CH. CHARAN SINGH UNIVERSITY, MEERUT
M.Sc.(Mathematics) SYLLABI (2010 Onwards)

M.Sc. Semester I			hrs/week	**Max. marks**
1.	**M – 101**	Algebra	6	100
2.	**M – 102**	Real Analysis	6	100
3.	**M – 103**	Differential Equations	6	100
4.	**M – 104**	Metric Spaces	6	100
5.	**M – 105**	Viva-voce based on above courses	4	100

M.Sc. Semester II

1.	**M – 201**	Topology	6	100
2.	**M – 202**	Measure and Integration	6	100
3.	**M – 203**	Advanced Discrete Mathematics	6	100
4.	**M – 204**	Operations Research	6	100
5.	**M – 205**	Viva-voce based on above courses	4	100

M.Sc. Semester III

1.	**M – 301**	Numerical Analysis	6	100
2.	**M – 302**	Complex Analysis	6	100
3.	**M – 303**	Mathematical Methods	6	100
4.	**M – 304**	Optional Course	6	100
5.	**M – 305**	Viva-voce based on above courses	4	100

M.Sc. Semester IV

1.	**M – 401**	Number Theory	6	100
2.	**M – 402**	Fluid Dynamics	6	100
3	**M – 403**	Fuzzy Sets and its Applications	6	100
4.	**M – 404**	Optional Course	6	100
5.	**M – 405**	Viva-voce based on above courses	4	100

CH. CHARAN SINGH UNIVERSITY, MEERUT
SYLLABUS FOR M.Sc. (MATHEMATICS)
2010 ONWARDS

M. Sc. (MATHEMATICS) COURSE STRUCTURE & EVALUATION SCHEME

Semester	Paper Code	Title of the Paper	Lectures hrs/week		Maximum Marks		
			L	P	IA	EA	Total
I	M- 101	Algebra	6	-	50	50	100
	M- 102	Real Analysis	6	-	50	50	100
	M- 103	Differential Equations	6	-	50	50	100
	M- 104	Metric spaces	6	-	50	50	100
	M- 105	Viva-voce based on M-101 to M-104	4	-	50	50	100
II	M- 201	Topology	6	-	50	50	100
	M- 202	Measure and Integration	6	-	50	50	100
	M- 203	Advanced Discrete Mathematics	6	-	50	50	100
	M- 204	Operations Research	6	-	50	50	100
	M- 205	Viva-voce based on M-201 to M-204	4	-	50	50	100
III	M- 301	Numerical Analysis	6	-	50	50	100
	M- 302	Complex Analysis	6	-	50	50	100
	M- 303	Mathematical Methods	6	-	50	50	100
	M- 304	Elective – 1	6	-	50	50	100
	M- 305	Viva-voce based on M-301 to M-304	4	-	50	50	100
IV	M-401	Number Theory	6	-	50	50	100
	M-402	Fluid Dynamics	6	-	50	50	100
	M-403	Fuzzy Sets and its Applications	6	-	50	50	100
	M-404	Elective – 2	6	-	50	50	100
	M- 405	Viva-voce based on M-401 to M-404	4	-	50	50	100
	GRAND TOTAL						**2000**

L: Lecture; P: Practical; IA: Internal Assessment; E A: External Assessment based on End Semester Examination

CH. CHARAN SINGH UNIVERSITY, MEERUT
M.Sc.(Mathematics) SYLLABI (2010 Onwards)

M.Sc. Semester I

1.	M – 101	Algebra
2.	M – 102	Real Analysis
3.	M – 103	Differential Equations
4.	M – 104	Metric Spaces
5.	M – 105	Viva-voce based on M-101 to M-104

M.Sc. Semester II

1.	M – 201	Topology
2.	M – 202	Measure and Integration
3.	M – 203	Advanced Discrete Mathematics
4.	M – 204	Operations Research
5.	M – 205	Viva-voce based on M-201 to M-204

M.Sc. Semester III

1.	M – 301	Numerical Analysis
2.	M – 302	Complex Analysis
3.	M – 303	Mathematical Methods
4.	M – 304	Optional Course (Any one of the following)

(I) Mechanics
(II) Algebraic Coding Theory
(III) Programming in C And Data Structure
(IV) Mathematical Statistics
(V) Partial Differential Equations
(VI) Lattice Theory
(VII) Mathematical Programming

5. M – 305 Viva-voce based on M-301 to M-304

M.Sc. Semester IV

1.	M – 401	Number Theory
2.	M – 402	Fluid Dynamics
3	M – 403	Fuzzy Sets and its Applications
4.	M – 404	Optional Course(Any one of the following)

(I) Functional Analysis
(II) File Structure And Database Management System
(III) Information Theory
(IV) Mathematical Cryptography
(V) Algebraic Topology
(VI) Differential Geometry
(VII) Plasma Dynamics

5. M – 405 Viva-voce based on M-401 to M-404

M – 101 ALGEBRA Teaching hrs/week: 6

The concepts and results of Algebra are fundamental to the study of Mathematics and represent a human achievement of great beauty and power and that is why the Mathematical Association of America has consistently recommended through its various Committees that a course in Algebra be a major part of any Mathematics Curriculum. Algebra is a core topic for all disciplines that use higher mathematics and logic.

After reading this course, the student shall be able to achieve the following two goals:

(i) He will learn about the core area of mathematics upon which many other areas of mathematics draw

(ii) It will help him in becoming sophisticated mathematicians.

CONTENTS

Unit-I

Normal subgroups, Quotient groups, Simple groups, Homomorphisms, Isomorphisms and Automorphisms, Cayley's theorem, Factor's theorem, Cauchy's theorem, Second Fundamental theorem.

Unit-II

Normal& Composition chains, Jordon Holder's Theorem, Solvable groups, Permutation groups, Alternating groups, Simplicity of An (n>=5), Galois theorem, Conjugacy, Class equations, Sylow's theorems, Direct products, Finite abelian groups, Fundamental theorem on finite abelian groups, Decomposable groups.

Unit-III

Rings, Ideals, Prime and maximal ideals, Homomorphism, Quotient- rings, Integral domains, Imbedding of rings, Field, Prime fields, Wilson's theorem, Zorn's lemma, Zrulls theorem, Field of quotients of an Integral domain, Euclidean domains, The ring of Gussian integers, Principal ideal domains, Unique factorization theorem, Fermat's theorem.

Unit-IV

Polynomial rings over rings and fields, Division algorithm, Gauss lemma, Eisenstein's irreduciblity criterion, Primitive polynomials, Cyclotomic polynomials, Unique factorization in R[x] where R is a Unique factorization Domain.

Unit-V

Field extensions, Algebraic and transcendental extensions, Normal extensions, Construction by Ruler and Compass, Finite fields, Structure of finite fields, Subfields of finite fields.

RECOMMENDED BOOKS:

1. **I. N. Herstein, Topics in Algebra**, New Age International (P) Limited, New Delhi
2. **P. B. Bhattacharya, S.K. Nagpaul**, **Basic Abstract Algebra** (2^{nd} Edition) Cambridge University Press, Indian Edition, 1997.
3. **M. Artin**, **Algebra,** Prentice Hall of India, New Delhi.
5. **N. Jacobson**, **Basic Algebra Vols. I &II,** W.H. Freeman. 1980
6. **S. Lang**, **Algebra,** 3^{rd} Edition, Pearson Education Asia, New Delhi
7. **I. S. Luther and IBS Passi**, **Algebra, Vol. I-Groups, Vol.-II Rings** Narosa Publishing House (Vol. I-1996 Vol. II-1996)
8. **J. B. Fraleigh, A First Course in Abstract Algebra**, Narosa Publishing House, New Delhi.
9. **S. K. Jain**, **A. Gunawardena and P. B. Battacharya**, **Basic Linear Algebra with MATLAB**, KCB (Springer-Verlag) 2001.

M – 102 REAL ANALYSIS Teaching hrs/week: 6

Real Analysis is a major course in mathematics, traditionally viewed as a difficult subject. It is important that this characteristic is not as something distasteful, but provides an exciting opportunity to expand mental horizons. Indeed, Real Analysis is a very rewarding subject that allows for an appreciation of the many interconnections with other mathematical areas and makes other necessary academic commitments. Beauty and creativity involved in this important area of mathematics is highly appreciable.

The theory behind the concepts of calculus will be studied in depth and with rigor. A great deal of the course is intended to immerse the student into the world of formal/abstract mathematics in which formal proofs and definitions are used in abundance.

CONTENTS

Unit I

Definition and existence of Reimann -Stieltjes integral. Properties of the integral, Integration and differentiation, the fundamental theorem of calculus, Integration of vector-valued functions.

Unit II

Sequences and series of functions. Pointwise and uniform convergence, Cauchy criterion for uniform convergence, Uniform convergence and continuity, Uniform convergence and Riemann-Stieltjes integration, Uniform convergence and differentiation, Weierstrass approximation theorem.

Unit III

Power series, algebra of power series, Uniqueness theorem for power series. Abel's and Tauber's theorems.

Unit IV

Functions of several variables, Linear transformation, Derivatives in an open subset of R^n, Chain rule, Partial derivatives, Interchange of the order of differentiation, Derivatives of higher orders, Taylor's theorem.

Unit V

Inverse function theorem and Implicit function theorem (without proof), Jacobians, Extremum problems with constraints, Lagrange's multiplier method, Differentiation of integrals.

RECOMMENDED BOOK:

1. **Walter Rudin, Principles of Mathematical Analysis, (3rd edition)** McGraw-Hill, Kogakusha, 1976, International student edition.

REFERENCES

1. **T. M. Apostol, Mathematical Analysis,** Narosa Publishing, New Delhi, 1985.
2. **J. White, Real Analysis**, A**n Introduction**, Addison-Wesley Publishing, Co. Inc., 1968.
3. **H. L. Royden, Real Analysis, (**4th Edition**)**, Macmillan Publishing Co. Inc. New York, 1993.

M–103 DIFFERENTIAL EQUATIONS Teaching hrs/week: 6

"The theory of differential equations" is an important branch of Mathematics. The subject may be considered to occupy a central position from which different lines of development extend in many directions. Moreover differential equations are the heart and soul of analysis. Study of differential equations is essential for understanding many physical and natural phenomena such as conduction of heat, transmission of electric waves and law of mass-action ete.
After completing the course, students will be able to formulate and solve differential equations arising from changes in physical world.

CONTENTS

Unit I

Ordinary Differential Equations: Qualitative properties of solution: Oscillation, Wronskian, Sturm separation and comparison theorems.

Unit II

Ordinary points, Regular singular points, Frobenius series solution.

Unit III

Gauss hyper geometric equation, the point at infinity, Gamma functions, Hermite polynomials

Unit IV

Partial Differential Equations: Origin of first order partial differential equations, Linear equations of the first order, Integral surfaces passing through a given curve, Surface orthogonal to a given system of surface, Non-linear partial differential equations of the first order, Charpits method, Special type of first order equations, Jacobi method. Origin of second order partial differential equation, Linear partial differential equations with constant coefficients, Equations with variable coefficients.

Unit V

Problems of Laplace, wave and diffusion equations by the method of separation of variables, Reduction of second order partial differential equation into its canonical form.
Non-linear equation of second order.

RECOMMENDED BOOKS

1- **G. F. Simmons: Differential Equations with Applications and Historical Notes,** Second Edition, Tata Mcgraw-Hill Publishing Company Ltd. New Delhi (2003).

2- **B. Rai, D.P. Chaudhary and H.I. Freedman: A Course in Ordinary Differential Equations,** Narosa Publishing House, New Delhi 2002. (Chapter 9)

3- **Ian Sneddon: Elements of Partial Differential Equation**, McGraw-Hill Book Company.

M – 104 METRIC SPACES Teaching hrs/week: 6

To gain proficiency in dealing with abstract concepts, with emphasis on clear explanations of such concepts to others, to introduce the theory of metric and topological spaces; to show how the theory and concepts grow naturally from idea of distance. To be able to give examples which show that metric spaces are more general than Euclidean spaces. To be able to work with continuous functions, and to recognize whether spaces are connected, compact or complete.
Metric spaces are vital prerequisite for most later mathematics courses including Analysis, Topology, Measure Theory, Complex Analysis etc.

CONTENTS

Unit I

Metric on a set, pseudo-metrics and metrics Distance between two sets. Equivalent metrics. Limit points and closure: closed sets, Derived set of a set. Adherent points and closure of a set, Dense-subsets, Interior of a set and its properties, Subspaces, Product spaces, Structure of Open balls in a product space. Closures and interiors in a product space, Finite product of metric spaces.

Unit II

Convergent sequences. Cauchy sequences. Characterization of adherent points and limit points in terms of convergent sequences. Convergence in products. Convergence in Euclidean spaces. Cluster points of a sequence. Subsequences. Cluster points and convergent subsequences. Algebra of convergent real sequences. Spaces of sequences.

Unit III

Continuity at a point. Continuity over a space. Continuity of composite, graph and projection maps. Algebra of real valued continuous functions in a metric space. Homeomorphisms. Isometries. Relation between isometries and Homeomorphism. Uniform continuity.

Unit IV

Complete metric spaces. Completeness and Continuous mappings. Completeness and subspaces. Cantor's Intersection Theorem. Contraction Mapping Principle. Connectedness: Connected metric spaces. Connected sets. Characterization of connected subsets of the real line. Properties of Connectedness

Unit V

Compact spaces and Compact subsets. Compact subsets of the real line. Sequential compactness and its characterization. Countable compactness, Bolzano-Weierstrass property. Sequential characterization of BWP. Equivalence of BWP and sequential compactness. Covering characterization of the BWP. Bolzano-Weierstrass Property and Total boundedness. Bolzano-Weierstrass Property and compactness. Lebesgue covering lemma. Compactness and completeness, Compactness and uniform continuity. Boundedness of continuous real-valued functions on compact metric spaces.

RECOMMENDED BOOKS:

1. **G. F Simmons:** **Introduction to Topology and Modern Analysis,** McGraw Hill, India
2. **E.T Copson:** **Metric Spaces,** Cambridge tracs
3. **Dieudonne:** **Foundation of Modern Analysis,** Academic Press, NY
4. **Kasriel:** **Metric Spaces,** Wiley, NY

M – 201 TOPOLOGY Teaching hrs/week: 6

Topology is a modern branch of geometry. It serves to lay the foundations for study in analysis and in geometry. It is also a prerequisite for functional analysis.
The course is designed to develop an understanding of topological ideas & techniques and their role in analysis.
At the end of the course, students should be able to understand and appreciate the central results of general topology, sufficient for the main applications in geometry, number theory and analysis.

CONTENTS

Unit I

Definition and examples of topological space, Closed sets, Closure, Dense subset, Neighborhoods, interior, exterior, boundary and accumulation points, Derived sets, Bases and sub-bases. Subspaces, product spaces and relative topology.

Unit II

Continuous functions, homeomorphisms, the pasting lemma, Connected and disconnected sets, connectedness on the real line, components, locally connected spaces.

Unit III

Countability axioms – First and second countable spaces, Lindelof's theorems, Separable spaces, second countability and separability.

Unit IV

Separation axioms – T_0, T_1, T_2, T_3, $T_{3½}$, T_4, their characterizations and basic properties. Urysohn's lemma and Teitze extension theorem, Statement of Urysohn's metrization theorem.

Unit V

Compactness – Continuous functions and compact sets, basic properties of compactness, compactness and finite intersection property, sequentially and countably compact sets, local compactness and one point compactification. Statements of Tychonoff's Product theorem and Stone-cech compactification theorem.

RECOMMENDED BOOKS:

1- **J. R. Munkres, Topology, A First Course,** PHI Pvt. Ltd., N. Delhi, 2000.
2- **S. Willard, General Topology**, Addison-Wesley, Reading, 1970.
3- **W. J. Pervin, Foundations of General Topology**, Academic Press Inc., New York, 1964.
4- **J. Dugundji, Topology,** Allyn and Bacon, 1966 (Reprinted in India by PHI).
5- **G. F. Simmons, Introduction to Topology and Modern Analysis**, McGraw-Hill Book Company, 1963.
6- **K D Joshi, Introduction to General Topology,** Wiley Eastern Ltd., 1983

M – 202 MEASURE AND INTEGRATION Teaching hrs/week: 6

A standard approach to integration on the real line, formalized by Riemann, is based on partitioning the domain into smaller intervals. This approach works in many situations but there are simple examples for which it fails. In 1902, H. Lebesgue produced a better theory in which the key idea is to extend the notion of length from intervals to more complicated subsets of R. This started an area of mathematics it its own right, called Measure Theory. Most generally, this is about how one may sensibly assign a size to members of a collection of sets.
To give an introduction to Lebesgue measure on the set of real numbers R and
the concept of measure in general, indicating its role in the theory of integration.
On successful completion of this course, students will understand

- how Lebesgue measure on R is constructed,
- the general concept of measure,
- how measures may be used to construct integrals,

CONTENTS

Unit I

Countable and uncountable sets, Infinite sets and the Axiom of Choice, Cardinal numbers and its arithmetic, Schroeder-Burstein theorem, Cantor's theorem and continuum hypothesis, Zorn's Lemma, Well-ordering theorem, Decimal, Binary and Ternary Expansion, Cantor's Ternary set.

Unit II

Algebra's of sets, Lebesgue outer measure, Measure of open and closed sets, Borel sets, Measurable sets, Regularity, A non-measurable sets.

Unit III

Measurable functions, Algebra of measurable functions, Step functions, Characteristic functions, Borel and Lebesgue measurability, Little wood's three principles, Convergence almost everywhere and convergence in measure, Egoroff's and Reisz- Fisher Theorems.

Unit IV

The Lebesgue Integral, Riemann and Lebesgue integral, The Lebesgue integral of a bounded function over a set of finite measure, the integral of non-negative functions, The general Lebesgue integral.

Unit V

Functions of Bounded Variation, Lebesgue Differentiation Theorem, Differentiation of Monotone Functions, Differentiation of an Integral, Absolute Continuity.

The L_p-Space, Convex function, Jensen's Holder's and Minkowsky's inequality, Completeness of L_p-space.

RECOMMENDED BOOKS:

1. **H.L. Royden**: Real analysis 4^{th} Edition MacMillan Publishing Co. Inc. N.Y.
2. **S. Goldberg**: Real analysis Oxford and IBH New Delhi.
3. **P.K. Jain & V.P. Gupta**: Lebesgue Measure and Integration, New Age International (P) Ltd., New Delhi.
4. **G de Barra**: Measure Theory and Integration, New Age International (P) Ltd., New Delhi.
5. **Inder K. Rana**, An Introduction to Measure and Integration, Narosa Publishing House, Delhi, 1997.
6. **Walter Rudin**, Real & Complex Analysis, Tata McGraw – Hill Publishing Co. Ltd., New Delhi, 1966.

M – 203 ADVANCED DISCRETE MATHEMATICS

Teaching hrs/week: 6

The primary goal of this course is to provide an introduction to discrete structures for information technology. Discrete structure is the study of the logical and algebraic relationships between discrete objects.
At the end of the course, students will be able to relate computing theory with applications, understand and design finite state machine, understand the importance of graph algorithms, apply the concepts of Boolean algebra in various areas of computer science.

CONTENTS

Unit 1

Formal Logic- Statements, Symbolic Representation of statements, duality, Tautologies and contradictions. Quantifiers, Predicates and Validity of arguments. Propositional Logic. Languages and Grammars, Finite State Machines and their transition table diagrams.

Unit 2

Lattices: Lattices as partially ordered sets, their properties, duality, Lattices as algebraic systems, Sub lattices, Direct products, Bounded Lattices, Complete Lattices, Complemented Lattices and Distributive lattices. Cover of an elements, atoms, join and meet irreducible elements.

Unit 3

Boolean Algebras: Boolean Algebras as lattices. Various Boolean Identities. The Switching Algebra example. Sub algebras, Direct products and Homeomorphisms.
Boolean forms and their Equivalence. Min-term Boolean forms, Sum of product Canonical forms. Minimization of Boolean functions, Applications of Boolean Algebra to Switching Theory (using AND, OR & NOT gates). The Karnaugh Map method.

Unit 4

Definition of (undirected) graph, Walk, Path, Circuit, Cycles, Degree of a vertex, Connected graphs, Complete and Bipartite graphs, Planar graphs, Euler's formula for connected Planar graphs, Kuratowski's Theorem (Statement only) and its uses. Colouring of graphs, Five colour theorem and statement of Four colour theorem.

Unit 5

Trees , Cut-sets, Spanning Trees, Fundamentals Cut-sets and minimum Spanning Trees, Prim's and Kruskal's algorithms, Connectivity, Matrix Representation of graphs, Directed Graphs, Indegree and outdegree of a vertex.

RECOMMENDED BOOKS:

1. **J. P. Trembley & R. Manohar**, Discrete Mathematical Structures with Applications to Computer Science, McGraw-Hill Book Co., 1997.
2. **J. L. Gersting**, Mathematical Structure for Computer Science (3rd ed.), Computer Science Press, N.Y.
3. **Seymour Lepschutz**, Finite Mathematics, McGraw-Hill Book Co. New –York.
4. **J. E. Hopcroft and J.D. Ullman**, Introduction to Automata Theory Languages & Computation, Narosa Publishing House, Delhi.
5. **C. L. Liu**, elements of Discrete Mathematics, McGraw-Hill Book Co.
6. **N. Deo**, Graph Theory with Applications to Engineering and Computer Sciences, PHI, New Delhi

M 204 OPERATIONS RESEARCH Teaching hrs/week: 6

Problems in optimization are the most common applications of mathematics. The main aim of this course is to present different methods of solving optimization problems in the areas of linear programming, inventory and queuing theory, In addition to theoretical treatments, there will be some introduction to numerical methods for optimization problems**.**

CONTENTS

Unit I

Operations research and its scope, Necessity of operations research in industry. Linear programming problems. Convex sets, Simplex method, Theory of simplex method. Duality theory and sensitivity analysis. Dual simplex method.

Unit II

Transportation and Assignment problems of linear programming. Sequencing theory and Travelling salesperson's problem.

Unit III

Replacement: Replacement of items that deteriorate. Problems of choosing between two machines, Replacement of items that fail completely, Problems in mortality and staffing. Inventory problems, Simple deterministic and stochastic models of inventory control.

Unit IV

Network analysis: Shortest-path problem, Minimum spanning tree problem, Maximum flow problem, Minimum cost flow problem, Network simplex method. Project planning and control with PERT/CPM.

Unit V

Queuing theory: Steady state solution of Markovian queuing models: M/M/1, M/M/1 with limited waiting space. Game theory: Two person zero-sum games, Games with mixed strategies, Graphical solutions, Solutions by linear programming.

RECOMMENDED BOOK

H.A. Taha: Operation Research- An introduction, Macmillan Publishing Co. Inc., NY

REFERENCES

1- **Kanti Swarup**, PK Gupta and Man Mohan, Operations Research, S Chand and sons, New Delhi.
2- **S.S. Rao**, Optimization Theory and Applications, Wiley Eastern Ltd, New Delhi.
3- G**. Hadley**, Linear Programming, Narosa Publishing House, 1995.
4- **F.S. Hillier** a**nd G.J. Lieberman,** Introduction to Operations Research (Sixth Edition), McGraw Hill International Edition, Industrial Engineering Series, 1995.

M 301: NUMERICAL ANALYSIS Teaching hrs/week: 6

This course aims to provide students with the techniques for finding approximate numerical solutions to mathematical problems for which exact or analytical solutions are unavailable or inappropriate.

Successful students will have an appreciation of the difficulties involved in finding reliable solutions and will gain practical knowledge of how to apply the techniques and methods to specific problems such as finding roots of equations, quadrature and numerical solution of ordinary differential equations.

CONTENTS

Unit I

Errors in computation- Floating point representation of numbers, Significant digits, Rounding and chopping a number and error due to these absolute and relative errors, Computation of errors using differentials, Errors in evaluation of some standard functions, Truncation error. Linear equations-Gauss elimination method, LU Decomposition method, Gauss–Jordan method, Tridiagonal system, Inversion of matrix, Gauss-Jacobi method, Gauss-Seidal method.

Unit II

Nonlinear equations-Iterative method, Bisection method, Method of false position, its convergence, Secant method, Newton-Raphson method, Convergence of Newton-Raphson method for simple and multiple roots,

Unit III

Interpolation-Some operators and their properties, Finite difference table, Error in approximating a function by polynomial, Newton forward and backward Difference formulae, Gauss forward and backward formulae, Stirling's and Bessel formulae, Lagrange's method, Divided differences and Newton's divided difference formula.

Unit IV

Numerical differentiation and integration-Differentiation methods based on Newton's forward and backward formulae, Differentiation by central difference formula, Integration-Methodology of numerical integration, Rectangular rule, Trapezoidal rule,Simpson's$1/3^{rd}$ and $3/8^{th}$ rules, Gauss-Legendre quadrature formula.

Unit V

Ordinary differential equations- Initial and boundary value problems, Solutions of Initial Value Problems, Picard's method, Taylor's method, Single and multistep methods, Euler's and Modified Euler's method, Runge-Kutta second order method and statement of fourth order, Milne's method, Adams-Bashforth method.

RECOMMENDED BOOKS

1. **Radhey S. Gupta**, Elements of Numerical Analysis, Macmillan India Ltd. New Delhi (2009).
2. **M.K. Jain, S.R.K. Iyengar, R.K. Jain,** Numerical Methods for Scientific and Engineering Computations, New Age International (P) Ltd. New Delhi (2003).
3. **James B. Scarborough**, Numerical Mathematical Analysis, , Oxford- IBH, India

M – 302 COMPLEX ANALYSIS Teaching hrs/week: 6

This course aims to provide an understanding of the basic facts of complex analysis, in particular the nice properties enjoyed by the derivatives and integrals of functions of a complex variable, and to show how complex analysis can be used to evaluate real integrals.

CONTENTS

Unit I

Complex integration. Cauchy-Goursat Theorem. Cauchy's integral formula. Higher order derivatives. Morera's Theorem. Cauchy's inequality and Liouville's theorem The fundamental theorem of algebra. Taylor's theorem. Maximum modulus principle. Schwarz lemma.

Unit II

Bilinear transformations, their properties and classifications. Definitions and examples of conformal mappings Meromorphic functions. The argument principle. Rouche's theorem. Inverse function theorem.(Statement only).

Unit III

Laurent's series. Isolated singularities. Residues. Cauchy's residue theorem. Evaluation of integrals. Branches of many valued functionswith special reference to arg z, log z and z^a .

Unit IV

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

Unit V

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

RECOMMENDED BOOKS:

1. **J. B. Conway,** Functions of One Complex Variable, Springer-Verlag, International student Edition, Narosa Publishing House, 1980.
2. **L.V. Ahlfors,** Complex Analysis, McGraw-Hill,1979
3. **H. A. Priestly,** Introduction to Complex Analysis**,** Clarendon Press, 1990
4. **R.V. Churchill,** Complex Variable and Applications, McGraw Hill

M – 303 MATHEMATICAL METHODS Teaching hrs/week: 6

The course covers two important areas. The objectives of the course are to teach students new techniques namely Fourier series methods and Integral equations methods for solving ordinary and partial differential equations involving initial and boundary value conditions.
After completing the course the students will be able to understand the terminology, scope, main results, and applications of Fourier analysis and integral equations to solve problems in mathematics, science, and engineering.

Unit I

Inner products of functions. Orthogonal set of functions. Fourier series and their properties. Bessels inequality and a property of fourier constants. Parseval's equation, Convergence of Fourier series, Fourier theorem, Uniform convergence of Fourier series.

Unit II

Differentiation of Fourier series, Integration of Fourier series, Solutions of ordinary boundary value problems in Fourier series. A slab with faces at prescribed temperature. A Dirichlet problem (in Cartesian coordinates only), a string with prescribed initial velocity, an elastic bar. Applications of Fourier series in Sturm Lioville problems

Unit III

Definitions of integral equations and their classification, Relation between integral and differential equations, Fredholm integral equations of second kind with separable kernels, Reduction to a system of algebraic equations.

Unit IV

Eigen values and eigen functions, iterated kernels, iterative scheme for solving Fredholm integral equation of second kind (Neumann series), Resolvent kernel, Application of iterative scheme to Volterra's integral equation of second kind.

Unit V

Hilbert Schmidt theory, symmetric kernels, Orthonormal systems of functions. Fundamental properties of eigenvalues and eigen functions for symmetric kernels. Solution of integral equations by using Hilbert Schmidt theory.

RECOMMENDED BOOKS

1. **J. W. Brown, R.V. Churchill, Fourier Series and Boundary Value Problems,** McGraw Hill Education**,** New Delhi
2. **R. P. Kanwal, Linear Integral Equation, Theory and Technique**, Academic Press New York 1971.
3. **V. Lovitt, Linear Integral Equation,** Wiley Inter science New York**.**
4. **F. B. Hildebrand, Method of Applied Mathematics,** CHAPTER 2 (2.1-2.11,2.19) Chapter 3 (3.1,3.2,3.6,3.11**),** PHI, India

M - 304 OPTIONAL PAPER (ANY ONE OF THE FOLLOWING)

(i) Mechanics

(ii) Algebraic Coding Theory

(iii) Programming in C and Data Structure

(iv) Mathematical Statistics

(v) Partial Differential Equations

(vi) Lattice Theory

(vii) Mathematical Programming

M – 304(i) MECHANICS

Teaching hrs/week: 6

Mechanics is the oldest branch of the Physics disciplines and is as well important in the discipline of Mathematics. It is, in fact a course in Classical Mechanics.

The objective of the course is to

- develop the ability to determine the Lagrangian and Hamiltonian of mechanical systems and use these functions to obtain the corresponding equations of motions as well as identify any conserved quantities associated with the system,
- apply fundamental conservation principles to analyze mechanical systems,
- introduce advanced theoretical techniques including variational principles and Hamilton Jacobi theory and develop the capability to apply these techniques to analyze elementary mechanical systems.

CONTENTS

Unit I

Generalized coordinates, Holonomic and non-holonomic systems. Scleronomic and rheonomic systems, Constraints, Generalized potential, Lagrange's equations of motion of second kind, Energy equation for conservative field.Derivation of Lagrange's equations from D' Alembert's principle, Simple applications of the Lagrangian formulation.

Unit II

Hamilton's variables, Hamiltonian, Hamilton canonical equations, Derivation of Hamilton's equations of motion by variational principle, Simple applications of Hamilton's equations of motion, Cyclic coordinates and conservation theorems, Routh's equations of motion., The principle of least action. Derivation of Lagrange's equations from Hamilton's principle, Derivation of Hamilton's principle from D' Alembert's principle.

Unit III

Fundamental lemma of calculus of variations, Some techniques of calculus of variations, Euler's equation for functions of one dependent variable and its generalization to (i) "n" dependent variables (ii) higher order derivatives, Motivating problems of calculus of variation - Shortest distance, Minimum surface of revolution, Brachistochrone problem, Isoperimetric problem, Geodesic, Conditional extremum under geometric constraints and under integral constraints.

Unit IV

Canonical transformation, Poisson brackets, Equations of motion in Poisson brackets form, Poisson's theorem, Jacobi-Poisson theorem, Lagrange's brackets. Invariance of Poisson and Lagrange's brackets with respect to canonical transformations, Relation between Poisson and Lagrange's brackets.

Unit V

Hamilton Jacobi theory: Hamilton Jacobi equation, Jacobi theorem. Method of separation of variables in Hamilton Jacobi equation and its simple applications.

RECOMMENDED BOOK

1. **H. Goldstein,** Classical Mechanics **(**2ND Edition**),** Narosa Publishing House, New-Delhi, 2001.

REFFERENCE BOOKS

1. **A. S. Ramsey,** Dynamics Part-II, The English Language Book Society and Cambridge University Press, 1972.
2. **F. Gantmacher,** Lectures in Analytic Mechanics**,** MIR Publishers Moscow, 1975
3. **I. M. Gelfand and S.V. Fomin,** Calculus of Variations**,** Prentice Hall.
4. **Narayan Chandra Rana & Pramod Sharad Chandra Joag,** Classical Mechanics**,** Tata McGraw Hill, 1991**.**

M – 304 (ii) ALGEBRAIC CODING THEORY Teaching hrs/week: 6

The objectives of the course are to teach the students how to produce algebraic codes based on the methods of groups and finite fields and to make the students familiar with some of the most widely used codes and their applications.
Learning outcomes**:** Students will be able to understand and implement the most widely used algebraic codes. Write programs coding and decoding messages.

CONTENTS

Unit I

The Communication Channel**.** The coding problem. Types of codes. Error – Detecting and Error – Correcting Codes. Linear Codes. The Hemming Metric. Description of Linear Block Codes by Matrices.

Unit II

Dual Codes. Standard Array Syndrome. Step by Step Decoding Modular Representation. Error – Correction Capabilities of linear codes. Bounds of Minimum Distance for Block Codes. Plotkin Bound. Hamming sphere packing Bound. Bounds for Burst – Error Detecting and Correcting Codes.

Unit III

Important linear Block – Codes. Hamming Codes. Golay Codes. Perfect Codes. Quasi – perfect Codes. Reed – Muller Codes. Codes derived by Hadamard Matrices. Product Codes. Concatenated Codes.

Unit IV

A double-error correcting decimal Code and an introduction to BCH Codes, BCH bounds. Cyclic Codes. Matrix representation of Cyclic Codes.

Unit V

Hamming and Golay Codes as Cyclic Codes. Error detection with Cyclic codes. MDS Codes

RECOMMENDED BOOKS

1. **J H Van Lint**, Introduction To Coding Theory**,** Springer Verlag, Heidelberg
2. **V. Pless,** Introduction to the theory of Error – Correcting Codes**,** 3rd Edition, 1998, Wiley Interscience, New York
3. **V. Pless and W C Huffman,** Fundamentals of Error – Correcting Codes, 2003, Cambridge University Press.
4. **Raymond Hill,** A first course in Coding Theory, Oxford University Press,1986.
5. **Man Young Rhee,** Error Correcting Coding Theory, McGraw Hill Inc., 1989

M- 304(iii) PROGRAMMING IN C & DATA STRUCTURES

Teaching hrs/week: 6

This course aims to provide a conceptual understanding of computer system and languages. The objective is to equipped students with the knowledge and skills required to implement solutions to problems using the C programming language.

On completion of this course, thestudent should be able to:

1. Describe the syntax and semantics of the ANSI C programming language
2. Explain the use of functions and function decomposition;
3. Differentiate local variables from global variables, and state the scope of a variable;
4. Work in a team to analyse problems and develop C programs for solving these.

CONTENTS

Unit I

Computer system introduction, Characteristics and classification of computers, CPU, ALU, Control unit, data & instruction flow, primary, secondary and cache memories, RAM, ROM, PROM, EPROM, Programming language classifications.

Unit II

C-Programming : Representation of integers, real, characters, constants, variables, Operators: Precedence & associative, Arithmetic, Relation and Logical operators Bitwise operators, increment and decrement operators, comma operator, Arithmetic & Logical expression.

Unit III

Assignment statement, Looping, Nested loops, Break and continue statements, Switch statement, goto statement.

Arrays, String processing, functions, Recursion, Structures & unions.

Unit IV

Simple Data Structures: Stacks, queues, single and double linked lists, circular lists, trees, binary search tree. C-implementation of stacks, queues and linked lists.

Unit V

Algorithms for searching, sorting and merging e.g, sequential search, binary search, insertion sort, bubble sort, selection sort, merge sort, quick sort, heap sort.

RECOMMENDED BOOKS

1. **Kernighan & Ritchie,** The C- programming Language
2. **Balaguruswami,** Programming in C, TMH India
3. **Y.P. Kanetkar,** Let us C, BPB, India

M- 304(iv) MATHEMATICAL STATISTICS Teaching hrs/week: 6

The aim of this course is to extend and master students' knowledge of probability and statistical methods and to provide theoretical background for studying advanced statistical methods.
Upon successful completion of this course, students will be able to study, correctly apply and interpret different statistical methods.

CONTENTS

Unit I

Probability: Set theoretic approach, Baye's theorem, Geometric probability, Random experiments, Sample spaces, Random variables, Distribution functions, Joint probability distribution function, Conditional distribution function, Transformation of one and two dimensional Random variables, Mathematical expectation : Covariance, Variance of variables, Chebysheff's inequality.

Unit II

Moment generating function, Cumulant generating function and cumulants, Applications and why they are used, Discrete distributions:
Geometric, Binomial, Poisson and uniform distributions, Continuous distributions : Normal, Exponential, Gamma, Chi-square ,t , F, Beta , and uniform on an interval.

Unit III

Central limit theorem and applications (1) for a sequence of independent, identically dist-tributed random variables (2) to establish normal approximations to other distributions, and to calculate probabilities, Statistical inference and sampling distribution.

Unit IV

Correlation and regression: Partial and multiple correlations, Correlation coefficients, rank correlation, Regression lines and its properties.

Unit V

Test of significance: (1) Null and alternative hypotheses, Simple and composite hypotheses, Errors, Test statistic. (2) Large sample tests for proportion and mean, Small sample test based on t, F and Chi-square statistics..

RECOMMENDED BOOKS

1. **V.K. Rohatgi, A. K. Md. Ehsanes Saleh**: An Introduction to Probability and Statistics, Wiley-Interscience
2. **Kennedy and Gentle**: Statistics Computing, Published by CRC Press, 1980
3. **P.L. Mayer**: Introductory Probability and Statistical Applications, IBH.
4. **A.M. Mood and F. Graybill**: Introduction to the Theory of Statistics, TMH, New Delhi.
5. **Robert V. Hogg, Allen Craig, Joseph W. McKean**: Introduction to Mathematical Statistics, Pearson Education, New Delhi

M-304(v) PARTIAL DIFFERENTIAL EQUATIONS

Teaching hrs/week: 6

Partial differential equations (PDEs) arise in every field of science and engineering. So the solutions of these PDEs are of great interest in understanding various physical phenomena. Text of this paper is organized to study the four important fundamental linear partial differential equations: Transport equation, Laplace equation, Heat equation and Wave equation, and various explicit formulas for solutions along with their numerical solutions using finite difference method. Nonlinear first order PDEs which arise in fluid dynamics, continuum mechanics and optics are also included in this paper.

CONTENTS

Unit I

Examples of PDE. Classification,
Transport Equation: Initial value Problem, Non-homogeneous Equation.
Laplace's Equation: Fundamental Solution, Mean Value Formulas, Properties of Harmonic Functions, Energy Methods.

Unit II

Heat Equation: Fundamental Solution; Mean Value Formula, Properties of Solutions, Energy Methods.
Wave Equation: Solution by Spherical Means. Non-homogeneous Equations, Energy Methods.

Unit III

Nonlinear First Order PDE-Complete Integrals, Envelopes, Characteristics; Hamilton -Jacobi Equations (Calculus of Variations, Hamilton's ODE, Legendre Transform, Hopf-Lax Formula, Weak Solutions, Uniqueness), Conservation Laws (Rankine-Hugoniot condition, Lax-Oleinik formula, Weak Solutions, Uniqueness).

Unit IV

Representation of Solutions-Separation of Variables, Similarity Solutions (Plane and Traveling Waves, Solitons, Similarity Linder Scaling), Fourier and Laplace Transform, Hopf-Cole Transform, Hodograph and Legendre Transforms. Potential Functions.

Unit V

Deriving Difference Equations, Elliptic Equations: Solution of Laplace’s equation, Leibmann,s method, relaxation method, solution of Poisson’s equation, Parabolic equation : solution of heat equation, Bender-Schmidt method. The Crank-Nicholson method, Hyperbolic equations : solution of hyperbolic equation.

RECOMMENDED BOOKS

1. **L.C. Evans**, Partial Differential equations. Graduate Studies in Mathematics. Volume 19, AMS, 1998.
2. **P. Prasad and R. Ravindran**, Partial Differential equations, New Age International Pub., N. Delhi..
3. **F. John**, Partial Differential equations, Springer- Verlag, N. York

M - 304(vi) **LATTICE THEORY** Teaching hrs/week: 6

Lattice theory is one of the important branches of algebra. Its concepts and methods have found fundamental applications in various areas of mathematics (e.g. diverse disciplines of abstract algebra, mathematical logic, projective and affine geometry, set and measure theory, topology) and theoretical physics (e.g. quantum and wave mechanics, and the theory of relativity)
At the end of the course, students will be able to understand the connections of lattice theory with other branches of mathematics.

CONTENTS

Unit I

Lattices: Algebra of lattices, the lattice theoretic duality principal, lattices as partly ordered sets, diagrams of lattices, sub-lattices, ideals, atoms, complements, relative complements, semi complements, irreducible and prime elements of a lattice and homeomorphisms of a lattice.

Unit II

Complete Lattices: Complete lattices, complete sub-lattices of complete lattice, conditionally complete lattice, and subalgebra, lattices of an algebra, closure operations, Galois connection, Dedekind cuts, and partly ordered sets as topological spaces.

Unit III

Modular lattices: Modular lattices, characterization of modular lattices by their sublattices, the isomorphism theorem of modular lattices, the covering condition, meet representations in modular lattice.

Unit IV

Distributive Lattices: Distributive lattices, infinite distributive and completely distributive lattices, Boolean algebra, characterization of distributive lattices by their sublattices, distributive sublattices of modular lattices, meet representations in distributive lattice.

Unit V

Special Subspaces of the Class of Modular Lattices: Modular lattices of locally finite length, the valuation of a lattice, metric and quest metric lattices, complemented modular Lattices.

RECOMMENDED BOOKS

(1) Introduction to Lattice Theory by G. Szasz. Ch. IV- X, Academic Press, NY
(2) Lattice Theory by G. Birkhoff
(3) Introduction to Lattices theory by D. E. Rutherford

M-304(vii) MATHEMATICAL PROGRAMMING Teaching hrs/week: 6

This course presents the theory and application of Mathematical Programming. Prerequisite of this course is M-204. It extents the theory of optimization methods to more realistic problems.

After completing this course students will be able to

1. Solve problems involving optimization models with integer constraints.
2. Have deep insight in solving optimization problems which are non-linear.
3. Distinguish between "single objective" and "multiple objective" functions.

CONTENTS

Unit I

Convex sets, convex functions, pseudo-convex functions, quasi-convex, explicit quasi-convex, quasi-monotonic functions and their properties from the point of view of mathematical programming. Kuhn-Tucker conditions of optimality.

Unit II

Theory of revised simplex algorithm. Duality theory of linear programming. Sensitivity analysis.

Unit III

Parametric linear programming. Integer programming and linear goal programming.

Unit IV

Quadratic programming: (i) Wolfe's algorithm (ii) Beale's algorithm (iii) Theil and Vande-Panne algorithm.

Unit V

Duality theory of quadratic and convex programming, separable programming, sequential unconstrained minimization.

RECOMMENDED BOOKS

1. **G. Hardy,** Linear Programming, Narosa Publishing house, 1995
2. **G. Hardy**, Nonlinear and Dynamic Programming, Addison-Wesley, Reading Mass.
3. **H. A.Taha**, Operations Research- An introduction, Macmillan Publishing Co, New York.
4. **N. S. Kambo**, Mathematical Programming Techniques, Affiliated East-West Press.
5. **O. L. Mangasarian**, Non linear Programming, McGraw Hill, New York.

M – 401 NUMBER THEORY Teaching hrs/week: 6

The aim of the course is to give an introduction to elementary number theory, to show how certain number theoretical theorems can be applied within cryptography and to use the theory to solve simple Diophantine equations.

CONTENTS

Unit I

The Division Algorithm, the gcd, The Euclidean Algorithm, Diophantine equation ax + by = c. The fundamental theorem of arithmetic. The Sieve of Eratosthenes. The Goldbach conjecture.

Unit II

Theory of Congruences – Basic properties of Consequence, Linear Congruences, Chinese remainder theorem, Fermat's Theorem, Wilson's Theorem. Statement of Prime number theorem. Some primality testing.

Unit III

Number-Theoretic Functions – The functions T and Sigma. The mobius inversion formula, The Greatest integer function, Euler's Phi function – Euler Theorem, Properties of the Phi-function, Applications to Cryptography.

Unit IV

The order of an integer modulo n, Primitive roots for primes, The theory of indices, Euler's criterion, Legendre's symbol and its properties, Quadratic reciprocity, Quadratic congruences with composite moduli.

Unit V

Perfect Numbers, Representation of integers as sum of two squares and sum of more than two squares.

RECOMMENDED BOOK:

1. **Davis M. Burton**: Elementary Number Theory, USB (Indian Reprint), 1991.

REFERENCES

1. **U. Dudley**, Elementary Number Theory, Freeman & Co.
2. **George Andrews**, Number Theory.

M – 402 FLUID DYNAMICS Teaching hrs/week: 6

Almost everything on this planet either is a fluid or moves within or near a fluid.
Fluids have the ability to transport matter and its properties as well as transmit force; therefore Fluid Mechanics is an important subject that is particularly open to cross fertilization with other sciences and disciplines of engineering.
The main objective of the course is

- to develop fundamental knowledge and understanding of the mechanics of fluid at rest and in motion,
- to ability to demonstrate ability to formulate physical problems encountered in different branches of engineering in mathematical form and arrive at useful solutions

CONTENTS

Unit I

Concept of fluid and its physical properties, Continuum hypothesis, Kinematics of fluids-Methods of describing fluid motion, Translation, Rotation and deformation of fluid elements, Stream Lines, Path lines and Streak lines, concepts of Vorticity.

Unit II

General theory of stress and rate of strain in a real fluid –Symmetry of stress tensor, Principal axes and Principle values of stress tensor, Constitutive equation for Newtonian fluid. Conservation laws-Conservation of mass, Conservation of momentum, Conservation of energy.

Unit III

One and two dimensional inviscid incompressible flow-Equation of continuity and motion using stream tube, , Circulation, Velocity potential, Irrotational flow, Some theorems about rotational and irrotational flows – Stoke's theorem, Kelvin's minimum energy theorem, Gauss theorem, Kelvin's circulation theorem.

Unit IV

Vortex motion and its elementary properties, Integration of equations of motion - Bernoulli's equation, Stream function in two dimensional motion, Complex variable technique, flow past a circular cylinder, Blasius theorem, Milne's circle theorem, Sources, Sinks and Doublets. Dynamical similarity, Buckingham's pie theorem, Non-dimensional numbers and their physical significance

Unit V

Incompressible viscous fluid flows- Steady flow between two parallel plates (non-porous and porous) - Plane couette flow, Plane poiseuille flow, Generalized plane couette flow, Steady flow of two immiscible fluids between two rigid parallel plates, Steady flow through tube of uniform circular cross section, Steady flow through annulus under constant pressure gradient.

RECOMMENDED BOOKS

1. **S. W. Yuan, FOUNDATIONS OF FLUID MECHANICS**, Chapters- 1, 3, 4, 5, 6, 7, 8. Prentice Hall of India Private Limited, New-Delhi, 1976.
2. **R. K. Rathy, AN INTRODUCTION OF FLUID DYNAMICS**, Chapters – 1, 3, 4, 5, 6, 7,8,11. Oxford and IBH Publishing company, New Delhi, 1976.

REFFERENCE BOOKS

1. **G. K. Betchelor, AN INTRODUCTION OF FLUID MECHANICS**, Oxford University Books, New Delhi, 1994.
2. **F. Charlton, TEXT BOOK OF FLUID DYNAMICS**, C.B.S. Publishers, Delhi. 1985

M – 403 **FUZZY SETS AND ITS APPLICATIONS** Teaching hrs/week: 6

The course presents some fundamental knowledge of fuzzy sets, fuzzy logic and its applications in fuzzy decision making. The aim is to equip students with some state-of-the-art fuzzy-logic technology to prepare them in a better way for the rapidly evolving high-tech information-based modern industry and market.

Objectives: Upon successful completion of this course, students should

1. be able to understand basic knowledge of fuzzy sets and fuzzy logic,
2. be able to apply fuzzy inferences,
3. be able to apply fuzzy information in decision making,
4. be able to appreciate the theory of possibility on the basis of evidences**.**

Unit I

Basic definitions, α -level sets, comparison with classical (crisp) sets,
Types of fuzzy sets, extension principle.

Unit II

Fuzzy complement, t-norms, t-conorms, combination of operations, aggregation operations.
Fuzzy numbers, linguistic variables, arithmetic operations on intervals, arithmetic operations on fuzzy numbers, lattice of fuzzy numbers, fuzzy equations.

Unit III

Crisp versus fuzzy relation, projections and cylindric extensions, binary fuzzy relations, binary relations on a single set, fuzzy equivalence relations, fuzzy compatibility and fuzzy ordering relations.
Fuzzy measures, evidence theory, possibility theory, fuzzy sets and possibility theory.

Unit IV

An overview of classical logic, multivalued logic, fuzzy propositions, fuzzy quantifiers, linguistic hedges, Inference from conditional fuzzy propositions, Inference from conditional and qualified propositions.
Information and uncertainty, non-specificity of crisp and fuzzy sets, fuzziness of fuzzy sets.

Unit V

Individual, multiperson, multicriteria decision making, fuzzy ranking method, fuzzy linear programming. Methods of defuzzyfication.

RECOMMENDED BOOKS:

1. Fuzzy Sets and Fuzzy Logic: Theory and Applications, **George J. Klir and Bo Yuan**,
Prentice Hall of India, New Delhi.
2. Fuzzy Set Theory & its Applications, **H.J. Zimmermann**, Allied Publishers Ltd.
New Delhi.
3. Fuzzy Logic with Engineering Applications, **Timothy J. Ross**, McGraw Hills inc.
New Delhi

M-404 Optional Paper (Any one of the following)

(i) Functional Analysis
(ii) File structure and Database Management System
(iii) Information Theory
(iv) Mathematical Cryptography
(v) Algebraic Topology
(vi) Differential Geometry
(vii) Plasma Dynamics

M – 404 (i) FUNCTIONAL ANALYSIS Teaching hrs/week: 6

This course extends the ideas studied in Analysis and Topology. Many of the topics studied in the course have applications in Approximation theory, operator's theory and other areas of mathematics.
At the end of the course, students will be aware of interplay of algebra and topology.

CONTENTS

Unit I

Normed linear spaces, Banach spaces, Examples and counter examples, Quotient space of normed linear spaces and its completeness. Equivalent norms,

Unit II

Reisz Lemma, Basic properties of finite dimensional normed linear spaces, Bounded linear transformations and normed linear spaces of bounded linear transformations, Uniform boundedness theorem and some of its applications.

Unit III

Dual spaces, weak convergence, open mapping and closed graph theorems, Hahn Banch theorem for real and complex linear spaces.

Unit IV

Inner product spaces, Hilbert spaces – Orthonormal sects, Bessel's inequality, complete orthonormal sets and Perseval's identity.

Unit V

Structure of Hilbert spaces, Projection theorem, Riesz representation theorem, Adjoint of an operator on Hilbert space, Self adjoint operators, Normal and Unitary operators. Projections

RECOMMENDED BOOKS

1. **C.Goffan & G Pedrick:** First course in Functional Analysis, PHI, New Delhi
2. **P.K. Jain, O.P. Ahuja & Khalil Ahmad**: Functional Analysis, New Age (International P. Ltd.) New Delhi.
3. **E. Kreyszig**: Introductory Functional Analysis with Applications, John Wiley and Sons, New York.
4. **G.F. Simmons**: Introduction to Topology and Modern Analysis, McGraw Hill Book Co., New York.
5. **A.E. Taylor**, Introduction to Functional Analysis, John Wiley and Sons, New York.
6. **Bela Bollobas**: Linear Analysis, an introductory course, Cambridge University Press, Cambridge.
7. **S.K. Berbarian**: Introduction to Hilbert Spaces, Oxford University Press, New York.

M-404(ii) FILE STRUCTURE AND DATABASE MANAGEMENT SYSTEM

Teaching hrs/week: 6

The aims and objectives of this course are

- To understand the basic concepts of file organization and Database
- To discuss the advantages of database system over conventional file system
- To make a logical and analytical comparison of different Data Models
- To provide strong dimensions, strengths and future prospects of Database Systems.
- To design and implementation of Database Modeling
- To transform ERD (Entity Relationship Diagram) into relations
- To develop good skills in SQL (Structured Query Language).

After successful completion of the course, students will be able to understand the Database System environment; Design and implement a Relational database for real life problems, Expertise in writing SQL queries, Suggest, design and implement solutions for the small business organizations.

CONTENTS

Unit I

File Organization: the constitution of a file, Operations on files, Primary key Retrieval, Sequential files, index sequential files: implicit index, limit indexing multilevel, indexing schemes, Structure of index sequential file, VSAM direct files, hashing techniques, Extended hashing.
Secondary Key Retrieval: Inverted and Multilist files.
Indexing Using Tree Structures: Tree schemes, operation, capacity, B-Tree, B^+- trees.

Unit II

Data base Management System: What is DBMS? Three - level architecture of DBMS.
Relation Data Model: Relational Database**:** Attributes and domains, Tuples, Relations and their schemes, Relation representation, Keys, Relational operations, Integrity Rules **Relational Algebra**: Basic Operations, Additional Relation algebraic operations, Some Relational Algebra Queries.

Unit III

Structural Query Language (SQL): Data definition, Data manipulation, Condition Specification, Arithmetic and aggregate operators, SQL join, Set Manipulation, categorization, updates.

Unit IV

Relational Database Design: Functional dependencies. First, second third and BCNF normal Forms,. Data integrity and recovery.

Unit V

Concurrency and security Management: Security of database. Serializability. Locking Schemes. Time stamp based order.

References:

1. Ullman, J D : Principles of Database systems.
2. Date, C.J. : Introduction to database system, Addison Wesley.
3. Bipin Desai : An Introduction to database system. Galgotia Publications.
4. A. Silberschatz : Introduction to Data base Management System, Tata McGraw Hill, New Delhi

M 403(iii) **INFORMATION THEORY** Teaching hrs/week: 6

Information theory is concerned with the analysis of an entity called a communication system. It deals with the construction of a mathematical model for different blocks of information. It is oriented towards the fundamental limitations on the processing and communication of information. After the completion of the course, the students will be able to understand fundamentals of communication system.

CONTENTS

Unit I

Measure of Information: Axioms for a measure of uncertainty. The Shannon entropy and its properties. Join and condition entropies. Transformation and its properties.

Unit II

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

Unit III

Discrete Memory less Channel: Classification of channels. Information processed by a channel. Calculation of Channel capacity. Decoding Schemes. The ideal observer. The Fundamental Theorem of Information Theory and its strong and weak converses.

Unit IV

Continuous Channels: The Time – discrete Guassian Channel. Uncertainty of absolutely continuous random variable. The converse to the coding theorem for time – discrete Gaussian Channel. The time – continuous Gaussian Channel. Band – limit Channels.

Unit V

Some intuitive properties, maximality, Stability, additivity, subadditivity, nonnegativity, continuity, branching etc and interconnection among them. Axiomatic characterization of the Shannon entropy due to Shannon and Fadeev.

References

1. **R. Ash** , Information Theory**,** Interscience, New York, 1995
2. **F. M. Reza,** An Introduction to Information Theory, McGraw Hill Book Company Inc. 1961
3. **J. M. Aczel and Z. Daroczy**, On Measures of Information and their Characterizations**,** Academic Press, New York.

M 404(iv) MATHEMATICAL CRYPTOGRAPHY

Teaching hrs/week: 6

Objective: To make students aware of some tools for network security and the mathematics behind their construction and strength.

After completing this course students will be able to use concepts from number theory, group theory, and ring theory to encrypt and decrypt messages using elementary ciphers such as affine ciphers, substitution ciphers, permutations ciphers, block ciphers, Playfair ciphers; encrypt and decrypt messages using public-key encryption systems such the RSA encryption system, and the ElGamal encryption system.

CONTENTS

Unit-I

Classical cryptography: Encryption schemes, Symmetric key encryption, Feistel ciphers, NDS, DES, Multiple encryptions, Modes of operation, Applications to authentication and identification.

Unit-II

Some Mathematical Tools: Algorithm, complexity, Modular arithmetic, Quadratic residues, Primality testing, Factoring and square roots, Discrete logarithm.

Unit-III

Public key Cryptography: Public key cryptosystems and their applications, RSA algorithm and its security, Key management, Diffie-Hellman key exchange.

Unit-IV

Elliptic curve cryptography, ID based public key cryptosystems.

Unit-V

Introductory concepts of Signcryption and Certificate less public key cryptosystems.

RECOMMENDED BOOKS

1. **D. R. Hankerson et al**, Coding Theory and Cryptography**.** Monographs and Textbooks # 234, Marcel Decker, 2000.
2. **W. Stallings**,Cryptography and Network Security, Prentice Hall India, 2000.

The following material from Internet

1. **Y. Zheng,** Digital signcryption or How to achieve cost (signature + encryption) < < cost (signature) + cost (encryption). Available at http://www.signcryption.org/publications/pdffiles/yz-c97-fnl-rvs.pdf
2. **D. Boneh and M. Franklin**, Identity based encryption from Weil pairing. Available at http://eprint.iacr.org/2001/090.pdf
3. **S. S. Al-Riyami and K. G. Patterson,** Certificate less public key cryptography. Available at http://eprint.iacr.org/2003/126.pdf

M – 404(v) ALGEBRAIC TOPOLOGY Teaching hrs/week: 6

The main goal of the course is to introduce students to algebraic topology and standard topological invariants. We also intend to discuss different connections with differentiable topology, (co)homology theory and complex/real algebraic geometry.
Learning outcomes: The students will learn important notions and results in algebraic topology, homological algebra and related invariants associated with topological spaces and continuous maps. They will gain crucial skills and knowledge in several parts of modern mathematics. Via the exercises, they will learn how to use these tools in solving specific topological problems.

CONTENTS

Unit I

Homotopy of paths, the Fundamental group, covering spaces, the fundamental group of the circle, Retractions and fixed points, the fundamental group of the punctured plane.

Unit II

Deformation retracts and hotopy type, the fundamental group of S^n,, Essential and inessential maps, the fundamental theorem of Algebra.

Unit III

Topology of E^n, Borsuk's separation theorem, deformation of subsets of E^{n+1}, the Jordan curve theorem, fiber spaces, Hurwicz uniformization theorem.

Unit IV

Classification of Surfaces: Fundamental groups of surfaces, Homology of Surfaces, Cutting and Pasting, the Classification theorem.

Unit V

Classification of Covering Spaces: Equivalence of Covering Spaces, Universal Covering Space, Covering Tranformations.

RECOMMENDED BOOKS

1. **James R Munkres**, Topology - A Modern Introduction, Prentice Hall of India, Delhi 1978.

REFERENCE BOOKS

James Dugundji, Topology, Allyn and Bacon, New York, 1975

1. **Marwin J Greenberg and J R Harper,** Algebraic Topology – A First Course, Addison Wesley, 1981
2. **W S Massey,** Algebraic Topology- An Introduction, Harcourt Brace,1977
3. **Satya Deo,** Algebraic Topology, Hindustan publishing House (TRIM Series)
4. **E H Spanier,** Algebraic Topology, Tata McGraw-Hill Private Ltd, New Delhi.

M-404(vi) DIFFERENTIAL GEOMETRY Teaching hrs/week: 6

Differential geometry is a mathematical discipline that uses the methods of differential and integral calculus, as well as linear and multilinear algebra, to study problems in geometry. The theory of plane and space curves and of surfaces in the three-dimensional Euclidean space formed the basis for its initial development in the eighteenth and nineteenth century. Since the late nineteenth century, differential geometry has grown into a field concerned more generally with geometric structures on differentiable manifolds. It is closely related to differential topology, and to the geometric aspects of the theory of differential equations. Grigori Perelman's proof of the Poincaré conjecture using the techniques of Ricci flow demonstrated the power of the differential-geometric approach to questions in topology and highlighted the important role played by the analytic methods. Differential geometry of surfaces already captures many of the key ideas and techniques characteristic of the field.

CONTENTS

Unit I

Theory of space curves, arc length, tangent and normals, Curvature and torsion of curve given as the intersection of two surfaces, Involute and Evolute.

Unit II

Metric: The first and second fundamental form, Weingarton equation, Orthogonal trajectories, Mensuier theorem, Gaussian curvature, Euler's theorem, Dupin's theorem, Rodrigue's theorem, Dupin's indicatrix.

Unit III

Envelopes, Edge of regression, Ruled surface. Developable surface, Monge's theorem, Conjugate directions.

Unit IV

Asymptotic lines, the fundamental equations of surface theory, Gauss's formulae, Gauss characteristics equations, Mainardi Codazzi equations, Weingarton equations, Bonnet's theorem on parallel surface.

Unit V

Geodesics, Clairaut's theorem, Gauss Bonnet theorem, conformal mapping and Geodesic mappings, Tissot's theorem, Dini's theorem.

RECOMMENDED BOOKS

1. **J.A. Thorpe,** Introduction to Differential Geometry, Springer-verlag.
2. **B.O. Neill,** Elementary Differential Geometry, Academic Press, 1966.
3. **S. Ternberg,** Lectures on Differential Geometry, Prentice-Hall, 1964.
4. **M. DoCarmo.** Differential Geometry of Curves and Surfaces, Prentice Hall, 1976.
5. **D. Laugwitz**, Differential and Riemannian Geometry, Academic Press, 1965.
6. **R.S. Millman and G.D. Parker**, Elements of Differential Geometry, Prentice Hall, 1977.
7. **W. Kleingenberg,** A course in Differential Geometry, Springer-Verlag.
8. **T.J. Willmore,** An Introduction to Differential Geometry and Riemannian Geometry, Oxford University Press, 1965.

M-404(vii) PLASMA DYNAMICS Teaching hrs/week: 6

Plasma dynamics is a branch of applied mathematics. Plasma is electrified or ionized gas with atoms dissociated into positive ions and negative electrons. Plasma is generally known as fourth state of matter. It is likely that 99% of the matter in the universe is in the plasma state and we live in the 1% of the universe in which plasma do not occur naturally. Some important applications of man-made plasmas are in gaseous electronics, MHD generator and controlled thermonuclear fusion.

Background knowledge of fluid dynamics is a necessary prerequisite. There must also be familiarity with Maxwell's equations, mechanics, vector algebra, ordinary & partial differential equations, and complex variable. The approach to plasma dynamics begins with a description of the orbits of charged particles in electromagnetic field followed by a treatment of hydromantic which includes discussions of flows, shocks and wave motion.

CONTENTS

Unit I

Introduction: Definition of plasma, Criteria for plasmas, Occurrence of plasma in nature, Applications of plasma physics.

Particle orbit theory: Constant uniform magnetic field, Constant uniform electric and magnetic fields, Inhomogeneous magnetic field, Time-varying electromagnetic fields, magnetic mirrors, Earth's radiation belts.

Unit II

Elements of Plasma Kinetic Theory: Phase space, Distribution function, Number density and average velocity, Boltzmann equation, Relaxation model for the collision term, Vlasov equation.

Average values and Macroscopic variables: Average velocity and peculiar velocity, Flux, Particle current density, Momentum flow tensor, Pressure tensor, Heat flow vector and triad, total energy flux triad.

Unit III

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

Hydromantic: Kinematics, Static problems, Hydro magnetic stability, Interchange instabilities, Alfven waves.

Unit IV

Hydro magnetic Flows: Hydro magnetic Navier-Stokes equation, Hartmann flow, Couette flow, Flow stability, parallel flows, Transverse flows.

Shock Waves in Plasmas: Hydro magnetic shock equations, Shock propagation parallel to magnetic field, Shock propagation perpendicular to magnetic field.

Unit V

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

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

RECOMMENDED BOOKS

1. **T. J. M .Boyd and J.J. Sanderson,** Plasma Dynamics, Nelson, 1969.
2. **J. A. Bittencourt,** Fundamentals of Plasma Physics, Springer (2004)
3. **F.F. Chen**, Introduction to Plasma Physics, Plenum Press, New York & London, 1974.
4. **Paul. M Bellan**, Fundamentals of Plasma Physics, Cambridge University Press (2006).
5. **J.L. Delcroix,** Plasma Physics, John Wiley & Sons Ltd, 1965.
6. **Arnab Rai Choudhury**, The Physics of Fluids & Plasmas, Cambridge University Press, 1999.
7. **N.A. Krall and A.W. Trivelpiece,** Principles of Plasma Physics, McGraw-Hill, 1973.
8. **Vinod Krishan,** Astrophysical Plasmas and Fluids, Kluwer Academic Publishers, Dordrecht.