॥ अंतरी पेटवू ज्ञानज्योत ॥

NORTH MAHARASHTRA UNIVERSITY, JALGAON.

Revised Syllabus for

M.Sc. [Mathematics]

(For Affiliated Colleges only)

Semester I and II

(with effect from June 2005)

Semester III and IV

(with effect from June 2006)

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NORTH MAHARASHTRA UNIVERSITY, JALGAON

M.Sc. MATHEMATICS

Revised Syllabus

(With effect from Academic year 2005-06)

B) **STRUCTURE**

The structure of M.Sc. Mathematics will be as under

Semester I	MT-101	Real Analysis -I
	MT-102	Topology
	MT-103	Algebra -I
	MT-104	Differential equations
	Any one of the followings	
	MT-105	Classical Mechanics
	MT-106	Computer Programming with C++
Semester II	MT-201	Real Analysis -II
	MT-202	Complex Analysis -I
	MT-203	Field Theory
	MT-204	Mathematical Methods -I
	Any one of the following	
	MT-205	Solid Mechanics
	MT-206	Number Theory
Semester III	MT-301	Functional Analysis
	MT-302	Fluid Mechanics
	MT-303	Algebra -II
	Any two of the followings	
	MT-304	Lattice Theory
	MT-305	Differential Geometry
	MT-306	Coding Theory
	MT-307	Mathematical Modelling
	MT-308	Mathematical Statistics
Semester IV	MT-401	Mathematical Methods -II
	MT-402	Graph Theory
	MT-403	Commutative Algebra
	Any two of the followings	
	MT-404	Combinatorics
	MT-405	Applied Numerical Methods
	MT-406	Algebraic Topology
	MT-407	Complex Analysis -II
	MT-408	Quantitative Techniques

Note :

1) There shall be 60 contact hours per theory course per semester out of which 48 hours are reserved for teaching and 12 hours for test, tutorials, orals and seminars

2) Tests, tutorials orals and seminars should be conducted for each course in addition to regular teaching schedule for which 20 marks be assigned as internal assessment

MT-101: REAL ANALYSIS – I

1. Partially Ordered sets, Well Ordered sets, Axioms of Choice, Zorn's lemma, Countable and Uncountable sets, Schrouder - Bernstein theorem, Relation between cardinality of a set and its power set, Hypothesis of Continuum, Cantor set, Cantor like sets. **(10 Hours)**

2 The Lebesgue Function, Lebesague outer measure, Measurable sets, σ-algebra, Borel set, Regularity of measure, Measurable functions, Borel sets and Measurability. **(15 Hours)**

3 Integration of non-negative functions of real variables, Fatou's lemma, Lebesgue monotone convergence theorem, The general Lebegue integral, Lebesgue dominated Convergence theorem, Integration of series, comparison of Riemann and Lebesgue Integrals **(15 Hours)**

4. Derivatives, functions of bounded variation, Positive, negative and total variation, Continuity almost every where and differentiability almost every where of a function of bounded variation, Properties of the functions of bounded variation, properties, Vitali's covering theorem, Fundamental theorem of integral calculus for Lebesgue integrals. **(20Hours)**

Recommended Books :-

1 G. de Barra : Measure Theory and Integration-New Age International (P) Ltd. Chapter1 Art 1.5, 1.7, Chapter 2. Art 2.1 to 2.5. Chapter 3. Art. 3.1 3.2.3.4. Chapter 44 Art 4.1 4.3 to 4.5 Chapters 9. Art 9.3

2. Royden H.L. :- Real Analysis 3rd edition Prentice – Hall of India (p) Limited New Delhi,Chapter 5 Art.1

Reference Books :-

1. Berberian S.K. Measure Theory and Integration. Mc Millian New York 1965
2 Halmos P R Measure Theory Springer International student Edition Narosa Publishing House. New Delhi.
3 Rana I.K. : An Introduction to Measure and Integration. Narosa Publishing House. New Delhi. 1997 Chapter 4 Art 4.4
4 Simmons G.F Introduction to topology and Modern Analysis, McGraw Hill Book Company New York 1967 Chapt 1 Art 6 to 8

MT-102: TOPOLOGY

1. Topological spaces, Basis for topology, The order topology, Subspace topology, closed sets & limit points, Continuous functions, The Product topology, The quotient topology. **(20 hours)** {sec. 2.1, 2.2, 2.3, 2.5, 2.6, 2.7, 2.8, 2.11. [1] }

2. Connected spaces, Connected sets in the real line, Components & path components, Local connectedness, Compact spaces, Limit point compactness. **(20 hours)**{Sec. 3.1, 3.2, 3.3, 3.4, 3.5, 3.7, 3.8 [1]}

3. The countability axioms, The separation axioms, The Urysohn Lemma.**(12 hours)**{Sec. 4.1, 4.2, 4.3 [1]}

4. The Tychonoff Theorem, Completely regular spaces. **(8 hours)**{Sec. 5.1, 5.2 [1]}

Recommended Books :-

1. J.R. Munkres : Topology (A first course), Prentice Hall of India Ltd.

Reference Book :

1. K.D. Joshi : Introduction to general topology, (Wiley Eastern)

MT-103: ALGEBRA – I

1. Direct product of subgroups, Class equation, Cauchy's Theorem, Sylow Theorem, Salvable groups, Jordan - Holder Theorem. **(30 hours)** (Sec. 1.10, 1.12, 1.13, 1.14 [1]}
2. Euclidean domains, Principal ideal domains, Unique Factorization domains, Polynomial rings, Roots of polynomials, factorization of polynomials. **(20 hours)** {Sec. 2.10, 2.11, 2.12, 2.13, 2.14, 2.15, 2.16 [1]}
3. Noetherian rings, Hilbert basis Theorem. **(10 hours)** {Sec. 3.1 [2]}

Recommended Books :-

1. N.S. Gopalkrishnan, University Algebra, Wiley – Eastern 1988
2. N.S. Gopalkrishnan, Commutative Algebra, Oxonian press pvt. Ltd. New Delhi, 1988

Reference Books: -

1. I.N. Herstein : Topics in Algebra, Wiley - Eastern, 1988
2. N. Jacobson : Basic Algebra, Vol. I
3. J.B. Freleigh : First Course in Abstract Algebra
4. Jain and Bhattacharya : Basic Abstract Algebra

MT-104: DIFFERENTIAL EQUATIONS

1. Power series solutions and special functions :-
Introduction a review of power series Series solutions of first order equations. Second order Linear equations. ordinary points. existence of unique solution at ordinary points Regular singular points Frobenius method of series solutions. Indicial equations **(15 hours)**

2. Some special functions of Mathematics Physics :-
Legendre's and Bessel's differential Equations. Legendre's and Bessel's functions and their

3. Applications **(18 hours)**
Partial differential equations of the second order: -
Origin applications in Physics. Linear P.D.E with constant coefficients. Linear P.D.E. with variable coefficients Classification of P.D.E of second order. Characteristics curves. Characteristic curves of second order equations. Characteristics of Equations in three variables The solution of Linear Hyperbolic Equations Riemann – Green's functions Separation of variables The method of integral transform **(27 Hours)**

Recommended Books :-

1 G.F Simmons :- Differential Equations
Ch 5 Articles 25 26 27 28 and 29
Ch 6 Articles 32 33 34 35

2 Ian Sneddon Elements of Partial Differential Equations.
Ch 3 Articles – 1 2 3 4 5 6 7 8 9 and 10

References Books :-

1 Arfken Mathematical Methods for Physics
2 Churchill and Brown Fourier Series and Boundary Value Problems

MT 105 : CLASSICAL MECHANICS

Mechanics of particles Mechanics of the system of particle constraints D Alembret's principle and LaGrange's equations velocity dependent potential and the dissipation function simple applications of the Lagrangian formations **(10 Hours)**

2. Hamilton's principle some techniques of the calculus of variations. Derivation of Lagrangian equations from Hamilton's principle. Extension of Hamilton's principle to nonholonomic system. conservation theorems and symmetry properties **(10 Hours)**

3. The independent co-ordinates of a rigid body. orthogonal transformations Formal properties of the transformations matrix, The Euler angles. The Cayley-Klein parameters and related quantities finite rotations, Rate of the change of a vector. Angular momentum and Kinetic energy of motion about a point. Tensors and dyadics, The inertia tensor and The moment of inertia. The eigen values of the inertia tensor and Principle axis transformations **(15 Hours)**

4. Legendre transformations and the Hamilton equation of motion. Derivation of Hamilton's equation from a variations principle. The principle of least action. **(10 Hours)**

5. The equations of canonical transformations Generating Functions Examples of Canonical transformations Conditions for a transformation to be Canonical. Bilinear invariant conditions, Poisson Bracket's (Definition), Invariance of Poisson Brackets' with respect to Canonical transformations. **(15 Hours)**

Recommended Books :-

1. H.Goldstein Classical Mechanics.(Addison Wesley)
   Chapter's 1,2,4,5,8,9

Reference Books :-

1. Carban and Steble : Classical Mechanics,(John Wiley press)
2. Marian : Classical Dynamics, (Academic Press)
3. Sudarsan & Mukunda: Classical Mechanics
4. J.C. Upadhyaya : Classical Mechanics, (Himalaya Publishing House)

MT 106: PROGRAMMING WITH C++

1. Elementary Concepts: **[5 hours]**
   Introduction, output operator, characters, literals, variables and declaration, program token, initializing variables and constants, input operator.

2. Fundamental Types: **[5 hours]**
   Numeric, Boolean, enumeration, character, integer, arithmetic, increment, decrement, and composite assignment operators Floating point type conversion, numeric outflow, round-off error, and the e-format.

3 Conditional statements [10 hours]
If, If-Else statements, statement blocks, compound conditions, short-circuiting, Boolean expressions, nested selection, else-if, switch statements and conditional expression operators.

4 Iteration [10 hours]
The while statement, terminating a loop, do-while, for statements, break, continue and go-to Statements

5 Functions. [10 hours]
Standard library functions, user defined functions, test drivers, functional declarations, local variables and functions, void functions, Boolean functions, Input-Output functions, passing by reference, passing by constant reference, inline function, slope, over loading, main function, default arguments.

6. Arrays. [10 hours]
Processing and initialization of arrays, array index, passing an array to a function, linear search, bubble sort, binary search algorithms, arrays with enumerations types, type definitions, multi-dimensional arrays

7 Practicals.
1 Any three simple programs on conditional statements.
2 Any three simple programs on do and do-while
3 Any two simple programs on user defined functions
4 Programs on Bubble sort and Linear search

Recommended Book: -
1 John R. Hubbard, Programming with C++ Schaum's outline series, 2002

Reference Books: -
1 Deital H.M. and Deital P J, C++ How to program, Prentice Hall of India, 1998
2 Capper, D.M. Introducing C++ for Scientists, Engineers and Mathematicians, Springer –Verlag, 1994.

MT-201: REAL ANALYSIS–II

1 Introduction to general measure **(3 hours)**

2 Lp-spaces, Convex functions, Jensen's inequality, the inequalities of Holder s and Minkowski, Completeness of Lp-spaces (Reisz-Fischer Theorem) (12 hours)

3. Convergence in measure convergence in mean of order p, almost uniform convergence, Egoroff's theorem. Implications among them. **(15 hours)**

4. Signed Measures and The Hahn Decomposition, The Jordan Decomposition, The Radon Nikodym theorem, Applications of Radon – Nikodym theorem. Lebesgue Decomposition theorem, Bounded Linear Funcuonals in Lp. Riesz representation theorem for Lp (p>1) **(20 hours)**

5. Measurability in a product space, product measure, Fubini's Theorem, Lebesgue measure in Euclidean space. **(10 hours)**

Recommended Books :-

1. G. de Barra: Measure Theory and Integration
   New Age International (p) limited, chapter 5 Art 5.1 to 5.6
   Chapter 6. Art. 6.1 to 6.5 Chapter. Art. 7.1 to 7.4
   Chapter 8. Art. 8.1 to 8.5 Chapter 10. Art 10.1 to 10.3
2. Royden H L - Real Analysis 3rd edition Prentice - Hall of India (p) limited New Delhi.

Reference Books: -

1. Berberian S.K.: - Measure Theory and Integration, McMillan New York 1965
2. Halmos P.R. : - Measure Theory, Springer International student Edition, Narosa Publishing House, New Delhi.
3. Rana I.K. : - An Introduction to Measure and Integration. Narosa Publishing House, New Delhi. 1997 Chapter 7 Art. 7.3
4. Walter Rudin :- Real and Complex Analysis (1986), Tata McGraw-Hill New York

MT202: COMPLEX ANALYSIS- I

1. Topology of C. open sets, connected subsets, components of open sets, uniform Convergence of sequences and series of functions, Wierstrass, M-test, power series, radius of convergence. **[6 hours]**

2. Analytic functions, exponential functions branch of a logarithm. C-R equations. harmonic functions and conjugate **[8 hours]**

3. Path, smooth path, piecewise smooth paths, conformal map, Mobious transformation. symmetry, principle and orientation principle **[8 hours]**

4. Riemann-Stieltjes Integral and complex integral, line integral of a continuous functions along rectifiable paths, fundamental theorem of calculus. **[8 hours]**

5 Power series expansion of an analytic function, fundamental theorem of Algebra.Liouville's theorem. Maximum modulus principle. index (winding number) of a curve around a point Cauchy s theorem. Cauchy's integral formula and Morera's theorem **[10 hours]**

6 Homotopic version of Cauchy's theorem, simple connectivity, logarithmic derivative of f(z) the Open Mapping theorem, the Argument principle. meromorphic functions. Rouche's theorem. **[10 hours]**

7 Singularities. classification. Poles and essential singularities, singular point. Laurent s series. Casorati-Weirstrass theorem. Residues and evaluation of integrals. Schwarz's lemma **[10 hours]**

Recommended Books: -

1. J.B Conway, Functions of one complex variable. Springer-verlag.

Reference Books: -

1. H Silverman, Complex variables. Houghton Milan & Co.
2. J E Marsden, Basic Complex analysis, Freeman & Co

MT- 203 FIELD THEORY

1. Algebraic extensions. Splitting field. Algebraic closure, Separable and Inseparable extensions. Normal extension. Perfect fields of finite fields. **(30 hours)**

2 Galois extensions, fundamental theorem. Roots of Unity solvability by radicals. Transcendental extensions transcendental base. (30 **hours)**

Recommended Book:

1 N.S. Gopalakrishnan, University Algebra. Wiley- Eastern.

Reference Books:

1 N. Jacobson. Basic Algebra Vol. I, Hindustan Publishing Corporation.
2. M. Nagata. Theory of Fields. Marcel-Dekker

MT 204 : MATHEMATICAL STATISTICS – I

1 Linear Boundary value problems **[15 hours]**
Introduction. derivation of wave equation. heat equation and Laplace's equation in Cartesian. cylindrical and spherical co-ordinates Principle of superposition series solutions. separation of variables. types of initial value problems and general solution of partial differential equations

Orthogonality. [15 hours]
Orthogonality of sets of functions in the space of piecewise continuous functions on (a,b), generalized Fourier Series, approximation in the mean, closed and complete orthonormal sets. Sturm-Liouville problems, orthogonality of the eigen functions and their uniqueness.

Applications [15 hours]
Boundary value problems involving the wave equation, heat equation and Dirichlet's problems. Temperature in a long cylinder, heat transfer at the surface of the cylinder and vibrations of a circular membrane.

Difference equations. [15 hours]
Definition, order, linear difference equation, formation, existence and uniqueness theorem, solution of the equation, general solution of the homogenous difference equation of order and non-homogenous linear difference equation. Simultaneous linear difference equations and matrix method of solution. Working method for solving a second order homo-difference equation with constant coefficients.

Recommended Books:
1. R.V. Churchill and J. W. Brown. Fourier Series and Boundary value problems. Mc Graw – Hill international.
2. J.P. Chauhan. Differential and Difference equations. Garg Publishing House.

Reference Books: -
1. Mary, L Boas, Methods of Mathematical Physics.
2. N.N. Lebedev. special functions and their applications, Prentice Hall.

MT 205 : SOLID MECHANICS

1. Stress and Strain. [10 hours]
Basic concepts of continuum, rigid body, elastic body, types of forces, types of supports, moment of a force, conditions of equilibrium, Statically determinate and indeterminate problems, definition and notation of stress complimentary property of shear, equations of equilibrium. Displacement field, strain components, strain in terms of displacement field. Stress-Strain relationships, one-dimensional Hook's law, elastic, shear and bulk modulii. 3-D Hook's law.

2. Plane Stress and Strain: [10 hours]
Introduction, principal axes, principal stresses, transformations and Mohr's circle Transformation equations for strain, properties of plane and Mohr's circle for principal strain

3. Moment of Inertia: [7 hours]
Center of gravity for standard figures. Moment of inertia of a plane area, method of finding M.I. Parallel axis and Perpendicular axis theorems, M.I. of standard sections

4. Shear force and B.M. [10 hours]
Shear force, Axial force and Bending Moment [B.M.], formulations, differential equations involving them, shear force and B.M. diagrams.

5. Bending and Deflection of beams: [13 hours]
Pure bending of Symmetric beams, normal stress and shear stress. Deflection of symmetric beams, differential equations for deflection, statically indeterminate problems.

6. Torsion: [10 hours]
Torsion in circular shafts, torsional stresses and strains, stress concentrations, polar moment of Inertia, power transmitted by a shaft, strengths of a solid and hollow shafts, torsion of thin walled non-circular shafts.

Recommended Book: -

1. I.H. Shames and J.M. Pitarresi, Introduction to Solid Mechanics, Prentice Hall of India, 2004

Reference Books:-

1. Tim Shenko, Solid Mechanics, Tata Mc Graw - Hill.
2. R.S. Khurmi, Strength of Materials, S.Chand & Co.
3. Papov, E.G., Engineering Mechanics of Solids, Pearson education.

MT-206: NUMBER THEORY

1. Revision of Divisibility, g.c.d., l.c.m., Prime numbers. The fundamental theorem of arithmetic, The Euclidean algorithm, The g.c.d. of more than two numbers. **(8 Hours)** {sec. 1.1, 1.2, 1.3, 1.4, 1.5, 1.7, 1.8 [1]}

2. Arithmetic function of Dirichlet multiplaction, the Mobius function $\mu(x)$, The Euler function $\phi(x)$. Dirichlet product of arithmetic functions. Dirichlet inverses & the Mobius inversion formula. The Mangolt function $\wedge(n)$, Multiplicative functions Dirichlet multiplication, The inverse of a completely multiplicative function Liouvilles function $\lambda(n)$ The divisor function $\sigma(n)$ Generalized convolutions **(16 Hours)**{Sec. 2.1 to 2.14 [1]}

3. Congruences : Congruences, Residue classes & complete residue systems Linear congruences. Reduced residue systems & Euler Fermat theorem. Polynomial congruences modulo p Lagranges theorem & its applications. The Chinese remainder theorem & its applications. Polynomial congruences with prime power moduli. **(12 Hours)** {Sec. 5.1 to 5.9 [1]}

4. Quadratic residues & Quadratic Reciprocity law : Quadratic residues, Legenre's symbol and its properties. Evaluation of $(1|P)$ & $(2|P)$. Gauss lemma, The Quadratic Reciprocity law & its applications. The Jacobi Symbol. **(12 Hours.)**{Sec. 9.1 to 9.7 [1]}

5. Primitive roots : The exponent of a number modulo m, Primitive roots, Primitive roots & reduced residue systems. The non existence of primitive roots mod p & p^{2e} for odd primes p and $n \geq 1$. The non-existence of primitive roots in the remaining cases. The number of primitive roots mod m. the primitive roots & quadratic residues. The index calculus. **(12 Hours)**{Sec. 10.1 to 10.9 [1]}

Recommended books :-

1. T.M. Apostol . Introduction to Analytic Number Theory (Springer International student Edition)

References :

1. D.M. Burton : Elementary Number Theory, (Universal Book Stall)

MT-301: FUNCTIONAL ANALYSIS

1. Normed Linear spaces, Banach spaces. Quotient spaces, Continuous Linear Transformations. The Hahn-Banach theorem and its Consequences. Conjugate space and separability, Second conjugate space. The natural embedding of normed Linear space and its second conjugate space, Weak* Topology on the Conjugate space. The open mapping theorem, Projection on Banach space, The closed graph theorem, The Conjugate of an operators. The uniform boundedness principle (Banach-Steinhauss Theorem). **(Hours 20)** .

2. Inner Product spaces, Hilbert spaces. Definition, examples and simple properties. Schwartz's inequality. Orthogonal complements. Projection theorem. Orthogonal sets. The Bessel's inequality. Fourier expansion and Parseval's equations, Gram-Schmidt orthogonalization process. Separable Hilbert space. The Conjugate space, Riesz Theorem. Operators and their adjoints on a Hilbert space. Self adjoint operators. Normal and unitary operators, Projections. **(Hours 25)**

2 Finite dimensional spectral theory: Determinants and spectrum of an operator. The Spectral theorem. Fixed points. Definition and examples. Banach contraction mapping theorem. Brower fixed point theorem. Schauder fixed point theorem.**(Hours 15)**

Recommended Books :-

1 Simmons G F Introduction to Topology and Modern Analysis
McGraw Hill Book Company New York 1963
Chapter 9. Art 46 to 53 Chapter 10. Art 52 to 59
Chapter 11. Art. 61 to 62. Appendix I

2 B Chaudhary and Sudarshan Nanda Functional Analysis with applications (Wiley - Eastern)

Reference Books :-

1. Bachman G. and Narici L.: Functional Analysis (Academic press)
2. Berberian S.K : Functional Analysis and Operator Theory McMillan New York
3 Limaye B.V.: Functional Analysis Second Edition. New Age International (P) Limited Publishers (1996) Chapter 6. Appendix A
4. Siddique A.H . Functional Analysis with applications Wiley – Eastern.

MT- 302: FLUID MECHANICS

1 Introduction **[10 hours]**
Basic concepts of Fluid Mechanics like pressure, density, external forces. Important types of flows and types of fluids. Some important formulae of vector calculus

2. Kinematics : **[10 hours]**
Two methods of study velocity and acceleration of fluid particle, equation of continuity, boundary conditions, boundary surface, stream lines, path lines and streak lines. Irrotational flow, velocity potential, vorticity vector, angular velocity and rotational motion.

3 Equations of motion : **[10hours]**
Euler's equation of motion for inviscid fluids, impulsive forces and equation of motion, energy equation. One – dimensional inviscid incompressible flow and Bernoulli's theorem

4 Motion in two dimensions . **[10 hours]**
Stream function sources sinks and doublets Complex Potential C-R equations in polar form, method and images image with respect to a line and circle, Circle theorem, theorem of Blasius Streaming Motion past a cylinder and sphere

5. General theory [10 hours]
General theory of irrotational motion flow and circulation. Stoke's theorem Green's theorem. Kelvin's theorem. Permanence of Irrotational motion. kinetic energy of infinite mass of liquid.

6. Laminar flow : [10 hours]
Real fluids, laminar flow for real fluids, N-S equations in Cartesian co-ordinates. some exact solutions of N-S equations. Coutte flow. Plane Poiseuille flow. theory of lubrication. flow through circular pipe. The Hagen – Poiseuille flow and laminar flow between co-axial cylinders.

Recommended Books :-
1. R.K. Rathy. An introduction to fluid Dynamics. IBH. 1985.
2. Roy Singhania. Fluid Mechanics. Sultan Chand & Co.

References Books :-
1. Landau and Lipschitz. Fluid Mechanics. Pergamon Press. 1985.
2. F. Chlorton. Text book of Fluid Dynamics. C.B.S. Publishers. 1988.
3. J P. Chauhan Fluid Dynamics. Garg Publishing House.

MT- 303 : ALGEBRA – II

1. Modules .- Submodules, R-homomorphism, Isomorphism. Direct sum of modules, free modules, Rank. Structure theorem for finitely generated modules over PID, Applications to finite abelian groups **(36 hours)**{sec. 3.6, 3.7 [1]}

2. Jordan & Rational Canonical forms **(16 hours)**{sec. 5.10 [1]}

3. Nil radical and Jacobson radical. Chinese remainder theorem, Local rings and Modules, Nakayama lemma. Localization of rings. Local rings and Modules. primary decomposition for modules. **(8 hours)**{Sec.2.1.2.2.2.3.3.1.3.2 [2] }

Recommend books :-
1. N.S. Gopalkrishnan. University Algebra. Wiley – Eastern. 1988.
2. N.S. Gopalkrishnan. Commutative Algebra, Oxonian press. 1988

References: -
1. I.N. Herstein. Topics in Algebra. Wiley – Eastern. 1988.
2. C.S. Musli. Introduction to Rings & Modules.

MT- 304: LATTICE THEORY

1 Introduction to Posets. Semi-lattice. two definitions of lattices. Congruence relations.Congruence lattice. The homomorphism theorem. Product of lattices. complete lattices. ideal lattice. Distributive and modular inequalities and identities. complements. Pseudocomplements. Boolean lattices. Boolean lattices of pseudocomplements in a meet semi lattice Atoms. irreducibility of elements.**(18 hours)**

2 Characterization theorem for modular and distributive lattice Dedekind's characterization of modular lattice. Birkhoffs characterization of distributive lattices. Representation of distributive lattices. Stone theorem. Natchbin theorem. Hashimoto's theorem Distributive lattice with pseudocomplementation. Stone lattice, characterization of Stone lattice. Stone algebra. characterization of stone algebra **(20 hours)**

3. Distributive. Standard and Neutral elements Distributive. Standard and Neutral ideals. Structure theorems. **(22 hours)**

Recommended Books :-

1 George Gratzer : General Lattice Theory. Birkhauser Verlag Basel.
Chapter 1 Sections 1, 2, 3, 4, 6.
Chapter 2: Sections 1 to 6
Chapter 3: Sections. 2. 3 and 4

Reference Books: -

1 Birkhoff G. : Lattice Theory
2 Crawley P and Dilworth R.P : Algebraic Lattice Theory.
3 Davey B.A. and Priestly : Introduction to Lattices and Order.

MT – 305: DIFFERENTIAL GEOMETRY

1. Graphs and Level sets. Vector Fields. the tangent space. **(5 hours)**
2. Surfaces, Vector fields on surfaces, Orientation, The Gauss map, Geodesics. **(13 hours)**
3. Parallel transport. the Weingarten Map, Curvature of plane curves **(12 hours)**
4. Arc length and Line Integrals. Curvatures of surfaces. Convex surfaces. **(12 hours)**
5. Convex surfaces, parametrized surfaces. Local equivalence of surfaces and parametrized surfaces. **(18 hours)**

Recommended Books: -
Elementary Topics in Differential Geometry – by John A. Thorpe.
Chapters 1 to 5 (Springer- Verlag)

References Books: -
1 Elementary Differential Geometry - B. Oneill - (Academic – New York)
2. Elements of differential Geometry - Milnan R.and Parker G. (Prentice Hall)
3 Diff Geometry - E.C. Weatherburn

MT- 306: CODING THEORY

1 Introductory concepts and useful background: Basic definitions, Weight, Minimum weight, maximum likelihood decoding. Syndrome decoding. Perfect codes, Hamming Codes, Sphere packing bound. The Packing radius, the covering radius, M.D S. code and some bounds Self-dual codes, The Golary codes. **(10 hours)**

2. Double error correcting code: A finite field of 16 elements. The double error correcting B.C.H. code. **(4 hours)**

3. Cyclic codes: The definition of cyclic codes. the generator polynomial, and the generator polynomial of dual code. Idempotents and minimal ideals for binary cyclic codes. **(10 hours)**

4. Group codes and Q.R. codes: The group of code, Q.R. codes, Extended Q.R. codes, square root bound and group of Q.R. codes. Permutation decoding of Golay code. **(22 hours)**

5. B.C.H. codes : Cyclic codes given in terms of roots. Vandermonde determinants. properties of B.C.H. codes, Reed-Solomon codes. Decoding B.C.H. codes **(10 hours)**

6. Weight Distributions: Preliminary concepts and a theorem on weights in Homogenous codes. The Mac Williams equations. **(4 hours)**

Recommended Books: -
1 Vera Pleass – Introduction to theory of error correcting codes. Wiley – Inter science Publications.

Chapter 1 : Sections 1.1 to 1.3 Chapter 2 : Sections 2.1 to 2.4
Chapter 3 : Sections 3.3 , 3.4 Chapter 5 : Sections 5.1 to 5.4
Chapter 6 : Sections 6.1 to 6.7 Chapter 7 : Sections 7.1 to 7.6

Reference Books:

1 J H Van Lint - Introduction to coding theory
2 R.Lidl and G Pilz Applied Abstract Algebra.

MT – 307: MATHEMATICAL MODELLING

1 Need, technique, classification and simple illustrations, Mathematical modeling through geometry, algebra, trigonometry and calculus Limitations of mathematical modeling. (10 hours)

2 Mathematical modeling through ordinary differential equations, Linear and non-linear growth and decay models, compartment models. Mathematical modeling in dynamics and geometric problems. (12 hours)

3. Mathematical modeling through systems of ordinary differential equations of the first orders, mathematical modeling in population, dynamic epidemics, and compartment models in economics, medicine, battles, and international trade dynamics. (12 hours)

4 Mathematical modeling through partial differential equations, first method of getting PDE models, second method of getting PDE models and third method of getting PDE models. Traffic flow on a highway, mathematical modeling in terms of wave equation. (16 hours)

5 Mathematical modeling through Functional equation, modeling through Integral equations and modeling delay-differential equations. (10 hours)

Recommended Book:

1 J N Kapur Mathematical Modeling Wiley Eastern Limited

Reference Book: -

1 F.R. Giordano et al. A first course in Mathematical Modeling. Vikas Publishing House.

MT- 308: MATHEMATICAL STATISTICS

1 Revision of Basic concepts [5 hours]
Arithmetic Mean, Geometric Mean, Harmonic Mean Median and Mode Range, Quartile deviation, Mean deviation, Standard deviation and Variance.

2 Probability. [7 hours]
Mathematical theory of probability, addition and multiplication theorems of probability, conditional probability and Baye's theorem

3 Theoretical distributions: [8 hours]
Binomial, Poisson and Normal distributions and their properties.

4 Correlation and Regression: [10 hours]
Definition, meaning, scatter diagram method, Karl Pearson's method, Probable error, Standard error and Rank correlation.

5 Regression: [10 hours]
Definition, meaning, two lines of regression, regression coefficients, standard error and relation between correlation and regression.

6 Sampling and Large sample tests: [10 hours]
Introduction and types of sampling, tests of hypothesis, level of significance, tests of significance for large samples. Tests for single proportion, difference of proportion, single mean, difference of means, difference of S.D

7. Exact sampling distributions: [10 hours]
Chi-Square variate and Chi-Square distribution, conditions of validity of Chi-Square test, applications of Chi-square distribution, Chi –Square test for population variance, Chi-squaretest for Goodness of fit and Independence of Attributes. Definition of student's 't' distribution and derivation, Fisher's 't' distribution constants of t-distribution, graph of t-distribution, application, test for single mean, test for difference of means, paired t-test testing significance of observed sample. Definition of F statistic, F-distribution, applications, F-test for equality of population variances.

Recommended Books: -

1. S.C. Gupta and V.K. Kapoor, Mathematical Statistics, Sultan Chand & Co-New Delhi.

Reference Books: -

1. E.J. Dudewicz and S.N. Mishra, Modern Mathematical Statistics, John Willey & Sons
2. Erwin Kreyszig, Introductory Mathematical Statistics, Willey International Ltd.
3. J.K. Goyal and J.N. Sharma, Mathematical Statistics, Krushna Prakashan.

MT- 401 : MATHEMATICAL METHODS – II

1. Integral Equations. **[12 hours]**
Introduction and classification of Linear Integral equations. Integro-differential equations. Fredholm's equations' Degenerate kernels, Hermitian and Symmetric kernels Volterr's equations and resolvent kernel: Convolution type of kernels.

2. Laplace Transforms . **[12 hours]**
Definition, notation, sufficient condition for existence, properties of L.T.; Initial value and final value theorems. Methods of finding L.T Series, direct, differentiation with respect to a parameter methods, evaluation of an integral. Laplace transforms of special functions like Gamma function, Bessel, Error, Unit step, Dirac-Delta functions

3. Inverse Laplace Transforms: **[12 hours]**
Definition uniqueness, Lerch's theorem, properties: Convolution theorem Methods of finding inverse L.T. – Partial fractions, series method, differential equations method; the complex inversion formula. Beta function and evaluation of integrals.

4 Applications of L.T.: **[12 hours]**
Applications to LDE with constant coefficients, variable coefficients, Simultaneous DE, Mechanics, Electrical circuits, Beams, Partial differential equations, Boundary value problems involving PDE, Integral equations including convolution type, Able's Integral equation, Integro-differential equations and difference equations.

5. Fourier Transforms: **[12 hours]**
The Fourier Integral, complex form of Fourier Integrals and Fourier Integral theorem; Fourier transforms; Fourier Cosine and Sine Transforms, finite Fourier transforms, convolution theorem, Parsvals Identity and relationship between Fourier transforms and Laplace transforms.

Recommended Books: -

1. I.I. G. Chambers. A short course on Integral Equations, International textbook company ltd.
2 Murray. J Spiegel, Laplace Transforms. Schaum's outline Series.
3 Goyal and Gupta. Laplace transforms and Fourier transforms. Pragati Prakashan. Meerut

Reference Book :-

1 Shigomovi and Andrews. Integral transforms for Engineering Systems

MT – 402 : GRAPH THEORY

1. Graphs : Definitions and examples. Graph as models. Subgraphs. operations on graphs. Matrix representation of graphs. Walks. trails. paths. and cycles. Connectedness and connectedness algorithm. **(10 hours)**

2. Trees and connectivity : Definition and simple properties of tree. Bridges. spanning trees. Caley's theorem. Kruskal's algorithm. Prim algorithm. shortest path problems. The Breadth first search algorithm. The Backtracking algorithm Dijksta's algorithm. Cut vertices. connectivity. **(12 hours)**

3. Eulerian and Hamiltonian graphs : Eulerian trails. Eulerian and semi-Eulerian graphs. Fleury's alorithm. Hierholzer's algorithm. The Chinese postman problem Hamiltonian graphs. Dirac theorem. Closure of a graph. Bondy and Chavatal theorem. Traveling salesman problem (Optimal algorithms and the closest intersection algorithm are not expected) **(8 hours)**

4. Matching : Matching and augmenting paths. Berge theorem. The Hall's marriage problem. The personnel assignment problem the matching algorithm for bipartite graphs. The Hungarian algorithm. **(20 hours)**

5. Net works: Max flow Min cut theorem. separating sets. Menger's theorem. **(6 hours)**

6. Ramsey numbers : Definition of Ramsey number. relations among Ramsey numbers. **(4 hours)**

Recommended Book: -

John Clerk and Derek Allan Holton: - A first look at Graph Theory. Allied Publisher ltd.

Chapter 1: Sections 1.1 to 1.8 Chapter 2: Sections 2.1 to 2.6
Chapter 3: Sections 3.1 to 3.3 Chapter 4: Sections 4.1 to 4.3
Chapter 8: Sections 8.1 and 8.3 Chapter 9: Sections 9.1 to 9.3

Reference Books: -

1. Bondy and Murthy - Graph Theory with applications.
2. Bhave N.S. and T.T. Raghunathan : Elements of Graph Theory.
3. Harary F - Graph Theory.
4. Parthsarthi K.R - Basic Graph Theory.

MT-403 : COMMUTATIVE ALGEBRA

1. Modules. Free modules, Projective modules. Tensor product and Flat modules {[1], chap. I. 1.1-1.4} **(16 hours)**
2. Artinian modules {Chap. III, 3.3} **(12 hours)**
3. Integral extensions – Integral elements, Integral extensions and Integrally closed domain: {[1] Chap IV, 4.1–4.3}**(16 hours)**
4. Dedekind domain – Valuation rings, Discrete valuation rings and Dedkind domain {[1] Chap.-V, 5.1 –5.3.}**(16 hours)**

Recommended Books: -

1 N.S. Gopalkrishnan. Commutative Algebra. Oxonian press pvt. Ltd. 1988

Reference Books: -

1 M.F. Atiyah and Mac Donald, Introduction to Commutative Algebra.
2. N. Jacobson, Basic Algebra vol–I & II. 1980.
3. Zarski and Samuel, Commutative Algebra.
4 L. Rowen. Ring theory vol-I & II. 1988.

MT-404: COMBINATRICS

1 Basic combinatorial numbers. **(16 hours)**
2 General functions and Recurrence relations. **(8 hours)**
3 The Principal of inclusion and exclusion. Mobious Inversion. Posets and their mobious functions.**(8 hours)**
4. Partitions, identities and arithmetic properties. Gauss-Jacobi identity, Jacobi identity.**(8 hours)**Distinct representatives : The theorem of P.Hall and D. Koning Simultaneous representatives. The permanents of integral Matrices with constant line sum. **(6 hours)**
5 Polya theory : Burnside's lemma, cycle index of a permutation group. Polya's theorem and their immediate applications. **(14 hours)**

Recommended Books: -

1 V.Krishnamurthy : Combinatorics theory and applications.
East west Press Private Ltd. New Delhi.
2 Marshall Hall Jr. Combinatorial theory. Wiley – Inter science Publications

Reference Books: -

1 Bal Krishna V.K Theory and Problems of Combinatorics
2. Joshi K. D. Foundations of Discrete Mathematics.
3 Tucker A Applied combinatorics

MT-405: APPLIED NUMERICAL METHODS

1. System of Linear Equations. **[10 hours]**
   Methods of triangularization – Do little algorithm. Crout's method, inverse of a matrix by Crout's method: Iterative methods – Jacobi's method, Gauss – Seidal method, Relaxation method, convergence.

2. Numerical Differentiation: **[7 hours]**
   Forward, Backward, Central differences, Error analysis, higher derivatives of continuous and tabulated functions, difference tables. Richardson's extrapolation.

3. Numerical Integration: **[7 hours]**
   Newton – Cotes Integration formulas, Trapezoidal rule, Simpson's rule and Romberg Integration and Numerical Double integration by trapezoidal and Simpson's rules.

4. Numerical solution of O.D.E. (BVP): **[18 hours]**
   Linear BVP, shooting method, alternative method, non-linear BVP – Secant method and Newton – Raphson method; Finite difference method of linear second order problems, derivative boundary condition, solution of tri-diagonal system, lteration methods for non-linear seconder problems, Newton – Raphson method, Finite Element methods.

5. Numerical solution of P.D.E. (BVP): **[18 hours]**
   Introduction, deriving difference equations; Leibman's iteration method for Laplace equation, Poisson's equation: Solution of Heat equation-Brendhor Schmidt method, Crank-Nicholson method: Hyperbolic equations, finite difference method and starting values

Recommended Books: -

1. M.K. Jain, S.R.K. Iyengar and R.K. Jain, Numerical methods for Scientific and Engineering Computation. New Age international Publishers.
2. S.S. Sastry, Introductory methods of Numerical Analysis Prentice Hall of India.
3. C. Gerald and O. Wheatley, Applied Numerical Analysis, Addison Publishing company.

Reference Books: -

1. E. Balagurswamy, Numerical Methods, Tata McGraw-Hill.
2. V.N. Vedamurthy and N.Ch.S.N. Iyengar, Numerical methods, Vikash Publishing House.

MT – 406: ALGEBRAIC TOPOLOGY

1. Geometric complexes, Polyhedra, Orientation of Geometric complexes.[10 hours]

2. Chains, Cycles, Boundaries, Homology Groups, Examples and structure of Homology Groups, The Euler-Poincare Theorem, Euler's Theorem, Pseudomanifolds, Fundamental Groups of S^n.[15 hours]

3. Simplicial Approximation, induced Homomorphhism on the Hology Groups, The Brouwer Fixed Point Theorem.[15 hours]

4. Homotopic Paths and Fundamental Group, Covering Homotopy property for) Examples of fundamental Groups, Relation between first Homology group and Fundamental Group.[20 hours]

Recommended Book: -

1 F.H. Croom · Basic Concepts of Algebraic Topology (Springer under graduate text) Topics 1.1 to 1.2.1 to 2.5,3.1 to 3.4,4.1 to 4.5

Reference Books :-

1 Mayer J · Algebraic Topology (Prentice Hill)
2. I.M. Singer & J.A. Thorpe: Lecture Notes on Elementary Topology and Differential Geometry (Springer- Verlog)
3 E.H Spanier · Algebraic Topology (Tata – McGraw Hill)

MT – 407 : COMPLEX ANALYSIS - II

1 Maximum modules Principle, Schwarz lemma, convex functions [1 (Chapter 6 {1, 2, 3 (3.1-3.4)}] (08 hours)

2 The spaces of continuos functions $c(G,\Omega)$, spaces of analytic functions, Spaces of meromorphic functions, The Riemann Mapping theorem, Weierstrass Factorization Theorem, Factorization of Sine function. [1(Chapter 7{1-6})] (16 hours)

3 Rings theorem simple connectness, Mittas Leffer theorem [1 chap 8](10 hours)

4 Analytic continuation Schwarz Reflection principle Analytic continuation along a path, Monodromy theorem.[1(Chapter 9{1-3})] (14 hours)

5 The range of an analytic function, Bloch's theorem The Little Picard theorem [1,Chapter 12{1.2}](12 hours)

Recommended Book :-

1. J.B. Conway, Functions of one complex variables. Springer International Student Edition.

Reference Book: -

1. W. Rudin, Real & Complex Analysis, Mc Graw Hill Book Company 1966 L.V Alfors, Complex Analysis, Mc Graw Hill International editions 1979.
2. S. Ponnusamy, Foundations of complex Analysis, Narosa Publishing House, 1997.

MT – 408 : QUANTITATIVE TECHNIQUES

1. PERT AND CPM : **[14 Hours]**
   Introduction, Phases of project management, Network diagrams, Fulkerson's rule, slack, forward pass, backward pass, critical path, project duration, various floats, tabular form, differences between PERT and CPM. Project cost and crashing the Network.

2. Queuing Models : **[10 Hours]**
   Introduction, application of Queuing models, characteristics, arrival and service distribution, Kendall's notation for Queuing models, Single channel queuing theory, M/M/I model and generalization, M/M/I:SIRO/model. M/M/1. FCFS/N/Finite queue length model, M/M/1:FCFS/n/N Limited source model. M/M/C:FCFS/ / Multi-channel queuing theory model

3. Sequencing Models and Related problems: **[6 Hours]**
   Introduction, processing jobs through 2-machines and 3-machines, processing two jobs through m machines and n jobs through m machines. The travelling sales man problem, minimal path problem.

4. Decision theory: **[10 hours]**
   Steps involved in Decision theory, decision making under uncertainity,: Minimax, Maximin, Maximax, Hurwicz and Laplace criteria. Decision making under risk: Expected monetary value and Expected opportunity loss criteria and EVPI. Decision trees.

5. Replacement Models, **[6 Hours]**
   Introduction, Replacement of Items that deteriorate with time with no changes in money value, with change in value of money, replacement of items that fail suddenly, individual replacement policy, group replacement policy and staffing problems.

6. Inventory Models [8 Hours]
Necessity and maintenance of inventory, inventory costs, inventory control problems, inventory models with deterministic demand, with probabilistic demand, with price breaks, multi-item deterministic models, forecasting of demand, forecasting methods, seasonal demand, when to order, safety stock and how much to order.

7. Simulation [6 Hours]
Introduction, when to use simulation, advantages and limitations of simulation technique, Monte Carlo method, generation of random numbers, time flow mechanism, simulation languages.

Recommended Books :

1. V.K. Kapur : Quantitative Techniques for Management, Sultan Chand & Co., New Delhi.
2. P.K. Gupta and D.S. Hira : Operations Research, Sultan Chand & Co., New Delhi.

Reference Books :

1. Taha, Operations Research : An introduction, Macmillan publishing Co.
2. Vohra, N.D., Quantitative techniques in management, Tata Mc-Graw Hill.