Faculty of Sciences

Syllabus

For

M. Sc. Mathematics
(Annual System)
(Parts-I & II)

Examination : 2010

GURU NANAK DEV UNIVERSITY
AMRITSAR

Price Rs. 80-00

ELIGIBILTY :

The examination shall be open to any person who :
(A). has passed at least one academic year previously :

(i). B.A./B.Sc. examination with Honours in Mathematics/Statistics/Operational Research.

OR

(ii). B.A. (Pass), B.Sc. (Pass), with 50 per cent marks in aggregate and having Mathematics as one of the subjects.

OR

(iii).B.Sc. (Hons. School in Physics), B.Sc. (Engg.), with 50 per cent marks in aggregate and having Mathematics as one of the subsidiary subjects.

OR

(iv).B.A. (Pass), B.Sc. (Pass) Examination in full subjects obtaining 45 per cent marks in Mathematics.

OR

(v). Master's Degree of this University in another subject or another Faculty.

OR

(vi). Master's Degree in any subject from another University.

DETAILED ORDINANCES RELATING TO EXAMINATION FOR THIS CLASS ARE CONTAINED IN THE GURU NANAK DEV UNIVERSITY CALENDAR, VOL. II READ WITH SYNDICATE DECISIONS / AMENDMENTS

Scheme of Examination

Part-I

Paper-I Real Analysis
Paper-II Complex Analysis and Differential Geometry.
Paper-III Algebra
Paper-IV Mechanics
Paper-V Differential and Integral equation

Note : (i) In any paper, the use of logarithmic tables and calculators (electronics as well as manual) will be allowed for solving numerical problems. However, the University will supply only logarithmic tables unless otherwise provided a question paper.

(ii) The students can use Non-Programmable Calculators.

Part-II

Paper-VI Measure Theory & Functional Analysis

Paper-VII Topology

Papers-VIII , IX & X Opt. (i) Modern Analysis

Papers-VIII , IX & X Opt. (ii) Ring Theory
Papers- VIII , IX & X Opt. (iii) Group Theory

Papers- VIII , IX & X Opt. (iv) Commutative Algebra

Papers- VIII , IX & X Opt. (v) Operations research

Papers- VIII , IX & X Opt. (vi) Special Functions

Papers- VIII , IX & X Opt. (vii) Theory of Elasticity

Papers- VIII , IX & X Opt. (viii) Number Theory & Lattice Theory

Papers- VIII , IX & X Opt. (ix) Geometry of Numbers

Papers- VIII , IX & X Opti. (x) Hydromechanics

Papers- VIII , IX & X Opt. (xi) Statistics

Papers- VIII , IX & X Opt. (xii) Set Theory and Discrete Mathematics

Papers- VIII , IX & X Opt. (xiii) Theory of Linear Operator

Papers- VIII , IX & X Opt. (xiv) Sobolev Spaces

Paper – I : REAL ANALYSIS

Time : 3 Hours **Max. Marks : 100**
Credit Hrs. : 5 per week

INSTRUCTIONS FOR THE PAPER SETTERS/EXAMINERS :

Question paper must contain at least 35% of the article/theory from the prescribed books. The question paper will consist of five units. Each unit will contain four questions.
The candidates are required to attempt two questions from each unit. All questions carry equal marks.

UNIT – I

Set Theory : Finite, Countable and Uncountable sets. Metric Spaces : Definition and examples, compactness of K-cells, compact subsets of Euclidean space RK, perfect sets. The Cantor set, connected sets in a metric space, connected subsets of real line.

UNIT – II

Sequences in Metric Spaces : Convergent sequences, subsequences, Cauchy sequence, Complete metric spaces, Cantor's intersection theorem, Baire's theorem. Banach Contraction Principle, Continuity: Limit of functions, continuous functions, continuity and compactness, continuity and connectedness, discontinuities, monotonic functions.

UNIT – III

Sequences and series of functions : Discussion of main problem, Uniform convergence, uniform convergence and continuity, uniform convergence and integration, uniform convergence and differentiation, Equi continuous families of functions, Arzela's theorem, Weierstrass approximation theorem.

UNIT – IV

Reimann Stieltje's integral: Definition and existence of integral, properties of integral, Integration and differentiation. Fundamental theorem of Calculus, 1st and 2^{nd} mean value theorems of Riemann Stieltje's integral. Lebesgue Measure: Outer measure, Measurable sets and Lebesgue Measure. A non-measurable set.

UNIT – V

Measurable functions, Littlewood's three principles. Lebesgue integral of bounded function, comparison of Riemann and Lebesgue Integral, Integral of a non-negative function, General Lebesgue Integral, Convergence in measure.

Books Recommended :

1. Walter Rudin : Principles of Mathematical Analysis (3rd edition), Ch. 2, Ch. 3. (3.1-3.12), Ch. 6 (6.1 – 6.22), Ch.7(7.1 – 7.27), Ch. 8(8.1- 8.5, 8.17 – 8.22).
2. G.F. Simmons : Introduction to Topology and Modern Analysis, Ch. 2(9-13), Appendix 1, p. 337-338.
3. Shanti Narayan : A Course of Mathematical Analysis, 4.81-4.86, 9.1-9.9, Ch.10,Ch.14, Ch.15(15.2, 15.3, 15.4)
4. T.M. Apostol : Mathematical Analysis, (2nd Edition) 7.30 and 7.31.
5. S.C. Malik : Mathematical Analysis.
6. H.L. Royden : Real Analysis, Ch. 3, 4.

PAPER-II COMPLEX ANALYSIS AND DIFFERENTIAL GEOMETRY

TIME : 3 Hrs
CREDIT HOURS: 5 PER WEEK **Max. Marks: 100**

Instructions for the paper setters/examiners:

Question paper must contain at least 35% of the article/theory from the prescribed books. The question paper will consist of five units. Each unit will contain four questions.
The candidates are required to attempt two questions from each unit. All questions carry equal marks.

Unit-I

Sequences and functions of complex variables, continuity and differentiability, analytic functions, Cauchy-Riemann equations, Cauchy's theorem and Cauchy's integral formula, conformal mappings, bilinear transformations.

Unir-II

Power Series, Taylor's series and Laurent's series, Singularities, Liouville's theorem, Fundamental theorem of algebra, Cauchy's theorem on residues with applications to definite integral evaluation, Rouche's theorem, Maximum Modulus principle, Schwarz Lemma.

Unit-III

Notation and summation convention, transformation law for vectors, Knonecker delta, Cartesian tensors, addition, multiplication, contraction and quotient law of tensors. differentiation of Cartesians tensors, metric tensor, contra-variant, covariant and mixed tensors, Christoffel symbols. Transformation of christoffel symbols and covariant differentiation of a tensor. Theory of space curves: - Tangent, principal normal, bin ormal, curvature and torsion. Serret- frenet formulae.

Unit-IV

Contact between curves and surfaces. Locus of centre of curvature, spherical curvature, Helices. Spherical indicatrix, Bertrand curves, surfaces, envelopes, edge of regression, developable surfaces. Two fundamental forms.

Unit-V

Curves on a surface, Conjugate direction, Principal directions, Lines of Curvature, Principal Curvatures, Asymptotic Lines. Theorem of Beltrami and Enneper, Mainardi-Codazzi equations. Geodesics, Differential Equation of Geodesic. Torsion of Geodesic, Geodesic Curvature, Clairaut's theorem, Gauss- Bonnet theorem, Joachimsthal's theorem, Geodesic Mapping, Tissot's theorem.

Books Recommended:

1. Ahelfors, D.V. : Complex Analysis

2. Conway, J.B. : Function of one complex variable

3. Pati,T. : Functions of complex variable

4. Shanti Narain : Theory of function of a complex Variable

5. Tichmarsh, E.C. : The theory of functions

6. H.S. Kasana : Complex Variables theory and applications

7 P.K. Banerji : Complex Analysis

8. Serge Lang : Complex Analysis

9. H.Lass : Vector & Tensor Analysis

10. Shanti Narayan : Tensor Analysis

11. C.E. Weatherburn : Differential Geometry

12. T.J. Wilemore : Introduction to Differential Geometry

13. Bansi Lal : Differential Geometry.

Paper-III **ALGEBRA**

Time : 3 Hours **Max. Marks : 100**
Credit Hrs. 5 per week

INSTRUCTIONS FOR THE PAPER SETTERS / EXAMINERS :

Question paper must contain at least 35% of the article/theory from the prescribed books. The question paper will consist of five units. Each unit will contain four questions.
The candidates are required to attempt two questions from each unit. All questions carry equal marks.

UNIT-I: Groups : Definition and examples. Subgroups and normal subgroups. Quotient groups, Lagrange's Theorem, Generating sets. Cyclic groups. The commutator subgroup Homomorphisms. Automorphisms. Permutation groups, Cayley's theorem. The alternating groups.

UNIT-II : Direct products. External and internal direct products. Structure of finite abelian groups. Conjugate elements and class equations of finite groups. Sylow's theorems and their simple applications. Solvable groups. Jordan-Holder Theorem.

UNIT-III: Rings, Subrings, Ideals and their operations. Factor rings, Homomorphisms, Integral domains. The field of quotients Euclidean domains. Principal Ideal Domains.

UNIT-IV: Unique factorization domain, Polynomial rings, Prime fields, finite and algebraic extensions. Roots of a polynomial, splitting fields; existence and uniqueness, Separable extensions.

UNIT-V: Finite fields; the structure, the existence of GF (p^n). Galois theory : Normal extensions, Galois groups, Symmetric functions, fundamental theorem, Constructible polygons. Solvabilty by radicals.

Books Recommended:

1. I.N. Herstein : Topics in Algebra, Ch. 2,3,5, (Section 1, 3 to 6), 7 (7.1).
2. Dan Saracino : Abstract Algebra; A First Course.
3. Mitchell and Mitchell : An Introduction to Abstract Algebra.
4. John B. Fraleigh : An Introduction to Abstract Algebra (Relevant Portion).
5. Surjit Singh & Qazi Zammeerudin : Modern Algebra.

6. I.S. Luther and I.P.S. Passi : Algebra Vol. I – Groups Vol. II Rings.

7. D.S. Malik, John N. Moderson, M.K. Sen : Fundamentals of Abstract Algebra, McGraw Hill, 1977.

8. I.N. Herstein : Abstract Algebra. Prentice-Hall, 1996

9. P.B. Bhattacharya, S.K. Jain & S.R. Nagpal : Basic Abstract Algebra, Cambridge Univ. Press, 1997.

10. Vivek Sahai, Vikas Bist : Algebra 1999.

Paper IV **MECHANICS**

Time : 3 Hours **Max. Marks : 100**
Credit Hrs. 5 per week

INSTRUCTIONS FOR THE PAPER SETTERS / EXAMINERS :
Question paper must contain at least 35% of the article/theory from the prescribed books. The question paper will consist of five units. Each unit will contain four questions.
The candidates are required to attempt two questions from each unit. All questions carry equal marks.
Dynamics of Particles

UNIT-I : General expression for velocity, acceleration in various systems of coordinates, Moving axes, Rectilinear motion with varying acceleration with or without dissipation. Motion in a plane. Motion in a circle and cycloidal motion (Chapters II, III excluding 3.6, 3.7 and 3.8 off. Chorlton).

UNIT-II : Projectile in resisting media, Central orbit, disturbed motion in central orbits, Principles of conservation of energy, momentum and angular momentum. Motion of a particle on the smooth surface of revolution with a verticle axis. System of particles (Chapters IV, V, VI excluding 5.7, 6.6 of F. Chorlton).

Dynamics of Rigid Body
UNIT-III: Moments and products of inertia and their allied properties. Motion of a rigid body in two dimensions under finite and impulsive forces. Motion about a fixed axis, Conservation of energy and momentum. Euler's equations. Motion about revolving axes (Chapters VII, VIII, IX excluding 9.5 off. Chorlton).

Generalised Coordinates
UNIT-IV: Lagrange's equation for holonomic systems and their applications to small oscillation. Normal modes of vibrations. Lagrange's functions. Ignorable coordinates. Variational methods. Hamiltonian equations. Hamilton principle (Chapters 10.11 excluding 10.13 to 10.16. off Chorlton).

UNIT-V : Calculus of Variations : Linear functionals, minimal functional therorem, general variation of a functional. Euler Lagrange equations of Single independent and single dependent variable, several dependent and several independent variables, Constraints and lagrange multipliers on a surface. Variational methods; Rayleigh-Ritz method, The Galerkin's method. The methods of Kanturovich and Treffiz method.

Note : Scope and standard of the syllabus in the same as given in text book of Dynamics by F.Chorlton. Vectorial approach be followed as far as possible.

Books Recommended:

1. F. Chorlton : Text Book of Dynamics.
2. D.E. Rutherford : Classical Mechanics.
3. Hildbrand,F : Methods of Applied Math.
4. Elsgists,L : Differential equations and the calculus of variations.
5. S.L. Loney : Dynamics (Articles 84-85, 100, 102, 103, 109, 111, 144- 151, 153-155 only).

Paper-V DIFFERENTIAL AND INTEGRAL EQUATIONS

Time : 3 Hours **Max. Marks : 100**
Credit Hrs. : 5 per week

INSTRUCTIONS FOR THE PAPER SETTERS / EXAMINERS :

Question paper must contain at least 35% of the article/theory from the prescribed books. The question paper will consist of five units. Each unit will contain four questions.
The candidates are required to attempt two questions from each unit. All questions carry equal marks.

UNIT-I: Bessel functions, Legendre polynomials, Hermite polynomials and laguerre polynomials. Recurrence relations, generating functions. Rodrigue formula and orthogonality.

UNIT-II: Existence theorem for solution of the equation

dy/dx= f (x,y)

(Picard's methods as in Yoshida). General properties of solutions of linear differential equations of ordern. Total differential equations, simultaneous differential equations.Adjoint and self-adjoint equations. Green's function method. Sturm liouville's boundary value problems. Sturm comparision and Separation theorems. Orthogonality of solutions.

UNIT-III: Classification of partial differential equations, Cauchy's problem and characteristics for first order equations. Classification of integrals of the first order partial differential equations. Lagrange's methods, Charpit's method and Jacobi's method for solving partial differential equations.

UNIT-IV: Higher order equations with constant coefficients and Monge's method. Classification of second order partial differential equations. Solution of Laplace. Wave and diffusion equations by separation of variable (Axially symmetric cases).

UNIT-V: Integral equations and algebraic system of linear equations. Volterra equation & L_2–Kernels and functions. Volterra equations of the first kind. Volterra integral equations and linear differential equations. Fredholm equations, solutions by the method of successive approximations. Neumann's series. Fredholm's equations with Poincere Goursat Kernels, the Fredholm theorem (Scope same as in Chapters I & II excluding 1.10 to 1.13 and 2.7 of integral equations by F.G. Tricomi).

Books Recommended:

1. Yoshida, K. : Lectures in Differential and Integral Equations.
2. N.M. Kapoor : Differential Equation (Pitamber Publications, New Delhi).

3. Tricomi, : F.G. Integral equations (Ch. I and II).

4. Rainuile : Special functions

5. Piaggio : Differential equations

6. Sneddon L N. : Elements of partial differential equations, Ch.I Art 1,3,4,5,6, ch.II. Art 1,2,3,4,5,6,7,9,10,13 Ch.III Art 1,4,5,11, Ch.IV. Art 5,6,11, Ch.V Art 2,3,5,7, Ch. VI Art 4,6

7. Kanwal Ram : V. Linear Integral Equations, Ch. I-VIII

8. S.L.Ross : Differential equations

Paper-VI: MEASURE THEORY & FUNCTIONAL ANALYSIS

Time : 3 Hours **Max. Marks : 100**
Credit Hrs. 5 per week

Note : Student can use Non-programmable Calculator.
INSTRUCTIONS FOR THE PAPER SETTERS/EXAMINERS :

Question paper must contain atleast 35% of the article/theory from the prescribed books

Question paper will consist of five units. Each unit will contain four questions. The candidates are required to attempt two questions from each unit.

UNIT-I : . Differentiation and Integration: Differentiation of monotone functions,Functions of bounded variation, Differentiation of an integral, Absolute continuity, spaces, Holder, Minkowski inequalities, convergence and completeness, bounded linear functional on the L^p spaces.

UNIT-II: Measure spaces, measurable functions, integration, general convergence theorems, signed measures, Radon-Nikodym theorem.

UNIT-III: Banach spaces : Definition and some examples, Continuous linear transformations. The Hahn-Banach theorem, The natural imbedding of N in N**.

UNIT-IV: The open mapping theorem. The closed graph theorem. The conjugate of an operator, The uniform boundedness theorem. Hilbert spaces : The definition and some simple properties, Orthogonal complements, orthonormal sets.

UNIT-V: The conjugate space H*, the adjoint of an operator. Self adjoint operators, normal and unitary operators, projections. Finite dimensional spectral theory : the spectrum of an operator on a finite dimensional Hilbert space, the Spectral theorem.

Books Recommended:

1. G.F. Simmons : Introduction to Topology and Modern Analysis. Ch. 9,10, relevant portions of Chap. 11

2. H.L. Royden : Real Analysis, Ch. 5 (excluding section 5), Ch. 6 and Ch 11.

3. E. Kreyszig: Introductory Functional Analysis with applications, John- Wiley & Sons, New York, 1978.

Paper VII

Topology

Time : 3 Hours **Max. Marks : 100**
Credit Hrs. 5 per week

Note : Student can use Non-programmable Calculator.
INSTRUCTIONS FOR THE PAPER SETTERS/EXAMINERS :

Question paper must contain atleast 35% of the article/theory from the prescribed books.

Question paper will consist of five units. Each unit will contain four questions. The candidates are required to attempt two questions from each unit. All questions carry equal marks

UNIT-I
Topological spaces, Basic concepts, Convergence of a sequence, Bases and sub bases for a topology, Subspaces and separated sets, Connected sets. Other approaches to a topological space.

Unit –II
Continuous functions, restrictions and extensions of mapping, Invariants under continuous mappings. Homeomorphisms. The product of two spaces and quotient space.

Unit –III
Complete normality of metric spaces, Product of metric spaces, a Metrization theorem, compactness conditions related to compactness. Separation properties.

Unit -IV
Compactness and separation properties, One point compactification. Compactness in terms of sub – bases, Tychonoff theorem. Tychonoff cubes, Tychonoff spaces. Homotopy and the fundamental group.

Unit –V
Directed sets and nets. Convergence of a net in a space. Compactness in terms of nets, topologies determined by nets, Peano spaces, continuous curves, continua and cut points, the arc and simple closed curve arcwise connectivity, the Cantor ternary sets, the Hahn – Mazurkiewicz theorem.

Books Recommended:

1. T.O Moore : Elementary General topology, chapters 2, 3, 4, 5, 6, 7, 8, 9 relevant portion.
2. J.L. Kelley : General Topology, chapters 1 to 5 (relevant portions).
3. James R. Munkres : Topology 'A First Course' Prentice Hall of India.

PAPER VIII, IX & X OPTION (I) MODERN ANALYSIS

Time : 3 Hours **Max. Marks : 100**
Credit Hrs. 5 per week

Note : Student can use Non-programmable Calculator.
INSTRUCTIONS FOR THE PAPER SETTERS/EXAMINERS :

Question paper must contain atleast 35% of the article/theory from the prescribed books.

Question paper will consist of five units. Each unit will contain four questions. The candidates are required to attempt two questions from each unit. All questions carry equal marks

UNIT- I
Measure spaces, measurable functions, integration, General Convergence theorems, signed measures, the Radon Nikodym Theorem, The L_p -spaces.

UNIT–II
Measure, Outer measure, the extension theorem, the Lebesgue-Stieltjes integral, Product measures, inner measure, Extensions by sets of measure Zero, Caratheodary outer measure.

UNIT–III
The Daniell integral, the extension theorem, Uniqueness, Measurability and measure, Measure and Topology, Baire sets, Borel sets, Positive, linear functionals on C(X), the Borel extension of a measure.

UNIT –IV
Mapping of measure spaces, point mappings and set mappings. Measure Algebras, Borel equivalences, Set mappings and point mapping in complete metric spaces, the isometrics of L_p, Banach algebras, regular and singular elements. Topological divisors of Zero.

UNIT –V
The spectrum, the formula for the spectral radius, the radical and semi – simplicity. The Gelfand mapping, application of the formula $r(x) = \lim \| x^n \|^{1/n}$ Infolutions in Banach algebras, the Gelfand-Neumark theorem.

Books Recommended:
1. H.L. Royden: Real Analysis, Chapters 11, 12, 13, 14, 15.
2. G.F. Simmon: Introduction to Topology and Modern Analysis.
3. Taylor A.E.: Functional Analysis.

Paper VIII, IX & X Option (ii) **Ring Theory**

Time : 3 Hours **Max. Marks : 100**
Credit Hrs. 5 per week

Note : Student can use Non-programmable Calculator.
INSTRUCTIONS FOR THE PAPER SETTERS/EXAMINERS :

Question paper must contain atleast 35% of the article/theory from the prescribed books.

Question paper will consist of five units. Each unit will contain four questions. The candidates are required to attempt two questions from each unit. All questions carry equal marks

Unit-I
Rings, ideals, matrix rings and their ideals, Rings with chain conditions. Hilbert basis theorem for noetherian rings.

Unit –II
Subdirect sum of rings, Zorn's Lemma, Subdirectly irreducible rings. Boolean rings Prime ideals and m systems Semi – prime ideal and the prime radical of rings.

Unit–III
Ring of endomorphisms, irreducible ring on endo-morphisms, primitive rings and rings with descending chain conditions, Wedderburn – Artin Theorem. Quasi – regular elements and the Jacobson radical Applications of the Wedderburn's theorem.

Unit -IV
Commulativity theorems, Wedderburn's theorem and some generalizations, some special rings.

Unit –V
Simple algebras, the Braur group Maximal subfieds, Some classical theorems, Crossed products. Representations of finite groups, the elements of the theory. A theorem of Hurwitz, applications to group theory.

Books Recommended:

1. N.H. McCoy : Theory of Rings.
2. I.N. Herstein : Non – Commutative Rings, Chapters 1, 2, 3, 4, 5.
3. N. Jacobson : Structure of Rings.

Paper VIII, IX & X Option (iii) **Group Theory**

Time : 3 Hours **Max. Marks : 100**
Credit Hrs. 5 per week

Note : Student can use Non-programmable Calculator.
INSTRUCTIONS FOR THE PAPER SETTERS/EXAMINERS :

Question paper must contain atleast 35% of the article/theory from the prescribed books.

Question paper will consist of five units. Each unit will contain four questions. The candidates are required to attempt two questions from each unit. All questions carry equal marks

Unit-I
Normal series, composition series, Zassenhaus Lemma Jordan, Holder Theorem, Groups of order p_q, p^2 p^3. Even and odd permutations, alternating group as holomorph of a group, complete group, normal or semi direct products.

Unit–II
Free group, subgroup of free groups, the Schreier and Nielsen method, solvable group, a theorem of Frobenius, Extended Sylow theorems in solvable groups.

Unit-III
Supersolvable and nilpotent groups. Lower and upper central series, theory of nilpotent groups, the Frattini subgroup of a group, super solvable groups. Modules, categories of Abelion groups, functional subgroups and quotient groups, topologies in group.

Unit–IV
Direct sums and direct products, directs, summands, pull back and push out diagrams, direct limits, Inverse limits, completeness and completion. Free Abelian groups, defining relations.

Unit -V
Finitely generate groups, linear independence and ranks Direct sums of cyclic p – groups subgroups of direct sums of cyclic groups, countable free group. Divisible groups, injective groups, Systems of equations, structure of divisible groups, the divisible hull, finitely congenrated groups.

Books Recommended :

1. M. Hall: The Theory of Groups, Chapter 4 (Art 4.4), 5 (Art 5.1 to 5.4), 6 (Art 6.3 to 6.5), 7.8 (Art 8.4, 8.5, 8.6), 9 (Art 9.1 to 9.3) 10.
2. L. Fuchs: Infinite Abelian Groups, Vol. I, Chapters 1, 2, 3, 4.
3. Schenkman: Theory of Groups.
4. W. Scott: Group Theory.
5. I. Kaplansky: Infinte Abelian Groups.

Paper VIII, IX & X Option (iv) COMMUTATIVE ALGEBRA

Time : 3 Hours **Max. Marks : 100**
Credit Hrs. 5 per week

Note : Student can use Non-programmable Calculator.
INSTRUCTIONS FOR THE PAPER SETTERS/EXAMINERS :

Question paper must contain atleast 35% of the article/theory from the prescribed books.

Question paper will consist of five units. Each unit will contain four questions. The candidates are required to attempt two questions from each unit. All questions carry equal marks

UNIT-I: Prime ideals and maximal ideals in commutative rings; Prime radical and Jacobson radical Extension and contraction of ideals.

Modules: Submodules, quotient modules, homomorphism, Direct sum & product, Finitely generated modules.

UNIT-II: Exact sequences Tensor product of modules. Exactness properties of the tensor products. Algebras tensor product of algebras; Rings & modules of fractions; local properties. Extended and contracted ideals in rings of fractions.

UNIT-III: Primary decomposition uniqueness theorems. Integral dependence. The going up theorem, Integrally closed integral domains. The going down theorem, valuation rings.

UNIT-IV: Chain conditions, Noetherian Rings, Primary decomposition in Noetherian Rings, Artinian rings.

UNIT-V: Discrete valuation rings, dedekind domains. Fractional ideals topologies & completions. Filtrations, graded rings & modules. Associated graded rings.

Books Recommended:

1.	M. F. Atiyah and I. G. Macdonald	Introduction to Commutative Algebra, Ch. 1 to 10.
2.	O. Zariski and P. Samuel	Commutative Algebra.
3.	N. Bourbaki	Commutative Algebra.
4.	D. G. North Cott	Ideal Theory.

Paper VIII, IX & X Option (v) **OPERATIONS RESEARCH**

Time : 3 Hours **Max. Marks : 100**
Credit Hrs. 5 per week

Note : Student can use Non-programmable Calculator.
INSTRUCTIONS FOR THE PAPER SETTERS/EXAMINERS :

Question paper must contain atleast 35% of the article/theory from the prescribed books.

Question paper will consist of five units. Each unit will contain four questions. The candidates are required to attempt two questions from each unit. All questions carry equal marks

UNIT-I: :The general linear programming. Theory of simplex method. The computational procedure, Artificial variable techniques, Problems of degeneracy, concept of duality, Fundamental theorem of duality, Dual simplex method, Dual simplex algorithm, Revised simplex method.

UNIT-II: The transportation problem, balanced transportation problem, unbalanced transportation problem. Computational procedure for solving the transportation problem, Assignment problem, unbalanced assignment problem. The replacement problem

UNIT-III: Convex sets, Separation theorems, convex sets, Convex and concave functions and their elementary properties. Generalized convexity. Theorem of maxima and minima of convex and convave functions, Quadratic programming, Wolfe's and Beal's methods.

UNIT-IV: Non-linear programming. Definition and examples of non-linear programming. Mubi-Tucker theory: K-T optimality conditions. K-T first order necessary optimality conditions, K-T second optimality conditions, Lagrange's method. Economic interpretation of multipliers-Wolfe duality theorem on non-linear programming.

UNIT-V: Integer programming. Definition, fixed charge problem, Dynamic Programming. Nature of dynamic programming, Deterministic processes, non-sequential discrete optimizations allocation problems assortment problems, sequential discrete optimization long term planning problem, multistage production processes.

Books Recommended

1. Gass, S. L.	Linear Programming
2. Hadley, G	Linear Programming
3. Kambo, K. S.	Mathematical Programming Techniques
4. Hadley, G.	Non-Linear and Dynamic Programming.
5. Mangassarian, O. L.	Non-Linear Programming.

Paper VIII, IX & X Option (vi) SPECIAL FUNCTIONS

Time : 3 Hours **Max. Marks : 100**
Credit Hrs. 5 per week

Note : Student can use Non-programmable Calculator.
INSTRUCTIONS FOR THE PAPER SETTERS/EXAMINERS :
Question paper must contain atleast 35% of the article/theory from the prescribed books.
Question paper will consist of five units. Each unit will contain four questions. The candidates are required to attempt two questions from each unit. All questions carry equal marks

UNIT-I: Rearrangement of power series: Analytic functions, Singularities, Law of permanence of functional equations.
Entire and Meromorphic Functions
Order relations for entire functions, Entire functions of finite order, function with real Zero's; Characteristics functions; Picard's and Landau's theorems the second functional theorem.

UNIT-II: Elliptic Functions:
Doubly periodic functions, Wezerstrass elliptic function, properties of Jacob's elliptic functions, theta functions. Beta & Gamma functions: Definition, analytic character, Euler's limit formula.

UNIT-III: Hypergeometric Functions:
Differential equation, solution near an ordinary point and near a regular singularity, integral representation, Value of Gauses 2 F, Barnes contour Integral, Relation between continuous functions. Kummers functions and its symptotic expansion.

UNIT-IV: Legendre Functions and Hermit Functions:
Legendre's functions, Laplace's integral for the Legendre's polynomials, generating functions, recurrence relation, orthogonality, the complete solution of Legendre's equation. Hermite polynomials. Recurrence relation's, Rodrigue's formula Hermite polynomial as 2FO. Orthogonality of Chebehev polynomials

UNIT-V: Bessel Functions
Basel functions of different types and their simple properties. Asymptotic expansion of Bessel and Hankel functions. Neumann Expansion Theory.

Books Recommended
1.	E. C. Titchmarsh	The Theory of Functions.
2.	Eliner Hille	Analytic Function Theory, Vol. II.
3.	T. Copsen	An Introduction to the Theory of Function of a Complex Variables.
4.	F. D. RainVille	Special Functions.
5.	Y. P. Luke	The Special Functions and Their Approximation.
6.	George Arfken	Mathematical Methods for Physicists.

Paper VIII, IX & X Option (vii) THEORY OF ELASTICITY

Time : 3 Hours **Max. Marks: 100**
Credit Hrs. 5 per week

Note : Student can use Non-programmable Calculator.
INSTRUCTIONS FOR THE PAPER SETTERS/EXAMINERS :

Question paper must contain atleast 35% of the article/theory from the prescribed books.

Question paper will consist of five units. Each unit will contain four questions. The candidates are required to attempt two questions from each unit. All questions carry equal marks

UNIT-I: Deformation Affine deformation Infinitesimal Affine deformation. Geometrical interpretation of components of Strain. Strain Quadric of Cauchy. Principal Strains. Strain invariants Examples of Strain. Equations of compatibility Strain in Cartesian coordinates Body and Surface forces Stress vector and tensor Equations of equilibrium Symmetry of stress tensor Transformations of co-ordinates Stress Quadric of Cauchy Principle Stress Stress invariants. Examples of stresses

UNIT-II:Equations of Elasticity: Hooke's Law Generalized Hooke's Law Homogeneous Isotropic Media Elastic Modulus for Isotropic Media. Simple Tension Pure Shear Hydrostatic Pressure Equilibrium Equations for an Isotropic Elastic Solid Dynamical equations for an Isotropic Solid Bedtram-Michel compatibility equations Strain energy Function and its connection with Hooke's Law.

UNIT-III: Extension, Torsion and Flexure of Beams: Statement of Problem. Extension of Beams by Longitudinal Forces Beam Stretched by its own weight Bending of Beams by Terminal couples. Stress Function Tension of circular shaft, cylindrical Bars, Ellipic cylinder rectangular Beams and a Triangular Prism Simple Solutions of the Torsion Problem. Effects of Grooves Flexure of Beams by Terminal Loops Center of Flexure

UNIT-IV: Two Dimensional problems Plane Strain and Plane Stress. Generalized Plane Stress Plane Elastotaic Problems Air's Stress Function, General solution of Biharmonic Equation. Formulas for stress and Displacements First and Second Boundary value problems in plane Elasticity.

UNIT-V:Variational Methods: Variational Problems and Euler's Equations for functions with one and two independent variables. Theorem of Minimum potential Energy Theorems of minimum complementary energy Theorem of work and Reciprocity Deflection of an Elastic stream central line of a beam and elastic Membrane and Torsion of Cylinders. Variation Problems related to the Biharmonic Equation.

Books Recommended:

1. Sokolnikoff, I. S. : Mathematical Theory of Elasticity.
2. Love, A. E. H. : A Treatise on the Mathematical Theory of Elasticity.
3. Godfrey, D. E. : Theoretical of Elasticity and Plasticity for Engineers.
4. Muskelishvill, N. I. : Some Basic problems of the Mathematical Theory of Elasticity.
5. Timoshenko. S. and Goddler, I. N. : Theory of Elasticity.

Paper VIII, IX & X Option (viii) NUMBER THEORY AND LATTICE THEORY

Time : 3 Hours **Max. Marks: 100**
Credit Hrs. 5 per week

Note : The students can use Non-Programmable Calculators.

Note : Student can use Non-programmable Calculator.
INSTRUCTIONS FOR THE PAPER SETTERS/EXAMINERS :

Question paper must contain atleast 35% of the article/theory from the prescribed books.

Question paper will consist of five units. Each unit will contain four questions. The candidates are required to attempt two questions from each unit. All questions carry equal marks

UNIT-I: Divisibility in integers, Prime integers, Fundamental Theorem of Arithmetic Congruences. Euler's theorem Fermat's theorem, Wilson's theorem Chinese remainder theorem, Primitive roots, Indices, Quadratic residues, Gauss's lemma, Quadratic reciprocity law.

UNIT-II: Arithmetic functions (n), and (n) Mobius inversion formula, Diophantine equations $x^2+y^2=z^2$ and $x^4+y^4=z^4$ Sum of two squares and sum of four squares, Warring's problem, Sum of Kth powers, g (k) and G (k).

UNIT-III: Farley fractions, Simple continued fractions, approximation to irrational numbers, Periodic continued fractions, Pell's equation.

UNIT-IV: The function $\pi(x)$, y (x), q (x) and Bertrand's conjucture, Statement of Prime number theorem. Elementary results on distribution of primes.

UNIT- V: Lattice theory : Partially ordered sets (Posets), Lattices, complete lattices, modular lattices, distributive lattices. Complements, Boolean algebra, Application to switching circuits.

Books Recommended:

1. Ivan Niven and Herbert S, Zuckerman	An introduction to the Theory of Numbers Ch. 1, Ch. 2 (2.1, 2.4, 2.9), Ch. 3, Ch 4 (3.2, 3.3), Ch. 5 (5.1, 5.10), Ch. 6 (6.1, 6.2) Ch.7
2. Hardy and Wright	An introduction to theory of Numbers by (Relevant portions for unit (IV).
3. William J. Gilbert	Modern Algebra with Applications, Ch. 2 (Relevant Portion).
4. D. Rutherford	Introduction to Lattice Theory (relevant portion).
5. N. Jacobson	Lectures in Abstract Algebra Vol. 1, (relevant portion).
6. V. K. Khanna	Lattices and Boolean Algebra (relevant portion).

Paper VIII, IX & X Option (ix) **GEOMETRY OF NUMBERS**

Time : 3 Hours **Max. Marks: 100**

Credit Hrs. 5 per week

Note : Student can use Non-programmable Calculator.
INSTRUCTIONS FOR THE PAPER SETTERS/EXAMINERS :

Question paper must contain atleast 35% of the article/theory from the prescribed books.

Question paper will consist of five units. Each unit will contain four questions. The candidates are required to attempt two questions from each unit. All questions carry equal marks

UNIT-I: Hermite's theorem on minima of positive definite quadratic forms. Minkowski geometrical proof Convex Bodies. Lattices Minkowski's fundamental theorem its application to linear forms. Statement of Minkowski Hajos theorem Dirchlet's theorem, Minkowski's improvement Konecker theorem, Application of Minkowski's theorem to other convex bodies. Generalization of Minkowski theorem due to Blichfelat Mordell and Vander Carpot Minkowski's second theorem.

UNIT-II: Exact minima for binary quadratic forms (first reminima for indefinite forms). Mordell's relation between the minima of positive define quadratic forms for n and n + 1 variables Minima for positive definite quadratic forms of three and four variables Admissible lattices, critical, determinant, critical lattices. Their connection with Diphanline inequalities. Pecking and their connection with these problems, Blidhfeldt's result on closest packing of dimensional spheres its consequences for minima of positive definite quadratic forms.

UNIT-III: Critical lattices for two dimensional convex bodies, Application to binary quadratic forms, Minkowski's connective about the critical, lattices for xpo/01Yp 33 amended by Davis.

Covering lattices coverings constants, lattice coverings their connection with Diophantine inequalities, Lattice coverings for two dimensional convex bodies. Lattice coverings by circle Statement of Known result for coverings. Lattice as well as non-lattice in the plane

UNIT-IV: Definition of g0 the density of the best lattice covering by n dimensional spheres. Proof of the covering:

¾ S<n

Statement of the stronger result of Davenport Statement of known result for On, On, Minkowski-Hlawk theorem (any proof). Its analogue for lattice covering by Symmetrical convex bodies, Minimum of products of three linear forms for the non-real case of the assumption that every critical lattice has a point on the boundary i. e. prove only that;

D

$L, (L_3 2+L_3)<-+ \quad <23$

UNIT-V: Modell's theorem on the binary cubic form (any proof), Product of n-real homogeneous forms (Result of Minkowski and Davenport statement of later results due to Rankin and Rogers) Minkowski's theorem on the product of two or three non homogenous real forms (any proof). Tchebetoroffs theorem on the product real non-homogeneous forms with statement of Davenport's improvement Minkowski's conjective with mension of Dyson's theorem non homogenous binary cubic of forms Mchler's existence theorem for critical lattices of bounded star-bodies.

Books Recommended

1. J. W. S, Cassels : Introduction to the Geometry of Numbers Springer, 1959.

1. H. Minkowski : Diophantische Approximation, Leipzig, 1907.

2. H. Minkowski : Geometric der Zahlen, Leipzig, 1985.

4. J. F. Konsma : Diophentische Approximation by 1937, (Berlin) reprinted by Ceelgea.

5. G. H. Hardy and E. M. Wright : Introduction to the Theory of Numbers, 2nd Ed. Oxford, 1945.

6. H. Han Cook : Development of the Minkowski Geometry of Numbers, New York 1939.

7. O. H. Keller : Geometric der Zahlan in Enzyklopadia der Mathematiche Wissen-schaftee Series; Leipzig (1944).

Paper VIII, IX & X Option (x) **HYDROMECHANICS**

Time : 3 Hours **Max. Marks: 100**
Credit Hrs. 5 per week

Note : Student can use Non-programmable Calculator.
INSTRUCTIONS FOR THE PAPER SETTERS/EXAMINERS :

Question paper must contain atleast 35% of the article/theory from the prescribed books.

Question paper will consist of five units. Each unit will contain four questions. The candidates are required to attempt two questions from each unit. All questions carry equal marks

UNIT-I: Fluid Pressure. Thrust on a plane area or any surface, Center of pressure, Equilibrium of floating bodies.

UNIT-II: Kinetic of flow. Equations of continuity Boundary surface, Eulerian and Lagrangian equations of motion, integration of the equations of motions. Bernoulli's theorem. Impulsive generation of motion. Irrotational motion in two dimensions. Stream function and complex potential. Sources, sinks, doublets and their images, The Blasius theorem.

UNIT-III: Analysis of motion in neighbourhood of a point. Flow and Circulation. Constancy of circulation Permanence of irrotation motion. Uniqueness theorem, mean potential over spherical surface, Kelvin's theorem of minimum kinetic energy, circular and elliptic cylinders, Theorem of Kutta-Joukowski..

UNIT-IV: Vortex motion, Vortex line, tubes and sheets Helmholtz, Laws, Simple aspects of motions of a group of parallel rectilinear vortices, image of a vortex with respect to a circle.

UNIT-V: Navier stokes equations and some exact solutions. Disspitation of energy, Diffusion of vorticity in an incompressible fluid, condition of no slip Steady flow (poiculled) through circular pipe.

Books Recommended

1. F. Chorlton	Text books of Fluid Dynamics.
2 W. H. Besant and A. S. Ramsay	Treatisc of Hydromechanics.
3. Miline, Thomson, L. M.	Theoretical Hydromechanics.
4. Bansi Lal	Hydromechanics.

Paper VIII, IX & X Option (xi) **STATISTICS**

Max. Marks: 70 for theory paper
30 for practical

Time for Theory: 3 hrs.
Time for Practical: 3 hrs
Credit Hrs. 5 per week

Note : Student can use Non-programmable Calculator.
INSTRUCTIONS FOR THE PAPER SETTERS/EXAMINERS :

Question paper must contain atleast 35% of the article/theory from the prescribed books.

Question paper will consist of five units. Each unit will contain four questions. The candidates are required to attempt two questions from each unit. All questions carry equal marks

MATHEMATICAL STATISTICS

UNIT-I: Measure of Centeral tendency and dispersion, Moments, Skewness and Kurtosis. Axiomatic theory of probability, Algebra of sets functions probability density function, distribution function, conditional probability, marginal and conditional distributions, stochastic Independence.

UNIT-II: Mathematical Expectations. Moments and moment generating function, Chebyshev's inequality, stochastic convergence and central limit theorem. Special distribution : Uniform, Binomial, Poisson. Poisson as limiting case of Binomial. Normal, Gamma, Beta, bivariate normal, multinomial distributions.

UNIT-III: Random sampling and sampling distribution, transformation of variables, chi-square, t and F distributions, distribution of sample mean and sample variance (simple applications based on these test statistics). Distribution of order statistics and the sample range from continuous populations.

UNIT-IV:Linear regression and correlation for a bivariate population, tests of significance of null hypothesis, regression and correlation coefficients, Analysis of variance.

UNIT-V: Estimation; Point estimation, concepts of unbiasedness, efficiency, completeness, uniqueness, methods of maximum likelihood, Interval estimation, confidence intervals.

Testing of hypothesis: simple and composite hypotheses. Best test, U. M. P test Test of goodness of fit.

Books Recommended

1. P. G. Hoel — Introduction to Mathematical Statistics, (2nd ed. Chapters 4, 5, (Section 5.1, 4. 1, 5.2, 4.2, 5.3, 4.3, 5.2, 4.4, 5.4, 4.5, omitting discussion on quality control, Chapters 7).

2. R. V. Hogg & A. T. Craig — Introduction to Mathematical Statistics, (Third ed.) Chapter 1, 2, 3, 4, 5, (Sec. 5.1, 5.2, 5.3, 5.4) 7, 8, 9, (Sec. 9.1, 9.2, 9.3,) 10 (Sec. 10. 1, 10. 2,)

Paper VIII, IX & X Option (xii) SET THEORY AND DISCRETE MATHEMATICS

Time : 3 Hours **Max. Marks: 100**
Credit Hrs. 5 per week

Note : Student can use Non-programmable Calculator.
INSTRUCTIONS FOR THE PAPER SETTERS/EXAMINERS :

Question paper must contain atleast 35% of the article/theory from the prescribed books.

Question paper will consist of five units. Each unit will contain four questions. The candidates are required to attempt two questions from each unit. All questions carry equal marks

UNIT-I: Elementary set theory, axioms, Boolean algebra of classes. Algebra of relations, functions of infinite Boolean operations, Direct product, power classes, equivalence classes, ordering.

UNIT-II: Ordinals, Transfinite inductions, the natural number, sequences and formal functions recursion theorem only statements and illustrations), ordinal arithmetic division algorithm and number, Base expansion theorem Axiom of choice and its equivalent forms.

UNIT-III: Cardinals finite and infinite sets, cardinal addition and multiplication Zormolo's inequality cardinal exponentiations, Elementary counting pigon hole principle exclusion-inclusion.

UNIT-IV: Principle Derangements, Ram says theorem orthogonalization of squares, Polya's theorem.

UNIT-V: Elements of graph theory and graphical enumeration. Planar and Direct Graphs. Trees.

Books Recommended

1. J. D, Monk : Introduction to set Theory .
2. Charles, C Pinter : Set Theory.
3. N. Bogrbaki : Theory of Sets.
4. R. J. Wilson : Introduction to Graph Theory.

Paper VIII, IX & X Option (xiii) **THEORY OF LINEAR OPERATORS**

Max. Marks:100

Time : 3 hrs.
Credit Hrs. 5 per week

Note : Student can use Non-programmable Calculator.
INSTRUCTIONS FOR THE PAPER SETTERS/EXAMINERS :

Question paper must contain atleast 35% of the article/theory from the prescribed books.

Question paper will consist of five units. Each unit will contain four questions. The candidates are required to attempt two questions from each unit. All questions carry equal marks. All questions carry equal marks

UNIT-I

Spectral theory in normed linear spaces, resolvent set and spectrum, spectral properties of bounded linear operators. Properties of resolvent and spectrum. Spectral mapping theorem for polynomials. Spectral radius of a bounded linear operator on a complex Banach space. Elementary theory of Banach algebras.

UNIT-II

General properties of compact linear operators. Spectral properties of compact linear operators on normed spaces. Bahaviours of Compact linear operators with respect to solvability of operator equations. Fredholm types theorems. Fredholm alternative theorem. Fredholm alternative for integral equations.

UNIT-III

Spectral properties of bounded self-adjoint linear operators on a complex Hilbert space. Positive operators. Monotone sequence theorem for bounded self-adjoint operators on a complex Hilbert space. Square roots of a positive operator. Projection operators. Spectral family of a bounded self-adjoint linear operator and its properties. Spectral representation of bounded self-adjoint linear operators. Spectral theorem.

UNIT-IV

Spectral measures. Spectral Integrals. Regular Spectral Measures. Real and Complex Spectral Measaures. Complex Spectral Integrals. Description of the Spectral Subspaces. Characterization of the Spectral Subspaces. The Spectral theorem for bounded Normal Operators.

UNIT-V

Unbounded linear operators in Hilbert space. Hellinger-Toeplitz theorem. Hilbert adjoint operators. Symmetric and self-adjoint linear operators. Closed linear operators and closures. Spectrum of an unbounded self-adjoint linear operator. Spectral theorem for unitary and self-adjoint linear operators. Multiplication operator and Differentiation Operator.

References:

1. E.Kreyszig: Introductory Functional Analysis with Applications, John-Wiley & Sons, New York, 1978.
2. P.R.Halmos: Introduction to Hilbert Space and the Theory of Spectral Multiplicity, Second-Edition, Chelsea Publishing Co., N.Y. 1957.
3. N.Dunford and J.T.Schwartz: Linear Operators-3 parts, Interscience/Willey, New York, 1958-71.
4. G. Bachman and L.Narici: Functional Analysis, Academic Press, New York, 1966.
5. Akhiezer, N.I. and I.M.Glazman: Theory of Linear Operators in Hilbert Space, P.Frederick Ungar Pub. Co., N.Y. Vol. 1(1961) Vol.II(1963).
6. P.R.Halmos, A.Hilbert Space Problem Book, D.Van Nostrand Company Inc. 1967.

Paper VIII, IX & X Option (xiv) **SOBOLEV SPACES**

Max. Marks: 100

Time : 3 hrs.
Credit Hrs. 5 per week

Note : Student can use Non-programmable Calculator.
INSTRUCTIONS FOR THE PAPER SETTERS/EXAMINERS :

Question paper must contain atleast 35% of the article/theory from the prescribed books.

Question paper will consist of five units. Each unit will contain four questions. The candidates are required to attempt two questions from each unit. All questions carry equal marks

UNIT-I

Distributions-Test function spaces and distributions, convergence distributional derivatives.

Fourier Transform-L^1-Fourier transform. Fourier transform of a Guassian, L^2-Fourier transform, Invertion formula. L^p-Fourier transform, Convolutions.

UNIT-II

Sobolev Spaces-The spaces W^{1p} (Ω) and W^{IP} (Ω). Their Simple characteristic properties, density result. Min and Max of W^{1p}-functions. The space $H^1(\Omega)$ and its properties, density results.

Imbedding Theorems-Continuous and compact imbeddings of Sobolev spaces into Lebesgue spaces. Sobolev imbedding theorm. Rellich-Kondrasov Theorem.

UNIT-III

Other Sobolev Spaces-Dual Spaces, Fractional Order Sobolev spaces, Trace spaces and trace theory.

UNIT-IV

Weight Functions-Definition, motivation, examples of practical importance. Special weights of power type. General Weights.

Weighted Spaces-Weighted Lebesgue space P(Ω,σ) weighted Sobolev spaces W^{kp} (Ω ,σ), Wo^{kp} (Ω , σ), and their properties.

UNIT-V

Domains-Methods of local coordinates, the classes C^o, C^{ok}, Holder's condition, Partition of unity, the class K (X_o) including Coneproperty.
Inequalities-Hardy inequality, Jenesen's inequality, Youngs inequality, Hardy-Littlewood. Sobolev inequality. Sobolev inequality and its various versions.

References:

1. R.A.Adams, Sobolev, Spaces, Academic Press, Inc. 1975.
2. S.Kesavan, Topics: Functional Analysis and Applications, Wiley Eastern Limited, 1989.
3. A.Kufner, O.John and S.Fucik, Function Spaces, Noordhoff International Publishing, Leyden, 1977.
4. A Kufner, Weighted Sobolev Spaces John Wiley & Sons. Ltd., 1985.
5. E.H.Lie and M.Loss Analysis, Narosa Publishing House, 1997.
6. R.S.Pathak, A Course in Distribution Theory and Applications, Narosa Publishing House, 2001.