UNIVERSITY OF PUNE
DEPARTMENT OF MATHEMATICS

SYLLABUS

M.Sc

A two years duration course with total 100 credit points

FIRST YEAR

SEMESTER I (All are compulsory and each course is of 5 credit points)

MT 101 Advanced Calculus
MT 102 Topology
MT 103 Measure and Integration
MT 104 Algebra
MT 105 Differential Equations

Total credits: 25 points

SEMESTER II (All are compulsory and each course is of 5 credit points)

MT 201 Functional Analysis
MT 202 Complex Analysis
MT 203 Field Theory
MT 204 Linear Algebra
MT 205 Numerical Analysis

Total credits: 25 points
SECOND YEAR

(In each of **semester III** and **semester IV**, any five of the following courses which are running in the department should be opted)

(each course is of 5 credit points)

MT 01. Operations Research
MT 02. Integral Transforms
MT 03. Number Theory
MT 04. Coding Theory
MT 05. Graph Theory
MT 06. Lattice Theory
MT 07. Computational Geometry
MT 08. Cryptography
MT 09. Financial Mathematics
MT 10. Modelling and Simulation
MT 11. Artificial Intelligence
MT 12. Symmetries
MT 13. Wavelets
MT 14. Combinatorics
MT 15. Partial Differential Equations
MT 16. Fuzzy Logic
MT 17. Statistics and Probability
MT 18. Fluid Dynamics
MT 20. Boundary Value Problems
MT 21. Baer * Rings
MT 22. Topics in Matroid Theory
MT 23. Topics in Sperner Theory
MT 24. Differential Equation and Dynamical System
MT 25. Mechanics
MT 51. Complex Analysis II
MT 52. Representation Theory of Groups
MT 53. Fourier Analysis on Finite Groups
MT 54. Differential Geometry
MT 55. Non-Linear Dynamical System
MT 56. Emerging Technologies
MT 57. Algebraic Topology
MT 58. Analysis on Manifolds
MT 59. Projective Geometry
MT 60. Algebraic Geometry
MT 61. Algebraic Number Theory
MT 62. Algebraic Curves
MT 63. Commutative Algebra
MT 64. Advanced Topics in Lattice Theory
MT 65. Advanced Topics in Graph Theory  
MT 66. Advanced Topics in Matroid Theory  
MT 67. Advanced Topics in Group Theory  
MT 68. Advanced Topics in Ring Theory  
MT 69. Topics in Non Commutative Rings.

SEMESTER I

MT 101 Advanced Calculus

1. Compact and Connected Subsets of $\mathbb{R}^n$.

2. Differentiation : Derivative, Continuously Differentiable functions, Chain rule, 
   Inverse function theorem, Implicit function theorem.

3. Integration: integral over a rectangle, Existence of the Integral, evaluation of 
   the integral, integral over a bounded set and rectifiable sets, improper integrals

4. Change of Variable Theorem (Proof of one variable) and Statement of n-variables 
   (with Illustrations)

5. Line Integrals with Applications

Textbooks :

1. Analysis on Manifolds - J.R. Munkres : Sections 4 to 15 and Section 17.
2. Calculus (Volume II) - T.M. Apostol, Chapter 10 : Sections 10.1 to 10.9

MT 102 Topology

1. Cartesian Products, Finite Sets, Countable and Uncountable Sets, Infinite Sets 
   and Axiom of Choice, Well Ordered Sets.

2. Topological Spaces : Basis for a topology, Order topology, Subspace Topology, 
   Product topology, closed sets and limit points, Continuous functions, Metric
Topology


Textbook :
J. R Munkres : Topology : A First Course. ( Prentice- Hall)

Chapter 1 : Sections 5,6,7,9,10
Chapter 2 : Sections 12 to 21
Chapter 3 : Sections 23 to 29
Chapter 4 : Sections 30 to 35
Chapter 5 : Section 37

MT 103 Measure and Integration

1. Preliminaries : Cardinal Numbers and Countability, Properties of Open Sets, Cantor Like Sets

2. Measure on Real Line : Lebesgue Outer Measure, Measurable Sets, Regularity, Measurable Functions, Borel and Lebesgue Measurability

3. Integration of Functions on Real Variable : Integration of Non Negative Functions, General Integral, Integration of Series, Riemann and Lebesgue Integral

4. Differentiation : Functions of Bounded Variation, Lebesgue Differentiation Theorem, Differentiation Theorem, Differentiation and Integration

5. Abstract Measure Spaces : Measures and Outer Measures, Extension of Measures, Uniqueness of Extension, Completion of Measure, Measure Spaces, Integration with respect to Measure


7. Convergence : Convergence in Measure, Almost Uniform Convergence, Convergence Diagrams, Counter Examples

Textbook :
Measure Theory and Integration : G. de Barra (New Age International Ltd, Publishers)
MT - 104 Algebra

1. Introduction to Groups, Symmetries of a square, Dihedral Groups, Examples and properties of Groups, Finite Groups, Subgroups, Cyclic Groups.

2. Permutation Groups and its properties, check digit scheme Based on $D_5$, Isomorphisms, Cayley’s Theorem, Cosets and Lagrange’s Theorem, Applications of Cosets and Permutaion Groups, Rotation Group of a Cube and Soccer.

3. External Direct Products with Applications, Normal subgroups and Factor Groups and Applications.


5. Sylow Theorems, Applications of Sylow Theorems.


Text Book:


Chapters: 1 to 18 and 24..

MT 105 Differential Equations

1. Linear equation of first order.


3. Linear equations with constant coefficients: Second order homogeneous
equations, initial value problems, linear dependence and independence, nonhomogeneous equations of nth order, Algebra of Constant Coefficients.

4. Applications : Simple Harmonic Motion, Damped Motion, Forced Motion, Other Applications in Electronics and Pendulum Problem

5. Linear equations with variable coefficients : Initial value problems, solutions of the homogeneous equation, Wronskian and linear independence, reduction of order nonhomogeneous equations Legendre equation.

6. Linear Equations with regular singular points : Euler equation, second order equation with regular singular points, exceptional cases, Bessel equation.


8. Existence and uniqueness of solutions to first order equations to systems and 2nd order equations


Text Book :

1) E. A. Coddington : An Introduction to Ordinary Differential Equatins (Prentice-Hall).

Chapter 1 : Sections 1 to 7.
Chapter 2 : Sections 1 to 12.
Chapter 3 : Sections 1 to 8.
Chapter 4 : Sections 1 to 4, 7 and 8.
Chapter 5 : Sections 1 to 6.
Chapter 6 : Sections 6, 7.


SEMESTER II

MT 201 Functional Analysis

1. Normed spaces, continuity of linear maps, Hahn - Banach theorems, Banach spaces.

3. Duals and transposes, duals of $L^p[a,b]$ and $C[a,b]$.

4. Inner product spaces, orthonormal sets, approximation and optimization, projections, Riesz representation theorem.

5. Bounded operators and adjoints on a Hilbert space, normal, unitary and self adjoint operators.

6. Fourier Series and Integrals.

Textbook:

Chapter 2 : Sections 5 to 8.
Chapter 3 : Sections 9 to 12.
Chapter 4 : Sections 13,14.
Chapter 6 : Sections 21 to 24.
Chapter 7 : Sections 25,26.
Chapter 1 : Section 4 (Fourier Series and Integrals).

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**MT 202 Complex Analysis**

1. Complex number system: Complex plane, polar representation, lines and half planes, Spherical representation.

2. Analytic functions: Power series, analytic functions, Mobius transformations,


4. Integration: Power series representation of analytic functions Zeros of analytic function, Index of a closed curve, Cauchy's theorem, Homotopy Versions (without proof), simple Connectivity version (without proof), counting zeroes, Goursats theorem.

5. Singularities: Classification, residues, argument principle.

   Chapter 1 : Sections 1 to 6.
   Chapter 3 : Sections 1 to 3.
   Chapter 4 : Sections 2 to 8.
   Chapter 5 : Sections 1 to 3.
   Chapter 6 : Sections 1 to 2.

Textbook 2 : Complex Variables and Applications - Ruel V. Churchill (Second Edition)
Chapter 9.

MT 203 Field Theory

1. Fields - Example, Algebraic and Transcendental Elements, Degree of Field Extension, Construction with Ruler and Compass, Symbolic Adjunction of Roots, Finite Fields

2. The Main Theorem of Galois Theory - Cubic Equations, Symmetric Functions, Primitive Elements, Proof of Main Theorem, Kummer Extension, Cyclotomic Extension, Quintic Extension.

Textbook :
Algebra - Michael Artin (Prentice Hall of India Private Limited).
Chapter 13 : Sections : 1 to 6.
Chapter 14 : Sections : 1 to 9.

MT 204 Linear Algebra

1. Modules : Definition and Examples, Further notions and Results

2. Free Modules : Linear Independence, Bases of Free Modules, Matrices and Homomorphisms

3. Vector Spaces : Definition and Examples, Subspaces, Bases and Dimensions, Linear Transformations, Quotient Spaces, Direct Sum, The matrix of Linear Transformation, Duality


5. Inner Product Spaces : Inner Product Spaces, Orthogonality, The Adjoint of Linear Transformation, Unitary operators, Self Adjoints and Normal Operators, Polar and
Singular Value Decomposition

6. Bilinear Forms: Definition and Examples, The matrix of a Bilinear Form, Orthogonality, Classification of Bilinear Forms

Textbook 1: Modules - Luther and Passi (Narosa Publishing House). Chapters 1, 2.
Textbook 2: Linear Algebra - Bisht and Sahai, Chapters 2 to 5.

MT 205 Numerical Analysis


2. Polynomial interpolation: interpolation polynomial, divided difference interpolation, Aitken's formula, finite difference formulas, Hermite's interpolation, double interpolation.


Textbooks:
SECOND YEAR COURSES

MT 301 Theory of Computer Science and Database Fundamentals


2. Finite State Machines - Introduction to Graphs, State Diagram, Transition Table, Finite State Automata, Deterministic and non-deterministic


4. Turing Machine - Tape Head Program, Deterministic, Non Deterministic, Accept, Reject, Loop

5. Grammar and Languages: Phase Structure Grammar, Types, Language Recognition, Regular Sets, Kleen's Theorem, Regular Grammar, Pumping Lemma Chomsky Hierarchy, Context Sensitive Grammar, Polish notation, Postfix, prefix, Grammars and Cohen Languages

6. Introduction to DBMS: File System Vs DBMS, Storing Data, Levels of abstraction, data independence, Structure of DBMS, Advantages of DBMS

7. Conceptual Design (ER Model) Additional constraints, weak entities, Aggregation, generalisation, conceptual design using ER, Entituy Vs relationship, binary Vs Ternary, Contraints beyond ER, Conceptual design for small to large enterprises, Case Studies,

8. Relational data model: Conversion of ER to Relational model, integrity constraints

9. Relational algebra: Preliminaries, Relational algebra

10. Relational calculus: Tuple calculus, Calculus Versus Relational Algebra

11. SQL: DDL, forms of a basic SQL query, union/ intersection/ except, nested queries, Aggregate Operators, Aggregate functions, Null Values, impact on SQL commands, outer joins, disallowing NULL, examles on SQL, Creating functions in PLSQL, cursors, triggers.
12. **Functional dependency**: Introductory to schema refinement, use of decomposition, problems relation to decomposition, functional dependencies, lossless-join decomposition, Normalisation and its forms.

**Reference Books**:

2. Introduction to Computer Theory by Colen

**MT 302 Programming in C and C++**

1. Introduction – Variables and Constants, Assignment Statements
2. Data Types – Integers, Floating Point Numbers, Void Data Type
3. Operators and Expressions – Operators, Assignment Operators, Precedence and Associativity
4. Control Statements – If Statements, Looping, Switch, Break, Continue Statements, Infinite Loops
5. Arrays and Pointers – Arrays, Initializing Arrays, Pointer Arithmetic, String Manipulations, Multidimensional Arrays, Pointers to Pointers, Dynamic Memory Allocation,
7. Files in C - File Operations, Command Line Arguments
8. Graphics in C - Concepts, Simple Programs
9. Preprocessor – Macro Substitution, Include Facility, Line Control
10. Types of Files – Logical File, Memory Hierarchy
11. File Organization – Fields and Record Organization, Overview of Indexes, Types.
12. Tree Structured Indexing – Sequential and Binary Searching, ISAM, B+ Tree Indexing, Static Hashing, Dynamic Hashing, Linear and Extendible Hashing
Management Systems.

16. Object Oriented Programming Concepts - Data Types, New Operators, Classes and access Specifiers, Array of Objects, Managing Console I/O stream class, Formatted and Unformatted Console I/O – Usage manipulator

17. Functions in C++ : Call by reference, Function Overloading and default argument, static class member, friend function.

18. Constructors and Destructors – Types, Usage of destruct

19. Operator Overloading – Overloading Unary and Binary Operators, Overloading using friend function, Usage of this pointer, Overloading insertion and extraction.

20. Inheritance – Types, Virtual Base class and abstract class, Virtual function and pure virtual function.

21. Working with Files – File Operations, File Pointers and manipulations, File Updation with random access

22. Templates : Class Template, function Templates, Overloading of Template Functions, Basics of Exception Handling.

Textbooks :

1. Let us C - Kanitkar
2. Object Oriented Programming with C++ - E. Balagurswamy.

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MT 303 DATA STRUCTURES

**Basics of digital Electronics:** Bits, Bytes, Binary Addition, Subtraction, Gates, Boolean Algebra, Half Adder, Half-subtractor, Full-adder, 2's Compliment method of subtraction, De-Morgan’s Theorems, Flip-Flops, Registers


Storage Devices: Magnetic Storage, Optical CR - R/ CD - RW


4. Introduction – Data Types, Data Structures, Arrays as Abstract Data Type 1-d, 2-d, Multidimensions

5. Stacks – Push and Pop Operations, Stack Implementations using C, Stack Applications, Recursions,

6. Queues – Concepts, Queue Applications, Priority Queues

7. Linked Lists – Static implementation using arrays, Doubly Linked List, Circular List, Linked List Applications, Polynomial Representation, Stacks and Queues as Linked Lists

8. Trees – Terminology and Concepts, BinaryTree Representation, Linked Representation, Binary Search Tree, Operations, Tree Traversals, Representing General Trees as binary Tree

9. Sorting – Need and concepts, Techniques like Bubble, Quick, Selection, Insertion, Tree, Merge, Radix


Text Books:

1. K Hwang and FA Briggs: Computer Architecture
2. Data Structures using C - Tenenbaum, Langsam, Augenstein.
1. Introduction to Java Programming - Overview, Java Tools, Java Byte Code

2. Elementary Programming Concepts - Variables & Identifiers, Java keywords, Data Types, Operators, Expression, Constants, Statements, Arrays

3. Classes and Packages - Defining classes, Static Members, Using packages, Access Specifiers, Constructors, Finalisers referencing objects

4. Inheritance, nested and inner class - Extending classes, Abstract Class Interface, Super Keyword, Final classes, Constructors and Inheritance, Dynamic Binding, Overriding methods

5. Exception and Input and Output - Byte streams, Character streams, File i/o basics, Introduction to exception, Try and catch block and finally block, Inbuilt Exception.


7. Applet and Event Handling and Controls

8. Input and Output package - Object serialization, reader and writer


10. JDBC - The design of JDBC, JDBC programming concepts making the connection, statement and result set class, Executing SQL commands, Executing Queries.

11. Multithreading - Running multiple threads, The runnable interface Threads priorities Daemon, Thread States, thread groups Synchronization and Interthread Communication Deadlocks.

Textbook:

A Complete Reference Java 2 - Herbert Schildt.
MT 402 - OPERATING SYSTEMS

1. Introduction to Operating Systems - Batch System, Time sharing system, personal computer system, Parallel system, Distributed System, Real Time System


3. Threads - Overview, Multithreading models, Threading Issues.

4. CPU Scheduling - Basics, Scheduling criteria, Scheduling Algorithms, Multiple Processor Scheduling.

5. Disk and Drum Scheduling

6. Memory Management - Background, Swapping, Contiguous allocation, Paging, Segmentation, Segmentation and paging- combined system, virtual memory concept, Demand paging, Paging replacement algorithms.


Textbook:

Operating System concepts by Silberschatz 6th edition
MT 403 DESIGN AND ANALYSIS OF ALGORITHMS

1. Mathematical Foundation, Growth Functions, Summations, Recurrences Substitutions, Iterations, Master Methods, Counting and probability

2. Sorting, Heap Sort, Quick Sort, Merge Sort, Sorting in linear Time, Medians and Order Statistics


5. Graphs - Traversals, Topological sort, Minimum spanning trees, single source shortest path, All pair shortest path, Maximum flow problems.

6. Sorting Networks - Comparision, bitonic sort and merge sort networks


7. FFT - Polynomials DFT, FFT

8. Number Theoretic Algorithm - Rabin - Karp, KMP, Bower - Moore algorithms

9. Geometric Algorithms - Finding convex hall, closes pair of points, linear programming problem

10. NP Completeness - P and NP classes, NP completeness and reducibility

11. Approximation Algorithms - Vertex cover problem, traveling salesman problem, set covering and subset sum problems

Textbook :
1. Introduction to Algorithms : T. H Coreman, Leiserson, Rivest.
MT 01 - OPERATIONS RESEARCH

Unit I - Kuhn – Tucker conditions of Optimality – Quadratic Programming (Sections 19.2.2B, 20.2.2)

Unit II - Inventory Models (Sections 14.1 to 14.3)

Unit III - Queueing Models (Sections 15.1, 15.2, 15.4, 15.5)

Unit IV - Project Scheduling By PERT – CPM (Sections 13.1 to 13.4)

Unit V - Simulation Modeling with SIMNET – II (Sections 17.1 to 17.10)


MT 02- INTEGRAL TRANSFORMS

A) Classification of Liner Integral Equations : Fredholm, Volterra, Integro-Differential Equations, Singular Integral Equations, Converting Volterra Equation to ODE, Conversion of IVP to Volterra equation Conversion of BVP to Fredholm equation


C) Volterra Integral Equation - Adomian Decomposition method, Series solution method, converting Volterra equation to VIP, Successive Approximation method, successive substitution method, comparison between alternative methods.


G) Existence and uniqueness of solutions using fixed-point theorems in case of Linear and non-linear Volterra and Fredholm integral equations.


J) Mellin Transforms: Definition, properties and evaluation of transforms, Convolution theorem for Mellin transforms, Applications to integral equations.

Reference Books:


MT 03 - NUMBER THEORY


3. Quadratic Residues, Quadratic Reciprocity.


5. Diophantine equations. The equation $ax + by = c$, Pythagorean triangles, Assorted examples. Rational points on curves.


**MT 04 - CODING THEORY**

1. Error detection: correction and decoding: Communication channels, Maximum likelihood decoding, Hamming distance, Nearest neighbour / minimum distance decoding, Distance of a code.

2. Linear codes: Vector spaces over finite fields, Linear codes, Hamming weight, Bases of linear codes, Generator matrix and parity check matrix, Equivalence of linear codes, Encoding with a linear code, Decoding of linear codes, Cosets, Nearest neighbour decoding for linear codes, Syndrom decoding.

3. Cyclic codes: Definitions, Generator polynomials, Generator and parity check matrices, Decoding of cyclic codes, Burst-error-correcting codes.

4. Some special cyclic codes: BCH codes, Definitions, Parameters of BCH codes, Decoding of BCH codes.

Reference: 1. San Ling and Chaoing xing, Coding Theory- A First Course  

**MT 05 - GRAPH THEORY**

1. Fundamental concepts: Definitions and examples, graphs as models, matrices and isomorphism, paths, connected graphs, bipartite graphs, extremality vertex degree, the Pigeonhole principal, Turan’s theorem, degree sequences, graphic sequences, degree and digraphs.

2. Tree and Distances: Properties of tree, distance in graphs, stronger results, disloint spanning trees, shortest paths, tress in computer science, Eulerian circuits.

3. Matching and Factors: Matching in bipartite graphs, maximum matchings, Hall’s matching conditions, Min-Matching in bipartite graphs, sets, applications and algorithms, maximum bipartite matching, weighted bipartite matching, in general graphs, Tutte’s 1-factor theorem, f-factors of graphs.


5. Edges and cycles: Line graph and edge-colouring, Hamiltonian cycles: necessary conditions, Sufficient conditions.
Recommended Book:
Douglas B. West, Introduction to Graph Theory Prentice- Hall, New Delhi (1999)

Reference Books:
1. John Clarke and D.A. Holton, A First Look at Graph Theory, Allied Publisher (1991)

**MT 06 - LATTICE THEORY**

Two definitions of lattices, Hasse diagrams, homorphism, isotone maps, ideals, congruence relations, congruence lattices, the homorphism theorem, product of lattices, complete lattice, ideal lattice, distributive –modular inequalities and identifies, complements, pseudocomplements, Boolean lattice of pseudocomplements, join and meet-irreducible elements.

Characterization theorems and representation theorems-Dedekind’s modularity criterion Bikhoff’s distributivity criterion, hereditary subsets, rings of sets, Stone theorems,Nachbin theorem, statements of Hashimoto’s theorem.

Modular lattices, isomorphism theorem, Upper and lower covering conditions, Kurosone theorem, independent sets (Drops results involving projectivity and sublattice generated by sets / elements )

SeMTodular lattices Jordan-Holder chain condition, Modular pair, M-symmetric lattices.

Book- General Lattice Theory


Chap. 1 Section 1,2,3,4,6, Cha. 2 Section-1, Chap.3. Section –1,2.
MT 07 - COMPUTATIONAL GEOMETRY

The course text will be We will cover most of the book, adding some additional material.

1. Geometric primitives [Chap. 1]
2. Line intersection [Chaps. 2] plus randomized incremental
3. Triangulation and visibility and [Chaps. 3,15]
4. Linear programming in two and three dimensions [Chap. 4]
5. Orthogonal range searching [Chaps. 5,10]
6. Point location and Binary Space Partitions [Chaps. 6,12]
7. Voronoi diagrams and Delaunay triangulation [Chaps. 7,9]
8. Convex hulls [Chap. 11]
9. Non-orthogonal range searching [Chap. 16]
10. Curved Elements (Bezier, B-Splines)
11. Curve Reconstruction (reconstruction a curve(surface) from sample points)
12. 3-Dimensional Geometry

Text Book:


MT 08 - CRYPTOGRAPHY

1. Introduction : Overview of course, Classical cryptography [parts of Chapter 1].
2. Secret Key Encryption : Perfect Secrecy - One time pads [Chapter 2.1], Stream ciphers and the Data Encryption Standard (DES) [Chapter 3
3. Public Key Encryption: Factoring and the RSA encryption [Chapter 4.1 - 4.4], Discrete log. Diffie-Hellman Key Exchange [Chapter 8.4 (only pages 270-273)], ElGamal encryption [Chapter 5 (only pages 162-164)], Digital Signatures [Chapter 6 (excluding 6.5 - 6.6)], One-time signatures, Rabin and ElGamal signatures schemes, Digital Signature Standard (DSS).


Reference Book:


MT 09 - FINANCIAL MATHEMATICS

1. Introduction to options and markets: types of options, interest rates and present values.

2. Black Scholes model: arbitrage, option values, payoffs and strategies, put-call parity, Black Scholes equation, similarity solution and exact formulae for European options, American option, call and put options, free boundary problem.


4. Monte Carlo simulation: valuation by simulation

5. Finite difference methods: explicit and implicit methods with stability and conversions analysis methods for American options, constrained matrix problem, projected SOR, time stepping algorithms with convergence and numerical examples.

6. Lab component: implementation of the option pricing algorithms and evaluations for Indian companies.

References:


**MT 10 - MODELLING AND SIMULATION**

1. Introduction to modelling and simulation. System analysis, classification of systems. System theory basics, its relation to simulation.


5. Continuous systems modelling. Overview of numerical methods used for continuous simulation.


7. Special model classes, models of heterogeneous systems.


10. Design and control of simulation experiments. Model optimization.


12. Overview of commonly used simulation systems.

References:


MT 11 - ARTIFICIAL INTELLIGENCE


5. Common Sense Reasoning: Nonmonotonic reasoning and modal logics for nonmonotonic reasoning. How to deal with Agents and their Beliefs.


MT 12 - SYMMETRIES

1. Symmetry of plane figures of motions of the plan, finite groups of motions, discrete groups of motion, symmetry, cosets, counting formula, permutation representations, finite subgroups of the generators and relations.

2. Operation of a group on itself, class equation of the isocahedral groups operations on subsets groups of order12, free group generators and relations.

3. Bilinear forms, symmetric forms, orthogonality, geometry associated to a positive from, Hermitian forms, spectral theorem, conics and quadrics, normal operators, skew symmetric forms.

Text: Artin: Algebra (Prentice-Hall)

Chapter 5, 6 (sections 1, 2, 3 and7)

MT 13 - WAVELET ANALYSIS

1. Fourier Transform : Fourier transform on $L^1(\mathbb{R})$ and $L^2(\mathbb{R})$ and basic properties and examples.

2. Windowed Fourier Transform : Motivation and definition of Windowed Fourier Transform and examples, Time frequency localization, the reconstruction formula.

3. Continuous Wavelet Transform : Motivation and Definition of the wavelet transform and examples, Basic properties, The reconstruction formula, Frequency localization, Orthonormal Wavelets.


Textbook :

MT 14 - COMBINATORICS


2. Generating function: Generating function models, calculating of generating functions, partitions exponential generating functions, a summation method.

3. Recurrence Relations: Recurrence relation model, divide and conquer relations, solution of inhomogeneous recurrence relation, solution with generating functions.

4. Inclusion-exclusion: Counting with Venn diagrams inclusion formula, restricted positions and rook polynomials.

5. Ramsey Theory: Ramsey theorem, applications to geometrical problems.

Recommended Books:


MT 15 - PARTIAL DIFFERENTIAL EQUATIONS

1. First order PDE, Linear Equations of first order, Charpit’s method, Jacobi’s method, Quasi-linear equations, Non-linear first order PDE.

2. Second ordered PDE: Genesis, Classification, One dimensional Wave equation, Laplace equation, Boundary Value Problems, Maximum and Minimum Principles, Cauchy Problem.

3. Heat Conduction Problem, Duhamel’s Principle

Text Book: -

MT 16 - FUZZY LOGIC

1. Fuzzy Sets and Operations on Them
2. Fuzzy Relations
3. Fuzzy Rules
4. Approximate Reasoning
5. Fuzzy Logic
6. Fuzzy Systems (e.g., Fuzzy Logic Control)
7. Fuzzy Logic in Pattern Recognition
8. Fuzzy Decision Making
9. Fuzzy Logic Applications

TextBook:


MT 17 - STATISTICS AND PROBABILITY

1. Introduction to Discrete Probability: Intuitive concepts: probability of an event as a measure between 0 and 1; random variable; probability distribution; frequency interpretation of probability; random numbers; coins, dice, and other games; simulations; odds; historical development of probability; random walks.

2. Formal concepts: sample space, outcomes, and events; random variable; discrete distribution functions and axioms of probability; unions, intersections, and complements; properties of probabilities, principle of inclusion and exclusion; tree diagrams; uniform distributions over finite sets, symmetry; infinite sample spaces with discrete probabilities.
3. Introduction to Continuous Probability: The intuitive problems with probabilities over space (line, plane, $\mathbb{R}^n$ in general). Monte Carlo simulations, Buffon's needle. Formal concepts: density function for a continuous random variable; integration; cumulative distribution functions; derivatives; exponential density function;

4. Conditional Probability: Intuitive concept of conditional probability; formal definition of conditional probability; Bayes' formula for inverting conditional probabilities; independent events; joint distribution functions; independent random variables; independent trials. Conditional density functions for continuous distributions; the beta distribution;

5. Distributions and Densities: Uniform continuous distributions; geometric distribution; Poisson distribution; exponential and gamma distributions; introduction to queueing theory; normal (Gaussian) distribution; Chi-squared distribution;

6. Expected Value and Variance: Expected value for discrete random variables, expectation; linearity of expectation; expectation of independent random variables; conditional expectation; variance and standard deviation; variance of various distributions. Expectation and variance for continuous random variables;

7. Sums of Random Variables: Analysis of sums of independent random variables with identical distributions, that is, independent trials.

8. Law of Large Numbers: Chebychev inequality, law of averages, law of large numbers.

9. The Central Limit Theorem: The central limit theorem for Bernoulli trials, binomial distributions again, the normal distribution, the general central limit theorem.

TextBook:

MT 18 - FLUID DYNAMICS

1. Physical Properties of fluids. Concept of fluids, Continuum Hypothesis, density, specific weight, specific volume.

2. Kinematics of Fluids : Eulerian and Lagrangian methods of description of fluids, Equivalence of Eulerian and Lagrangian method, General motion of fluid element, integrability and compatibility conditions, strain rate tensor, stream line, path line, streak lines, stream function, vortex lines, circulation.

3. Stresses in Fluids : Stress tensor, symmetry of stress tensor, transformation of stress components from one co-ordinate system to another, principle axes and principle values of stress tensor.


5. Irrotational and Rotational Flows : Bernoulli’s equation, Bernoulli’s equation for irrotational flows, Two dimensional irrotational incompressible flows, Blasius theorem, Circle theorem, sources and sinks, sources sinks and doublets in two dimensional flows, methods of images.

TextBooks :

MT 19 - BANACH ALGEBRA

1. Relatively compact sets, compactly continuous operators, finite dimensional operators, transformation that is bounded but not completely continuous, a type of transformation that is always completely continuous, further properties of completely continuous transformations.

2. Spectra and the resolvent set, Approximate proper values, Banach Algebra With identity, compactness of the spectrum, the resolvent operator, Spectral radius and spectral mapping theorem for polynomials, the Gelfand Theory.
3. Sesquilinear functions: Spectral results for normal and completely continuous operators, numerical range

4. The Fredholm alternative theory, the spectral theorem for bounded, normal Finite dimensional operators.

5. Commutative Banach Algebras, ideals and homomorphisms.

TextBook:
Prescribed Text Book


**MT 21 - BAER* RINGS**

1. Rings with involution
2. Poset of projections
3. Proper involutions and C*-algebras
4. Rickart *-rings and Bear *-ring
5. Weakly Rickart *-rings and unitification
6. Central cover
7. Additivity of projections
8. Comparability axioms and parallelogram law
9. Finite and abelian projections
10. Structure Theorem

Prescribed Book: Bear *-rings, S.K. Berberian, Springer

**MT 22 - MATROID THEORY**

1. Basic definitions and examples

Independent sets and circuits, bases, rank, closure, geometric representations of matroids of small rank, transversal matroids, the lattice of flats, the greedy algorithm.

2. Duality

The definition and basic properties, duals of representable matroids, duals of graphic matroids, duals of traversal matroids.
3. Minors

Contraction, Minors of certain matroids, flats and the sum theorem

4. Connectivity

Connectivity, for graphs and matroids, properties of matroid connectivity, more properties of connectivity.

Text Book:

James G. Oxley, Matroid Theory Science Publications, Oxford (1992)(Chapter 1 to 4)

**MT 23 - SPERNER THEORY**

1. Introduction and sperner`s Theorem: A Simple intersection result, Sperner`s theorem, Theorem of Bollobas.

2. Normalized Matching and rank numbers: Sperner`s proof, system of distinct representatives, L Y M inequalities, and normalized matching property. Rank numbers, some examples.

3. Systemmebric Chain: Sysmmertric chain decompositions, Dilworth`s theorem, symmetric chains of sets, Application to Nested chains, posets with symmetric chain decompositions.

4. Rank numbers of multisets. Unimodality and log connectivity, the normalized matching property. The largest size of a rank number.

Prescribed Text Book

Ian Anderson : Combinatorics of Finite Sets. (Oxford Science Publications)

Reference Book.

Konrad Engel: Sperner Theory (Cambridge University Press)
**MT 24 - DIFFERENTIAL EQUATIONS AND DYNAMICAL SYSTEMS**


2) Nonlinear Systems: Local Theory, Fundamental existence theorem dependence on initial conditions and parameters, the maximal interval of existence, Flow defined by a differential equation. Linearization, stable manifold theorem, Hartman-Grobman theorem, Stability and Liapunov functions, Saddles, Nodes, Foci and centers, Nonhyperbolic critical points in $R^n$, Gradient and Hamiltonian system.

Text (1) L. Perko- Differential Equations and Dynamical systems (1991) Springer-verlag


**MT 25 - MECHANICS**

1. Sec 1.1-1.6 Survey of Elementary Particles
2. Sec. 2.1-2.7 Variational Principles & Lagranges` Equation
3. Sec.3.1-3.7 Central Force problem
4. Sec. 4.1-4.10 Kinematics of rigid body motion
5. Sec. 8.1-8.2 Hamilton Equations of motion
6. Sec.9.1-9.9 Canonical Transformations