences and series of functions, pointwise and uniform convergence, Cauchy criteria for uniform convergence, Weierstrass M-test, Abel's and Dirichlet's tests for uniform convergence, uniform convergence and continuity, uniform convergence and Riemann-Stielijes integration. Uniform convergence and differentiation, Weierstrass approximation theorem, Power series uniqueness theorem for power series. Abel's and Tauber's theorems.

Functions of several variables, linear transformations, Derivatives in an open subset of Chain rule, Partial derivatives, interchange of the order of differentiation, Derivatives of high orders, Taylor's theorem, Inverse function theorem, Implicit function theorem, Jacobians, Lagrange's multiplier method.

Lebesgue outer measure. Measurable sets. Regularity. Measurable functions. Borel and Lebesgue measurability. Non-measurable sets, Reimann and Lebesgue Integrals.

Measures and outer measures, Extension of a measure. Uniqueness of extension compleltion of a measure. Measure spaces. Integration with respect to a measure.

Section B : Complex Analysis **MM 50**

Complex integration, Cauchy-Goursat theorem. Cauchy's integral-formula. Higher order derivatives. Morera's theorem. Cauchy's inequality and Liouville's theorem. The fundamental theorem of algebra. Taylor's theorem. Maximum modulus principle. Schwarz lemma. Laurent's series. Isolated singularities. Meromorphic functions. The argument principle. Rouche's theorem, Inverse function theorem.

Residues. Cauchy's residue theorem. Evaluation of integrals. Branches of many valued functions with special reference to arg z, log z and z^a.

Bilinear transformations, their properties and classifications. Definitions and examples of Conformal mappings.

Weierstrass' factorization theorem. Gamma function and its properties. Riemann Zeta function. Riemann's functional equation. Runge's theorem. Mittag-Leffler's theorem. Analytic Continuation. Uniqueness of direct analytic continuation. Uniqueness of analytic continuation along a curve. Power series method of analytic continuation. Schwarz Reflection Principle.

Canonical products. Jensen's formula. Poisson-Jensen Formula. Hadamard's three circles theorem. Order of an entire function. Exponent of Convergence. Borel's theorem. Hadamard's factorization theorem.

References

1. HA. Priestly. Introduction to Complex Analysis. Clarendon Press. Oxford, 1990.
2. J.B. Conway, Function of one Complex variable Springer-Verlag. International student-Edition. Narosa Publishing House, 1980.

3. Walter Rudin, Principles of Mathematical Analysis (3rd edition) McGraw-Hill, Kogakusha. 1976, International student edition.
4. T.M. Apostol, Mathematical Analysis, Narosa Publishing House, New Delhi, 1985.
5. Gabriel Klambauer, Mathematical Analysis, Marcel Dekkar, Inc. New York, 1975.
6. A.J. White, Real Analysis; an introduction, Addison-Wesley Publishing Co., Inc., 1968.
7. P.K. Jain and V.P. Gupta, Lebesgue Measure and Intergration, New Age International (P) Limited Published, New Delhi, 1986 (Reprint 2000).
8. J.P. Natanson, Theory of Functions of a Real Variable. Vol. I, Frederick Ungar Publishing Co., 1961.
9. H.L. Royden, Real Analysis, Macmillan Pub. Co. Inc. 4th Edition, New York, 1993.
10. P.R. Halmos, Measure Theory, Van Nostrand, Princeton, 1950.
11. T.G. Hawkins, Lebesgue's Theory of Integration : Its Origins and Development, Chelsea, New York, 1979.
12. R.G. Bartle, The Elements of Integration, John Wiley & Sons, Inc. New York, 1966.
13. Serge Lang, Analysis I& II, Addison-Wesley Publishing Company, Inc. 1969.
14. Inder K. Rana, An Introduction to Measure and Integration, Norosa Publishing House. Delhi, 1997.
15. Walter Rudin, Real & Complex Analysis, Tata Mc Graw-Hill Publishing Co. Ltd. New Delhi, 1966.
16. S.C. Malik and S. Arora, Mathematical Analysis, New Age International (P) Ltd. Publishers, 1992.
17. S.L. Gupta and N.R. Gupta, Principles of Real Analysis, Pearson Education, Singapure, 2003.

18. Liang-shin Hahn & Bernard Epstein, Classical Complex Analysis, Jones and Bartlett Publishers International, London, 1996.
19. L.V. Ahlfors. Complex Analysis, McGraw- Hill 1979.
20. S. Lang, Complex Analysis, Addison Wesley, 1977.
21. D. Sarason, Complex Function Theory, Hindustan Book Agency, Delhi, 1994.
22. Mark J. Ablowitz and A.S. Fokas, Complax Variables : Introduction and Applications, Cambridge University Press, South Asian Edition, 1998.
23. E. Hille, Analytic Function Theory (2 Vols.), Gonn & Co., 1959.
24. W.H.J. Fuchs, Topics in the Theory of Functions of one Complex Variable, D. Van Nostrand Co.,.1967.
25. C. Caratheodory, Theory of Functions (2 Vols.), Chelsea Publishing Company, 1964.
26. M. Heins. Complex Function Theory, Academic Press, 1968.

M.A./M.SC. MATHEMATICS (PREVIOUS)

PAPER-III **M.M. : 100**

DIFFERENTIAL EQUATIONS

Preliminaries-initial value problem and the equivalent integral equation, mth order equation in d-dimensions as a first order system, concepts of local existence, existence in the large and uniqueness of solutions with examples.

Basic Theorems-Ascoli- Arzela theorem. A theorem on Convergence of solutions of a family of initial value problems.

Picard-Lindelof theorem- Peano's existence theorem and corollary. Maximal intervals of existence. Extension theorem and corollaries. Kamke's convergence theorem. Kneser's theorem (statement only).

Differential Inequalities and Uniqueness- Gronwall's inequality. Maximal and Minimal solutions. Differential inequalities. A theorem of Winter. Uniqueness theorems. Nagumo's and Osgood's criteria.

Egres points and Lyapunov functions. Successive approximations.

Linear Differential Equations- Linear System, Variation of constants, reduction to smaller systems. Basic inequalities, constant coefficients. Floquet theory. Adjoint systems, Higher order equations.

Dependence on initial conditions and parameters; Preliminaries. Continuity. Differentiability. Higher Order Differentiability.

Poincare- Bendixson Theory-Autonomous systems. Umlanfsatz. Index of a stationary point.

Poincare- Bendixson theorem. Stability of periodic solutions, rotation points, foci, nodes and saddle points.

Linear second order equations-Preliminaries. Basic facts. Theorems of Sturm. Sturm-Liouville Boundary Value Problems. Number of zeros. Nonoscillatory equations and principal solutions. Nonoscillation theorems.

Use of Implicit function and fixed point theorems-Periodic solutions. Linear equations. Nonlinear problems.

Second order Boundry value problems- Linear problems. Nonlinear problems. Aproni bounds.

Recommended Text

P. Hartman, Ordinary Differential Equations, John Wiley (1964).

References

1. W.T. Reid, Ordinary Differential Equations, John Wiley & Sons, NY (1971).
2. E.A. Coddington and N. Levinson, Theory of Ordinary Differential Equations. McGraw-Hill, NY (1955).

M.A./M.SC. MATHEMATICS (PREVIOUS)

PAPER-IV **M.M. : 100**

ADVANCE FLUID DYNAMICS

Kinematics of Fluids- Lagrange's and Euler's Methods, Stream Lines, Equation of Continuity, Boundary Surface Equaton of Motions of Non-Viscous Fluids-Euler's Equation of Motion (Vector form), Bernoulli's Pressure equation, Equation for Impulsive Motion (Vector form). Motion in Two Dimensions: Stream Function, Complex Potential of the motion, Sources and Sinks in Two dimensions, Doublets, Images, Circle theorem, Blasius theorem and its applicaton..

General Theory of Irrotational Motion- Flow and Circulation, Permanence of Irrotational Motion, Kelvin's Circulation Theorem, Minimum Energy Theorem, Kulta-Joukowski Theorem, Kinetic Energy of Infinite Liquid. Motion of Cylinders, Motion of a Circular Cylinder, Liquid Streaming past a fixed circular cylinder, Motion of two co-axial cylinders, Circulation about a Circular Cylinder. Motion of an Elliptic Cylinder, Liquid streaming past a fixed Elliptic Cylinder, Rotating Elliptic Cylinders.

Irrotational motion in three dimensions: Motion of a sphere. Sphere through a liquid at rest at infinity. Liquid streaming past a fixed sphere. Equation of motion of a sphere. Stokes stream function.

Vortex motion and its elementary properties. Kelvin's proof of permanence Motions due to circular and rectilinear vortices. 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. Flow through a nozzle.Normal and oblique shocks.

Stress components in a real fluid. Relations between rectangular components of stress. Connection between stresses and gradients of velocity. Navier-stoke's equations of motion. Plane Poiseuille and Couctte flows between two parallel plates. Theory of Lubrication. Flow through tubes of uniform cross section in form of circle. annulus. ellipse and equilateral triangle under constant pressure gradient. Unsteady flow over a flat plate.

Dynamical similarity, Buckingham p-theorem. Reynolds number. Prandfs boundary layer. Boundary layer equations in two-dimensions. Blasius solution.

Boundary layer thickness. Displacement thickness. Karman integral conditions. Separation of boundary layer flow.

References

1. W.H. Besaint and A.S. Ramsey, A Treatise on Hydromechanics, Part II, CBS Publishers Delhi, 1988.
2. G.K. Batchelor, An Introduction to Fluid Mechanics, Foundation Books, New Delhi 1994.
3. F. Chorlton, Textbook of Fluid Dynamics, C.S.S. Publishers, Delhi, 1985.
4. A.J. Chorin and A. Marsden, A Mathematical Introduction to Fluid Dynamics, Springer-Verlag New York 1993.
5. L.D. Landau and E.M. Lipschitz, Fluid Mechanics. Pergamon Press. London,1985.
6. H. Schlichting, Boundary Layer Theory, McGraw Hill Book Company. New York 1979.
7. R.K. Rathy, An Introduction to Fluid Dynamics, Oxford and IBH Publishing Company, New Delhi, 1976.
8. A.D. Young, Boundary Layers. AIAA Education Series, Washington DC, 1989.
9. S.W. Yuan. Foundations of Fluid Mechanics, Prentice Hall of Indian Private Limited, New Delhi 1976.

M.A./M.SC. MATHEMATICS (PREVIOUS)

PAPER-V **M.M. : 100**

ADVANCED DISCRETE MATHEMATICS

Formal Logic-Statements. Symbolic Representation and Tautologies. Quantifiers, Predicates and Validity. Propositional Logic.

Semigroups & Monoids- Definitions and Examples of Semigroups and Monoids (including those pertaining to concatenation operation). Homomorphism of semigroups and monoids. Congruence relation and quotient Semigroups. Subsemigroup and submonoids. Direct products. Basic Homomorphism Theorem.

Lattices- Lattices as partially ordered sets. Their properties. Lattices as Algebraic systems. Sublattices, Direct products, and Homomorphisms. Some Special lattices e.g., Complete, Complemented and Distributive Lattices.

Boolean Algebras-Boolean Algebras as lattices. Various Boolean Identities. The Switching Algebra example. Sub algebras, Direct Products and Homomorphisms. joinirreducible elements, Atoms and Minterms. Boolean Forms and their Equivalence. Minterm Boolean Forms, Sum of Products. Canonical Forms. Minimization of Boolean Functions. Applications of Boolean Algebra to Switching Theory (using AND, OR & NOT gates). The Karnaugh Map method.

Graph Theory- Definition of (undirected) Graphs Paths, Circuits, Cycles, & Subgraphs. Induced Subgraphs. Degree of a vertex. Connectivity. Planar Graphs and their properties. Trees, Euler's Formula for connected Planar Graphs. Complete & Complete Bipartite Graphs. Kuratowski's Theorem (statement only) and its use. Spanning Trees, Cut-sets, Fundamental Cut-sets, and Cycles. Minimal Spanning Trees and Kruskal's Algorithm. Matrix Representations of Graphs.

Euler's Theorem on the Existence of Eulerian Paths and Circuits. Directed Graphs. In degree and Out degree of a vertex. Weighted undirected Graphs. Dijkstra's Algorithm. Strong Connectivity & Warshall's Algorithm. Directed Trees. Search Trees. Tree Traversals.

Introductory Computability Theory-Finite State Machines and their Transition Table Diagrams. Equivalence of Finite State Machines. Reduced Machines. Homomorphism. Finite Automata. Acceptors. Non-deterministic Finite Automata and equivalence of its power to that of Deterministic Finite Automata. Moore and Mealy Machines.

Turing Machine and Partial Recursive Functions.

Grammars and Languages-Phrase-Structure Grammars. Rewriting Rules. Derivations. Sentential Forms. Language generated by a Grammar. Regular, Context-Free, and Context Sensitive Grammars and Languages. Regular sets, Regular Expressions and the Pumping Lemma. Kleene's Theorem.

Notions of Syntax Aalysis. Polish Notations. Conversion of Infix Expressions to Polish Notations. The Reverse Polish Notation.

References

1. J.P. Tremblay & R. Manohar, Discrete Mathematical Structures with Applications to Computer Science, McGraw-Hill Book Co., 1997.
2. J.L. Gersting, Mathematical Structures for Computer Science, (3rd edition), Computer Science Press, New York.
3. Seymour Lepschutz, Finite Mathematics (International edition 1983). McGraw-Hill Book Company, New York.
4. S. Wiitala, Discrete Mathematics-A Unified Approach, McGraw-Hill Book Co.
5. J.E. Hopcroft and J.D. Ullman, Introduction to Automata Theory, Languages & Computation, Narosa Publishing House.
6. C.L. Liu, Elements of Discrete Mathematics, McGraw-Hili Book Co.
7. N. Deo, Graph Theory with Applications to Engineering and Computer Sciences, Prentice hall of india.

M.A./M.SC. MATHEMATICS (FINAL)

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

PARTIAL DIFFERENTIAL EQUATIONS AND THEIR NUMERICAL SOLUTIONS

Examples of PDE, Classification,

Transport Equation-Initial Value Problem, Non-homogeneous Equation.

Laplace's Equation-Fundamental Solution, Mean Value Formulas, Properties of Harmonic Functions, Green's Function, Energy Methods.

Heat Equation-Fundamental Solution, Mean Value Formula, Properties of Solutions, Energy Methods.

Wave Equation- Solution by Spherical Means. Non-homogeneous Equations, Energy Methods.

Nonlinear First Order PDE- Complete Integrals, Envelopes, Characteristics, Hamilton Jacobi Equations (Calculus of Variations, Hamilton's ODE, Legendre Transform, Hopf-Lax Formula, Weak Solutions, Uniqueness), Conservation Laws (Shocks, Entropy Conditions, Lax-Oleinik Formula, Weak Solutions, Uniqueness, Riemann's Problem, Long Time Behaviour)

Representation of Solutions-Separaton of Variables, Similarity Solutions (Piane and Travelling Waves, Solutions, Similarity Under Scaling), Fourier and Laplace Transform, Hopf-Cole Transform, Hodograph and Legendre Transforms. Potential Functions, Asymptotics (Singular Perturbations. Laplace's Method, Geomatric Optics. Stationary Phase, Homogenization), Power Series (Non Characteristic Surfaces, Real Analytic functions, Cauchy-Kovalevskaya Theorem).

Deriving Difference Equations, Eltiptic equations : solution of Laplace's equation, Liebmann's iterative method, relaxation method, solution of Poisson's equations, Parabolic equations, Solution of heat equation, Bender-Schmidt method. The Crank-Nicholson method, Hyperbolic equations : solution of hyperbolic equations.

References

1. LC. Evans, Partial Differential Equations. Gradute Studies in Mathematics. Volume 19, AMS, 1998.

2. Books with the above title by I.N. Sneddon, F. John, P.Prasad and R. Ravindran, Amarnath etc.

M.A./M.SC. MATHEMATICS (FINAL)

PAPER-II **M.M. : 100**

OPERATIONS RESERACH

Operations Research and its Scope. Necessity of Operations Research in Industry.

Linear Programming-Simplex and revised simplex Method. Theory of the Simplex Method. Duality and Sensitivity Analysis.

Other Algorithms for Linear Programming-Dual Siplex Method. Parametric Linear Programming. Upper Bound Technique. Interior Point Algorithm. Linear Goal Programming.

Transportation and Assignment Probelms.

Network 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.

Dynamic Programming-Deterministic and Probabilistic Dynamic programming.

Game Theory-Two-Person, Zero-Sum Games. Games with Mixed Strategies. Graphical Solution. Solution by Linear Programming.

Integer Programming-Branch and Bound Technique.

Applications to industrial Problems-Optimal product mix and activity levels. Petroleumrefinery operations. Blending problems. Economic interpretation of dual linear programming problems. Input-output analysis. Leontief system. Indecomposable and Decomposable ecomomies.

Nonlinear Programming-One and Multi-Variable Unconstrained Optimization. Kuhn-Tucker Conditions for Constrained Optimization. Quadratic Programming. Separable Programming. Convex Programming. Non-convex Programming.

References

1. F.S. Hillier and G.J. Lieberman. Introduction to Operations Research (Sixth Edition), McGraw Hill International Edition, Industrial Engineering Series, 1995. (This book comes with a CD containing tutorial software).
2. G. Hadly, Linear Programming, Narosa Publishing House, 1995.
3. G. Hadly, Nonlinear and Dynamic Programming, Addison-Wesley. Reading Mass.
4. Mokhtar S. Bazaraa, John J. Jarvis and Hanif D. Sherali, Linear Programming and Network flows, John Wiley & Sons, New York, 1990.
5. H.A. Taha, Operations Rsearch-An introduction, Macmillan Publishing Co. Inc., New York.
6. Kanti Swarup, P.K. Gupta and Man Mohan. Operations Research. Sultan Chand & Sons. New Delhi.
7. S.S. Rao, Optimization Theory and Applications, Wiley Eastern Ltd., New Delhi.
8. Prem Kumar Gupta and D.S. Hira : Operations Research-An Introduction. S. Chand & Company Ltd., New Delhi.
9. N.S. Kambo, Mathematical Programming Techniques. Affiliated East-West Press Pvt. Ltd., New Delhi, Madras.

M.A./M.SC. MATHEMATICS (FINAL)

PAPER-III **M.M. : 100**

TOPOLOGY

Countable and uncountable sets. Infinite sets and the Axiom of Choice. Cardinal numbers and its arithmetic. Schroeder-Bernstein theotem. Cantor's theorem and the continuum hypothesis. Zorn's lemma. Well-ordering theorem.

Definition and examples of topological spaces. Closed sets. Closure. Dense subsets. Neighbourhoods. Interior, exterior and boundary. Accumulation points and derived sets. Bases and sub-bases. Subspaces and relative topology.

Alternate methods of defining a topology in terms of Kuratowski-Closure

Operator and Neighbourhood System.

Continuous functions and homeomorphism.

First and Second Countable spaces. Lindelof's theorems. Separable spaces. Second Countability and Separability.

Separation axioms T_0, T_1, T_2, T_3, T_4; their Characterizations and basic properties. Urysohn's lemma. Tietze extension theorem.

Compactness. Continuous functions and compact sets. Basic properties of compactness. Compactness and finite intersection property. Sequentially and countably compact sets. Local compactness and one point compactification. Stone-vech compactification. Compactness in metric spaces. Equivalence of compactness, countable compactness and sequential compactness in metric spaces.

Connected spaces. Connectedness on the real line. Components. Locally connected 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 (Tychonoff's theorem). Countability and product spaces.

Embedding and metrization. Embedding lemma and Tychonoff embedding. The Urysohn metrization theorem.

Nets and filters. Topology and convergence of nets. Hausdorffness and nets. Compactness and nets. Filters and their convergence. Canonical way of converting nets to filters and vice-versa. Ultra-filters and Compactness.

Metrization theorems and Paracompactness-Local finiteness. The Nagata-Smirnov metrization theorem. Paracompactness. The Smirnov metrization theorem.

The fundamental group and covering spaces-Homotopy of paths. The fundamental group. Covering spaces. The fundamental group of the circle and the fundamental theorem of algebra.

Reference

1. James R. Munkres, Topology, A first Course. Prentice Hall of India Pvt. Ltd., New Delhi, 2000.
2. J. Dugundji, Topology, Allyn and Bacon. 1996 (Reprinted in India by Prentice Hall of India Pvt. Ltd.).

3. George F. Simmons. Introduction to Topology and Modern Analysis, McGraw Hill Book Company, 1963.
4. K.D. Joshi, Introduction to General Topology, Wiley Eastern Ltd., 1983.
5. J. Hocking and G. Young, Topology, Addison-Wesley. Reading, 1961.
6. J.L. Kelley, General Topology, Van Nostrand, Reinhold Co., New York, 1995.
7. L. Steen and J. Seebach, Counter examples in Topology, Holt, Rinehart and Winston, New York, 1970.
8. N. Bourbaki, General Topology Part I (Transl.), Addison Wesley, Reading, 1966.

M.A./M.SC. MATHEMATICS (FINAL)

OPTIONAL PAPERS

(Any two of followings)

1. FUNCTIONAL ANALYSIS — M.M. 100

Normed linear spaces. Banach spaces and examples. Quotient space of normed linear spaces and its completeness, equivalent norms. Riesz Lemma, basic properties of finite dimensional normed linear spaces and compactness. Weak convergence and bounded linear transformations, normed linear spaces of bounded linear transformations, dual spaces with examples. Uniform boundedness theorem and some of its consequences. Open mapping and closed graph theorems. Hahn-Banach theorem for real linear spaces, complex linear spaces and normed linear spaces. Reflexive spaces. Weak Sequential Compactness. Compact Operators. Solvability of linear equations in Banach spaces. The closed Range Theorem.

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 a Hilbert space. Reflexivity of Hilbert spaces. Self-adjoint operators, Positive projection, normal and unitary operators. Abstract variational boundary-value problem. The generalized Lax-Milgram theorem.

Reference

1. H.L. Royden, Real Analysis, Macmillan Publishing Co: Inc., New York, 4th Edition, 1993.
2. G. Bachman and L. Narici, Functional Analysis, Academic Press, 1966.
3. R.E. Edwards, Functional Analysis, Holt Rinehart and Winston, New York, 1965.
4. P.K. Jain, O.P. Ahuja and Khalil Ahmad, Functional Analysis, New Age International (P) Ltd. & Wiley Eastern Ltd., New Delhi, 1997.
5. E. Kreyszig, Introductory Functional Analysis with Applications, John Wiley & Sons, New York, 1978.
6. B. Choudhary and Sudarsan Nanda, Functional Analysis with Applications, Wiley Eastern Ltd., 1989.
7. B.V. Limaye, Functional Analysis, Wiley Eastern Ltd.
8. G.F. Simmons, Introduction to Topology and Modern Analysis, McGraw-Hill Book Company, New York, 1963.
9. A.E. Taylor, Introduction to Functional Analysis, John Wiley and Sons, New York, 1958.
10. Walter Rudin, Functional Analysis, Tata McGraw-Hill Publishing Company Ltd., New Delhi, 1973.
11. A.H. Siddiqui, Functional Analysis with Applications, Tata McGraw-Hill Publishing Company Ltd., New Delhi.

M.A./M.SC. MATHEMATICS (FINAL)

OPTIONAL PAPERS

2. MATHEMATICAL STATISTICS M.M. 100

Probability- Set theoretic approach, Boole's inequality, Baye's theorem, Geometric probability, Random Variables- Distribution function, Joint probability distribution function, Conditional distribution function, Transformation of one and two dimensional Random variables Mathematical Expectation- Covariance, variance of n variates, Chebycheffs Inequality, Weak and Strong Laws of large numbers.

Moment Generating and Characteristic Functions and Cumulants- Study of the following distributions, their relationship with each other, distribution of their sum, difference, product, quotient etc.(a) Binomial, Poisson, Negative Binomial, Geometric, Pascal's, Polya's Hypergeometric distributions, Multinomial power series and discrete uniform, Compound binomial and poisson distributions. (b) Normal log-normal, log-normal, Gamma, Beta, Exponential, Bivariate Normal, Laplace, Weibul, Cauchy and Pearson's distributions.

Central Limit theorem, Underberg-Levy theorem., Derivation of Chi-square distributions, Non central chi-square distribution, Test of significance. Distribution Function-of t, F and z Test of significance. Theory of estimates- Principle of maximum likelihood, Properties of maximum likelihood estimators, Analysis of Variance- Analysis of variance in one way and two way classification.

References :

1. J.N. Kapur, Mathematical Statistics
2. S.C. Gupta & V.K. Kapur, Fundamentals of Mathematical Statistics.
3. J.K. Goyal & J.N. Sharma, Mathematical Statistics.
4. M. Ray & H.S. Sharma, Mathematical Statistics.

M.A./M.SC. MATHEMATICS (FINAL)

OPTIONAL PAPERS

3. Programming in C (with ANSI features)-Theory and Practical M.M.100

Note : The paper will have 70 marks for theory examination and 30 marks for practical examination.

An overview of programming. Programming language, Classification.

C Essentials-Program Development. Functions. Anatomy of a C Function. Variables and Constants. Expressions. Assignment Statements. Formatting Source Files. Continuation Character The Preprocessor.

Scalar Data Types-Declarations, Different Types of Integers. Different kinds of Integer Constants. Floating-Point Types. Initialization. Mixing Types. Explicit Conversions-Casts Enumeration Types. The Void Data Type. Typedefs. Finding the Address of an object. Pointers.

Control Flow-Conditional Branching, The Switch Statement. Looping

Nested Loops. The break and continue Statements. The goto statement. Infinite Loops.

Operators and Expressions-Precedence and Associativity. Unary Plus and Minus operators. Binary Arithmetic Operators. Arithmetic Assignment Operators. Increment and Decrement Operators. Comma Operator. Relational Operators. Logical Operators. Bit-Manipulation Operators.Bitwise Assignment Operators. Cast Operator. Size of Operators Conditional Operator. Memory Operators.

Arrays and Pointers-Declaring an Array. Arrays and memory. Initializing Arrays. Encryption and Decryption. Pointer Arithmetic. Passing Pointers as Function Arguments. Accessing Array Elements through Pointers. Passing Arrays as Function Arguments. Sorting Algorithms. Strings. Multidimensional Arrays. Arrays of Pointers. Pointers to Pointers.

Storage Classes-Fixed. vs. Automatic Duration. Scope. Global variables. The register Specifier. ANSI rules for the syntax and Semantics of the storage-class keywords. Dynamic Memory Allocation.

Structures and Unions-Structures. Linked Lists. Unions. enum Declarations.

Functions- Passing Arguments. Declarations and Calls. Pointers to Functions. Recursion. The main ( ) Function. Complex Declarations.

The C Preprocessor-Macro Substitution. Conditional Compilation. Include Facility. Line Control.

Input and Output-Streams, Buffering. The<Stdio.h> Header File. Error Handling. Opening and Closing a File. Reading and Writing Data. Selecting an I/O Method. Unbuffered I/O Random Access. The standard library for Input/Output.

Recommendead Text:

1. Peter A. Darneil and Philip E. Margolis, C: A Software Engineering Approach, Narosa Publishing House (Springer International Student Edition) 1993.

References

2. Samuel P. Harkison and Gly. L. Steele Jr., C : A Reference Maunal, 2nd Edition, Prentice Hall, 1984.
3. Brian W. Kernighan & Dennis M. Ritchie, The C Programme Language. 2nd Edition (ANSI features). Prentice Hall 1989.

M.A./M.SC. MATHEMATICS (FINAL)

OPTIONAL PAPERS

M.M. 100

4.Difference Equations

Introduction, Difference Calculus-The Difference Operator, Summation, Generating functions a approximate summation.

Linear Difference Equations-First order equations. General results for linear equation. Equations with constant coefficients. Applications. Equations with variable coefficients. Nonlinear equations that can be linearized. The z-transform.

Stabilty Theory-Initial value problems for linear systems. Stability of linear systems Stability of nonlinear systems, Chaotic. behaviour.

Asymptotic methods-Introduction. Asymptotic analysis of sums. Linear equations, Nonlinear equations.

The self-adjoint second order linear equation. Introduction. Sturmian Theory. Greens functions, Disconjugacy. The Riccati Equations. Oscillation.

The Sturm-Liouville problem-introduction, Finite Fourier Analysis, A non-homogeneous problem.

Discrete Calculus of variations-Introduction. Necessary conditions. Sufficient Conditions and Disconjugacy.

Boundary Value Problems for Nonlinear equations-Introduction. The Lipschitz case. Existence of solutions. Boundary Value Problems for Differential Equations.

Partial Differential Equations.

Discretization of Partial Differential Equations.

Solution of partial Differential Equatins.

Recommended Text

Walter G. Kelley and Allan C. Peterson-Difference Equations. An Introduction with Applicatons. Academic press Inc., Harcourt Brace Joranovich Publishers, 1991.

References

Calvin Ahlbrandt and Allan C. Peterson. Discrete Hamiltonian Systems, Difference Equations, Continued Fractions and Riccati Equations. Kluwer, Boston, 1996.

M.A./M.SC. MATHEMATICS (FINAL)

OPTIONAL PAPERS

5. Integral Equations and Boundary Value Problems M.M. 100

Definitions of Integral Equations and their classification. Eigen values and Eigen functions. Fredholm integral equations of second kind with separable kernels. Reduction to a system of algebraic equations. An Approximate Method. Method of Successive Approximations. Iterative Scheme for Fredholm Integral equations of the second kind. Conditions of uniform convergence and uniqueness of series solution. Resolvent kernel and its results. Application of iterative Scheme to Volterra integral equations of the Second kind.

Classical Fredholm Theory. Fredholm Theorems.

Integral Transform Methods. Fourier Transform. Laplace Transform. Convolution integral. Application to Volterra integral equations with convolution. type kernels, Abel's equations. Inversion formula for singular integral equalions with kernel of the type (h(s)-h(t)-a, 0<a<1. Cauchy's Principal Value of singular integrals. Solution of Cauchy-type singular integral equation. The Hilbert Kernel. Solution of the Hilbert-Type singular integral equation.

Symmetric kernels. Complex Hilbert Space. Orthonormal system of functions. Fundamental properties of eigen values and eigen functions for symmetric kernels. Expansion in eigen function and bilinear form. Hilbert Schmidt Theorem and some immediate consequences. Solutions of integral equations with symmetric kernels.

Definition of a boundary value problem for an ordinary differential equation of the second order and its reduction to a Fredholm integral equation of the second kind. Dirac Delta Function. Green's function approach to reduce boundary value problems of a self-adjoint differential equation with homogeneous boundary conditions to integral equation forms. Auxiliary problem satisfied by Green's function. Integral equation formulations of boundary value problems with more general and inhomogeneous boundary conditons. Modified Green's function.

Integral representation formulas for the solution of the Laplace's and Poisson's equations. Newtonian single-layer and double layer potentials. Interior and exterior Dirichlet and Neumann boundary value problems for Laplace's equation.

Green's function for Laplace's equation in a free space as well as in a space bounded by a ground vessel. Integral equation formulation of boundary value problems for Laplace's equation.

Poisson's integral formula. Green's function for the space bounded by grounded two parallel plates or an infinite circular cylinder.

Perturbation techniques and its applications to mixed boundary value problems. Two-part and three-part boundary value problems.

Solutions of electrostatic problems involving a charged circular disk and annular circular disk, a spherical cap, an annular spherical cap in a free space or a bounded space.

Reference

1. R.P. Kanwai, Linear Integral Equation. Theory and Techniques, Academic Press, New York, 1971.
2. S.G. Mikhlin, Linear Integral Equations (translated from Russian) Hindustan Book Agency, 1960.
3. I.N. Sneddon, Mixed boundary value problems in potential theory North Holland, 1966.
4. I. Stakgold, Boundary value porblems of Mathematical Physics, Vol. I, II, Mac Millan, 1969.

M.A./M.SC. MATHEMATICS (FINAL)

OPTIONAL PAPERS

6.SOLAR MAGNETO HYDRODYNAMICS M.M. 100

Description of the Sun : Brief history, Interior of the Sun, Outer atmosphere of the Sun, The quiet Sun, Transient features.

Basic Equations of MHD : Electromagnetic equations, Plasma equations, Energy equations, Induction equation, Lorentz force, Some theormes, Magnetic flux tube behaviour, Current sheet behaviour.

Magnetohydrostatic : Plasma structure in prescribed magnetic field, Structure of magnetic flux tubes, Current free fields, force free fields, Magnetohydrostatic fields.

Waves : Sound waves, Magnetic waves, Internal-Gravity waves, Inertial waves, Magnetoacoustic waves, Acoustic-Gravity waves, Magnetoacoustic-Gravity waves, Five minute oscillations, Waves in strongly inhomogeneous medium, Surface waves on magnetic interface.

Shock waves : Hydrodynamic shocks, Perpendicular shocks, Oblique shocks.

Heating of the Upper Atmosphere : Models for atmospheric structure, Acoustic wave heating, Magnetic heating, Coronal loops.

Instability : Linearized equations, Normal mode method, Rayleigh-Taylor instability, Variational (Energy) method, Kink instability, Interchange instability, Kelvin-Helmholtz instability, Resistive Instability, Convective instability.

Sunspots : Magnetoconvection, Magnetic buoyancy, Cooling of sunspots, Equilibrium structure of Sun spots, penumbra, Evolution of a sunspot, Intense flux tubes.

Solar Flares: Magnetic reconnection, Simple-loop flare, Kink instability, Two-Ribbon flare, Eruptive instability, Post-flare loops.

Prominences : Formation, Magnetohydrostatics of support in a simple arcade, Kippenhahn-Schluter model, Support in configurations with helical fields, Coronal transients, Twisted & untwisted loop models.

Solar Wind : Parker's solution, Models for a spherical expansion, Streamers and coronal holes, Pneuman-Kopp model, Coronal hole models.

References:

1. E. R. Priest, Solar Magnetohydrodynamics, D. Reidel Publishing Company, Dordrecht, Holland, 1982.
2. A. Jeffrey, Magnetohydrodynamics, Oliver & Boyd, Edinburgh, 1966.
3. T.G. Cowling, Magnetohydrodynamics, Adam Hilger, Bristol, England, 1976
4. K.J.H. Phillips, Guide to the sun, Cambridge University Press, 1992.
5. P.H. Roberts, An introduction to Magnetohydrodynamics, Longmans, 1967.
6. S. Chandrasekhar, Hydrodynamic and Hydromagnetic Stability, Cambridge University Press, England, 1961.
7. R.G. Athay, The Solar Chromosphere and Corona : Quiet Sun, D. Reidel Dordrecht, Holland, 1976.

M.A./M.SC. MATHEMATICS (FINAL)

OPTIONAL PAPERS

7. Information Theory **M.M. 100**

Measure of Information- Axioms for a measure of uncertainity. The Shannon entropy and its properties. Joint and conditional entropies. Transformation and its properties.

Noiseless coding- Ingredients of noiseless coding problem. Uniquely decipherable codes. Necessary and sufficient condition for the existence of instantaneous codes. Construction of optimal codes.

Discrete Memoryless Channel- Classification of channels. Information processed by a channel. Calculation of channel capacity. Decoding schemes. The ideal observer. The fundamental theorem of information theory and its strong and weak converses.

Continuous Channels- The time-discrete Gaussian channel . Uncertainity of an absolutely continuous random variable. The converse to the coding theorem for time-discrete Gaussian channel. The time-continuous Gaussian channel. Band-limited channels.

Some imuitive properties of a measure of entropy Symmetry, normalization, expansibility, boundedness, recursivity maximality, stability, additivity, subadditivity, nonnegativity, continuity, branching etc, and interconnections among them. Axiomatic characterization of the Shannon entropy due to Shannon and Fadeev.

Information functions, the fundamental equation of information, information functions continuous at the origin, nonnegative bounded information functions, measurable Information functions and entropy. Axiomatic characterizations of the Shannon entropy due to Tverberg and Leo. The general solution of the fundamental equation of information. Derivations and their role in the study of information functions.

The branching property. Some characterizations of the Shannon entropy based upon the branching property. Entropies with the sum property. The Shannon inequality. Subadditive, additive entropies.

The Renji entropies. Entropies and mean values. Average entropies and their equality, optimal coding and the Renji entropies. Characterization of some measures of average code length.

References

1. R. Ash, Information Theory, Interscience Publishers, New York, 1965.
2. F.M. Reza, An Introduction to Information Theory, MacGraw-Hill Book Company Inc., 1961.
3. J. Aczel and Z. Daroczy, On measures of information and their characterizations, Academic Press, New York.

M.A./M.SC. MATHEMATICS (FINAL)

OPTIONAL PAPERS

8. Fuzzy Sets and Their Applications M.M. 100

Fuzzy Sets-Basic definitions. α-level sets. Convex fuzzy sets. Basic operations on fuzzy sets. Types of fuzzy sets. Cartesian products. Algebraic products. Bounded sum and difference. t-norms and t-conorms.

The Extension Principle-The Zadeh's extension principle. Image and inverse image of fuzzy sets. Fuzzy numbers. Elements of fuzzy artithmetic.

Fuzzy Relations and fuzzy Graphs-Fuzzy relations on fuzzy sets. Compositon of fuzzy relations. Min-Max composition and its properties. Fuzzy equivalence relations. Fuzzy compatibility relations. Fuzzy relation equations. Fuzzy graphs. Similarity relation.

Possibility Theory-Fuzzy measures. Evidence theory. Necessity measure. Possibility measure. Possibility distribution. Possibility theory and fuzzy sets. Possibility theory versus probability theory.

Fuzzy Logic-An overview of classical logic, Multivalued logics. Fuzzy propositions. Fuzzy quantifiers. Linguistic variables and hedges. Inference from conditonal fuzzy propositions, the compositional rule of inference.

Approximate Reasoning-An overview of fuzzy expert system. Fuzzy implications and their selection. multiconditional approximate reasoning. The role of fuzzy relation eqnation.

An Introduction to Fuzzy Control-Fuzzy controlers. Fuzzy rule base. fuzzy inference engine. Fuzzification. Defuzzification and the various defuzzification methods (the centre of area, the centre of maxima, and the mean of maxima methods).

Decision Making in Fuzzy Environment-Individual decision making. Multiperson decision making. Multicriteria decision making. Multistage decision making. Fuzzy ranking methods. Fuzzy linear programming.

References

1. H.J. Zimmermann. Fuzzy set theory and its Applications, Allied Publishers Ltd., New Delhi , 1991.
2. G.J. Klir and B. Yuan-Fuzzy sets and fuzzy logic. Prentice-Hall of India, New Delhi, 1995.

M.A./M.SC. MATHEMATICS (FINAL)

OPTIONAL PAPERS

9. Differential Geometry of Manifolds... M.M. 100

Definition and examples of differentiable manifolds. Tangent spaces. Jacobian map. One parameter group of transformations. Lie derivatives. Immersions and imbeddings. Distributions. Exterior algebra. Exterior derivative.

Topological groups. Lie groups and lie algebras. Product of two Liegroups. One Parameter subgroups and exponential maps. Examples of Liegroups. Homomorphism and Isomorphism. Lie transformation groups. General linear groups. Principal fibre bundle. Linear frame bundle. Associated fibre bundle. Vector bundle. Tangent bundle. Induced bundle. Bundle homomorphisms.

Riemannian manifolds. Riemannian connection. Curvature tensors. Sectional Curvature. Schur's theorem. Geodesics in a Riemanninan manifold. Projective curvature tensor. Conformal curvature tensor.

Submanifolds & Hypersurfaces. Normals. Gauss formulae. Weingarten equations. Lines of curvature. Generalized Gauss and Mainardi-Codazzi equations.

Almost Complex manifolds. Nijenhuis tensor. Contravariant and covariant almost analytic. vector fields. F-connection.

References

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, Chandrarna Prakashan, Allahabad, 1984.
3. B.B. Sinha, An Introduction to Modern Differential Geometry, Kalyani Publishers, New Delhi, 1982.
4. K. Yano and M. Kon, Structure of Manifolds, World Scientific Publishing Co. Pvt. Ltd., 1984.

M.A./M.SC. MATHEMATICS (FINAL)

OPTIONAL PAPERS

10. Wavelets Preliminaries. **M.M. 100**

Different ways of constructing wavelets-Orthonormal bases generated by a single function: the Balian-Low theorem. Smooth projections on $L^2(R)$. Local sine and cosine bases and the construction of some wavelets. The unitary folding operators and the smooth projections. Multiresolution analysis and construction of wavelets. Construction of compactly supported wavelets and estimates for its smoothness. Band limited wavelets.Orthonormality. Completeness. Characterization of Lemarie-Meyer wavelets and some other characterizatons. Franklin wavelets and Spline wavelets on the real line. Orthonormal bases of piecewise linear continuous functions for $L^2(T)$. Orthonormal bases of periodic splines, Periodization of wavelets defined on the real line.

Characterizations in the theory of wavelets-The basic equations and some of its applications. Characterizations of MRA wavelets, low-pass filters and scaling functions. Non-existence of smooth wavelets in $H^2(R)$.

Frames- The reconstruction formula and the Balian-Low theorem for frames. Frames from translations and dilations. Smooth frames for $H^2(R)$.

Discete transforms and algorithms-The discrete and the fast Fourier transforms. The discrete and the fast cosine transforms. The discrete version of the local sine and cosine bases. Decomposition and reconstruction algorithms for wavelets.

Recommendead text

Eugenio Hernandez and Guido Weiss; A First Course on Wavelets, CRC Press, NewYork) 1996.

References

1. C.K. Chui, An Introduction to Wavelets, Academic Press, 1992.

2. I. Daubechies, Ten Lectures on Wavelets, CBS-NSF Regional Conferences in Applied Mathematics, 61, SIAM, 1992.
3. Y. Meyer, Wavelets, algorithms and applications (translated by R.D. Rayan. SIAM, 1993.
4. M.V. Wickerhauser, Adapted wavelet analysis from theory to software, Weilesley, MA, A.K. Peters, 1994.

M.A./M.SC. MATHEMATICS (FINAL)

OPTIONAL PAPERS

11. BIOMECHANICS **M.M. 100**

Prerequisite : Fluid Mechanies

Newton's equations of motion. Mathematical modeling. Continuum approach.

Segmental Movement and Vibratons.

External Flow: Fluid Dynamic Forces Acting on Moving Bodies.

Flying and Swimming.

Blood Flow in Heart, Lung, Arteries, and Veins.

Micro-and macrocirculation.

Respiratory Gas Flow.

The Laws fo Thermodynamics. Molecular Diffusion, Mechanisms in Membrances and Multiphasic Structure.

Mass Trasport in Capillaries, Tissues, Interstitial Space, Lymphatics, Indicator Dilution Method and Peristalsis.

Description of Internal Deformation and Forces.

Stress, Strain and Stability of Organs.

Strength, Trauma and Tolerance.

Biomechanical Aspects of Growth. Engineering of Blood Vessels. Tissue Engineering of Skin.

Recommended Text

Y.C Fung, Biomechanics, Springer-Verlag, New York Inc., 1990.

M.A./M.SC. MATHEMATICS (FINAL)

OPTIONAL PAPERS

12. PLASMA DYNAMICS M.M. 100

Introduction

Particle orbit theory

Macroscopic Equations: Fluid model of a plasma, Moment equations, Hydromagnetic equations, Criteria for applicability of a fluid description.

Hydromagnetic : Kinematics, Static problems, Hydromagnetic stability, interchange, Instabilities, Alfven waves.

Hydromagnetic Flows: Hydromagnetic Navier-Stokes equation, Hartmann flow, Couette flow, Flow stability, Parallel flows, Transverse flows, Plasma propulsion, MHD generators.

Shock Waves in Plasma: Hydromagnetic shock equations, Shock propagation parallel to magnetic field, Shock propagation perpendicular to magnetic field, Shock thickness, Collisionless shocks.

Waves in Cold Plasma: Some general wave concepts, Waves in cold plasmas: Alfven waves, Ion-cyclotron waves, Experimental results for low frequency waves, General theory of waves in cold plasmas, CMA diagram.

Waves in Warm Plasmas: MHD waves, Longitudinal waves in warm plasmas, Ion acoustic waves, Landau damping of longitudinal plasma waves, Experimental results for waves in warm plasmas, General dispersion relation.

Kinetic Theory: Equation for distribution function, Near-equilibrium plasma, Vlasov equation, Landau damping, Boltzmann equation, Properties of Boltzmann equation, Fokker-Planck equation, Transport coefficients, Derivation of Landau equation.

Plasma Radiation: Angular distribution from an accelerated charge, Frequency spectrum of radiation from an accelerated charge, Cyclotron radiation by an eleactron, Bremsstrahlung from a plasma, Radiation from plasma oscillations, Scattering of radiation in plasma, Transport of radiation in a plasma, Black body radiation from a plasma.

References:

1. T.J.M.Boyd and J.J. Sanderson, plasma Dynamics, Nelson, 1969.

2. F.F.Chen, Introduction to Plasma Physics, Plenum Press, New York & London, 1974.
3. J.L. Delcroix, Plasma Physics, John Wiley & Sons Ltd, 1965.
4. Arnab Rai Choudhury, The Physics of Fluids & Plasmas, Cambridge Univerdity Press, 1999.
5. N.A. Krall and A.W. Trivelpiece, Principles of plasma Physics, McGraw-Hill, 1973.
6. M.A. Uman, Introduction to Plasma Physics ,McGraw-Hill Book Company, NewYork.
7. Vinod Krishan, Astrophysical Plasmas and Fluids, Kluwer Acadmic Publishers, Dordrecht.

M.A./M.SC. MATHEMATICS (FINAL)

OPTIONAL PAPERS

13.General Relativity and Cosmology — M.M. 100

General Relativity-Transformation of coordinates. Tensors. Algebra of Tensors. Symmetric and skew symmetric Tensors. Contraction of tensors and quotient law.

Reimannian metric. Parallel transport. Christoffel Symbols. Covarient derivatives. Intrinsic derivatives and geodesics, Riemann Christoffel curvature tensor and its symmetry properties. Bianchi identities and Einstein tensor.

Review of the special theory of relativity and the Newtonian Theory of gravitation. Principle of equivalence and general covariance. geodesic principle. Newtonian approximation of relativistic equations of motion. Einstein's field equations and its Newtonian. approximation.

Schwarzschild external solution and its isotropic form. Planetary orbits and anologues of Kepler's Laws in General realtivity. Advance of perihelion of a planet. Bending of light rays in a gravitational field. Gravitational redshift of spectral lines. Radar echo delay.

Energy-momentum tensor of an perfect fluid. Schwarzschild internal solution. Boundary conditions. Energy momentum tensor of an electromagnetic field. Einstein-Maxwell equations. Reissner-Nordstrom solution.

Cosmology-Mach's principle, Einstein modified field equations with cosmological term, Static Cosmological models of Einstein and De-Sitter, their derivation, properties and comparison with the actual universe.

Hubble's law Cosmological principles. Weyl's postulate. Derivation of Robertson-Walker metric. Hubble and deceleration parameter Redshift. Redshipft versus distance relation. Angular size versus redshift relation and Source counts in Robertson-Walker space-time.

Friedmann models. Fundamental equatons of dynamical cosmology. Critical density. Closed and open Universes. Age of the universe. Matter dominated era of the Universe. Einstein-deSitter model. Particle and even horizons.

Eddington-Lamaitre models with l-term. Perfect cosmological principle. Steady state cosmology.

References

1. C.E. Weatherbourn An Introduction to Remennian Geometry and the tensor Calculus, Cambridge University Press 1950.
2. H Stepheni General Relativity An introduction to the theory of the gravitational field. Cambridge University Press, 1982.
3. A.S. Eddington, The mathemetical Theory of Relativity, Cambridge University Press, 1965.
4. J.V. Narlikar, General Relativity and Cosmology : The Macmillan Company of India Limited, 1978.
5. J.V. Narlikar, Introduction to Cosmology, Cambridge University Press, 1993.
6. R.K. Sachs and H. Wu. General Relativity for Mathematician, Springer Verlag, 1977.

M.A./M.SC. MATHEMATIÇS (FINAL)

OPTIONAL PAPERS

14.DISSERTATION **M.M. 100**

Dissertation may be opted as one of the optional paper only for regular students who have obtained at least 60% Marks in M.Sc. Previous.

Note: The Dissertation shall be evaluated by the supervisor and an external examiner appointed by the university. Both examiners shall have equal weightage to award the marks.

Course outcomes (Mathematics)

B.Sc. (Mathematics) CO1 Algebra and Trigonometry including sequence and seies, group, rings, complex functions hyperbolic function, Gregory series.
B.Sc. (Mathematics) CO2 Calcules including Rolle's Theorem, Mean Value Theorem, Successive differentiation, Maxima & Minima, Beta and Gamma functions, Areas and Volumes.

B.Sc. (Mathematics) CO3 Geometry and Vector Calculus including Three Dimensional System, Central conicoids, Vector differentiation and integration, Line integrals, Theorem of Gauss, Green and Stokes.

B.Sc. (Mathematics) CO4 Linear Algebra and Matrices including vector spaces and their elementary properties, Types of Matrix, Characteristic equation, Eigen values and Eigen vectors.

B.Sc. (Mathematics) CO5 Differential Equations and Integral Transforms including Types of Differential Equations and Method of their solution, Integral Transforms, fourier Transforms.

B.Sc. (Mathematics) CO6 Machanics including velocity and acceleration, SHM, Motion in resisting medium, Rocket motion, common catenary.

B.Sc. (Mathematics) CO7 Real Analysis including real numbers, sequences of real numbers, properties of sequential continuous functions, Riemann Integral, metric spaces.

B.Sc. (Mathematics) CO8 Complex Analysis including functions of a complex variable, Analytic functions, Fourier series, Mapping, Complex Int.

B.Sc. (Mathematics) CO9 Numerical Analysis and Programming in C including Finite differences, Divided differences, Num. Int., Solution of the equations, programmer's model of computer.

B.Sc. (Mathematics) CO10 Linear Programming including Linear Programming problems, convex sets, Transportation Problems, Assignment Problems

M.Sc. I (Mathematics) CO1 Advanced Algebra including Group, Ring Theory, Inner Product Spaces, Canonical forms.

M.Sc. (Mathematics) CO2 Analysis: Real & Complex Properties of the integral, sequences and series of functions, Measure spaces, complex Integral, Evaluation of integrals, Bilinear transformation.

M.Sc. (Mathematics) CO3 Differential Equations Preliminaries, Basic Theorem, Differential Inequalities and Uniqueness, Poincare, Linear second order equation.

M.Sc. (Mathematics) CO4 Advanced Fluid Dynamics Kinematics & Kinetics Irrotational Motion in 3D, Reynold number, Dynamical Similarity.

M.Sc. (Mathematics) CO5 Advanced Discrete Mathematics including semigroups and Monoids, Lattices, Boolean Algebra, Graph Theory, Introductory computarility Theory, Grammars and Languages.

M.Sc. (Mathematics) CO6 Partial Differential Equations and Their Numerical Solutions) including Transport Equation, Laplace's Equation, Heat Equation, Wave Equation, Non-linear First order PDE, Representation of Solutions.

M.Sc. (Mathematics) CO7 Operations Research including Linear Programming, Transportation and Assignment Problems, Dynamic Programming, Integer Programming, Non linear Programming.

M.Sc. (Mathematics) CO8 Topology including Topological spaces, Countable spaces, Separable spaces, Compactness connected spaces, Nets and filters, Metrization Theorems.

M.Sc. (Mathematics) CO9 Mathematical Statistics including Probability, Moment Generating and Characteristic Functions and Cumulants, Gamma, Beta distribution functions of t, F and z test of significance, Theory of estimates.

M.Sc. (Mathematics) CO10 General Relativity and Cosmology including General Relativity, Algebra of Tensors, Reimannian metric, Theory of gravitation, Cosmology- Mach's Principle.

Programme outcomes

B.Sc. (Mathematics) PO1 Basic knowledge of Trigonometry, Tangents, Normals, Quadrature, Rectification, Volumes and Surfaces of solids of revolution, system of conics, Three dimensional system, Two dimensional system and Vectors.

B.Sc. (Mathematics) PO2 Basic knowledge of Velocity and acceleration, Simple Harmonic motion, Motion under the laws of forces, Earth attraction, Rocket motion, Central orbits. Constrained Motion.

B.Sc. (Mathematics) PO3 Basic knowledge of Centre of gravity, stable and unstable equilibrium, virtual work, Forces in three dimensions.

B.Sc. (Mathematics) PO4 Basic knowledge of Transportation Problems, Assignment Problems, Game Theory.

M.Sc. (Mathematics) PO1 Advanced knowledge of Network Analysis, Project planning and Control with PERT-CPM.

M.Sc. (Mathematics) PO2 Advanced knowledge of Flow Through a nozzle, Liquid streaming post a fixed sphere, stress components in a real fluid, sonic and supersonic flows of a gas.

M.Sc. (Mathematics) PO3 Advanced knowledge of finite state Machines and their Transition, Tabu diagrams, Equivalence of finite state Machines, Graph Theory, Turing Machine.

Programme specific outcomes (Mathematics)

B.Sc. (Mathematics) PSO1 Providing tuitions to Intermediate & UG classes to become as Self Employee.

B.Sc. (Mathematics) PSO2 Eligible for all Civil Services Examinations and Recruitment for Bank's P.O. clerical etc.

B.Sc. (Mathematics) PSO3 All types of job as Technical Assistant in Govt. Sectors as well as private sectors.

M.Sc. (Mathematics) PSO1 Lectures in Govt. Inter College/Aided Inter College.

M.Sc. (Mathematics) PSO2 After competiting, CSIR-UGC NET to become Assistant Professors, Researcher etc.

M.Sc. (Mathematics) PSO3 Specific jobs such as Statistical officer, Scientist Data Analyst etc.