# M.Sc. Applied Mathematics

## First Semester

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**PRACTICAL**

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**Total**: 21

## Second Semester

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## Third Semester

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**ELECTIVES**

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**Total Credits:** 80
1. PARTIAL DIFFERENTIATION


2. IMPLICIT FUNCTIONS AND INVERSE FUNCTIONS


3. TAYLOR’S THEOREM AND APPLICATIONS

Taylor’s theorem for functions of two variables – Maxima and Minima of functions of two and three variables – Lagrange Multipliers.

4. LINE AND SURFACE INTEGRALS

Definition of line integrals – Green’s theorem – Applications – Surface integrals – Gauss theorem – Verification of Green’s and Gauss theorems.

5. TRANSFORMATION AND LINE INTEGRALS IN SPACE

Change of variables in multiple integrals – Definition of line integrals in space – Stoke’s theorem - Verification of Stoke’s theorem.

BOOK FOR STUDY:

1. Widder D.V., “Advanced Calculus”, Prentice Hall of India, New Delhi, 12th Print, 2nd Edition, 2002. (Unit 1: Chapter 1: Sections 3, 4, 8 and 11, Unit 2: Chapter 1: Sections 5, 6, 7, 10 and 12, Unit 3: Chapter 1: Section 9 and Chapter 4: Sections 1-5, Unit 4: Chapter 7: Sections 1-4, Unit 5: Chapter 7: Sections 5 and 6 (except 6.5)).

REFERENCES:

1. GROUPS AND SYMMETRY


2. MORE GROUP THEORY


3. RINGS

Definition of a Ring - Formal Construction of Integers and Polynomials - Homomorphism and Ideals - Quotient Rings and Relations in a Ring - Adjunction of Elements - Integral Domains and Fraction Fields - Maximal Ideals.

4. FACTORIZATION

Factorization of Integers and Polynomials - Unique Factorization Domains, Principal Ideal Domains, and Euclidean Domains - Gauss’s Lemma - Explicit Factorization of Polynomials - Primes in the Ring of Gauss Integers - Algebraic Integers.

5. FIELDS

Examples of fields - Algebraic and Transcendental Elements - The Degree of a Field Extension - constructions with Ruler and Compass - Symbolic Adjunction of Roots - Finite Fields - Function Fields - Transcendental Extensions.

BOOK FOR STUDY:
1. Artin M., “Algebra”, Prentice - Hall, New Jersey, 1991. (Chapter 2 sections 3, 8 and 10 Chapter 5, Chapter6 first 7 sections, Chapter 10 first 7 sections, Chapter 11 first 6 and Chapter 13)

REFERENCES:
1. LINEAR EQUATIONS


2. EXISTENCE THEOREM AND BOUNDARY VALUE PROBLEMS

Successive approximations - Picard’s theorem – Boundary Value problems – Sturm–Liouville problem - Green’s Functions.

3. STABILITY


4. LEGENDRE EQUATION


5. BESSEL EQUATION

Second order equations with regular singular points – Series solution – Bessel Equation – Bessel functions of first kind – Recurrence relations – Orthogonality.

TEXT BOOKS:


REFERENCES:


1. KINEMATICS
   Kinematics of a particle and a rigid body – Moments and products of inertia – Kinetic energy – Angular momentum.

2. METHODS OF DYNAMICS IN SPACE
   Motion of a particle – Motion of a system – Motion of a rigid body.

3. APPLICATIONS OF DYNAMICS IN SPACE
   Motion of a rigid body with a fixed point under no forces – Spinning top - General motion of top.

4. EQUATIONS OF LAGRANGE AND HAMILTON
   Lagrange’s equation for a particle – Simple dynamical system – Hamilton’s equations.

5. HAMILTONIAN METHODS
   Natural Motions – Space of events – Action – Hamilton’s principle - Phase space – Liouville’s theorem.

BOOK FOR STUDY:

REFERENCES:
1. FUNCTIONS AND CLASSES IN C++


2. INHERITANCE AND POLYMORPHISM IN C++

Single inheritance – Multiple inheritance – Hierarchical inheritance – Hybrid inheritance – Abstract base class – Virtual functions – Dynamic binding – Polymorphism – Virtual base classes

3. INPUT/OUTPUT IN C++

Input/Output operations – Overloading the insertion and extraction operators – I/O stream classes – File Input/Output – Exception handling

4. JAVA FUNDAMENTALS

Features of Java – Classes – Inheritance – Packages - Interfaces – Exception handling.

5. JAVA PROGRAMMING


BOOKS FOR STUDY:


REFERENCES:

REAL ANALYSIS

1. RIEMANN-STIELTJES INTEGRAL
   Definition and existence of the integral, Properties of the integral, Integration and Differentiation. The Four Derivatives-Continuous non differentiable functions-Functions of Bounded Variation

2. SEQUENCES AND SERIES OF FUNCTIONS
   Pointwise convergence, Uniform convergence, Uniform convergence and continuity, Uniform convergence and Integration, Uniform Convergence and differentiation. Equi-continuous families of functions, Stone-Weierstrass theorem

3. MEASURE AND MEASURABLE SETS
   Lebesgue Outer Measure-Measurable Sets-Regularity-Measurable Functions-Borel and Lebesgue Measurability-Abstract Measure-Outer Measure-Extension of a Measure—Completion of a Measure.

4. LEBESGUE INTEGRAL
   Integrals of simple functions-Integrals of Non Negative Functions-The General Integral-Integration of Series-Riemann and Lebesgue Integrals-Legesgue Differentiation Theorem- Integration and Differentiation-The Lebesgue Set-Integration with respect to a general measure

5. LEBESGUE DECOMPOSITION AND PRODUCT MEASURE
   Convergence in Measure-Almost Uniform convergence-Signed measures and Hahn Decomposition - Radon-Nikodym Theorem and its applications-Measurability in a product space- The Product measure and Fubini’s Theorem.

BOOKS FOR STUDY:

REFERENCES:
1. Function Overloading (both in C++ and Java)
2. Function Templates and Class Templates in C++
3. Classes in C++ with all possible operations/operators for encapsulating Complex Number, String, Time, Date and Matrix (Operators are to be overloaded)
4. Employee class with derived classes for specialized employees (Both in C++ and Java)
5. Interfaces and Packages in Java
6. Polymorphism (both in C++ and Java)
7. Multithreading in Java
8. Applet in Java
9. Window using AWT in Java
1. VECTOR SPACES AND LINEAR MAPS


2. DIAGONALIZATION AND THE PRIMARY DECOMPOSITION THEOREM


3. UNITARY TRANSFORMATIONS

Unitary matrices and their properties-rotation matrices-Schur, Diagonal and Hessenberg forms and Schur Decomposition.

4. THE JORDAN CANONICAL FORM

Similarity Transformations and change of basis-Generalised eigen vectors- Canonical basis-Jordan canonical form – Applications to linear differential equations – Diagonal and the general cases.

5. APPLICATIONS


BOOKS FOR STUDY:


REFERENCES:

1. **PROBABILITY AND RANDOM VARIABLES**


2. **TWO DIMENSIONAL RANDOM VARIABLES**

   Joint distributions – Transformation of random variables and their distributions – Conditional expectation – Computing probabilities and expectations by conditioning – Correlation and Regression.

3. **LIMIT THEOREMS**

   Modes of convergence – Markov, Chebyshev’s and Jensen’s inequalities – Weak law of large numbers – Strong law of large numbers – Kolmogorov’s inequality - Central limit theorem (iid case).

4. **MARKOV CHAINS**


5. **MARKOV PROCESSES**


**BOOKS FOR STUDY:**


**REFERENCES:**

1. COMPLEX INTEGRATION
   Analytic functions – Cauchy’s theorem for rectangle – Cauchy’s theorem for disk - Integral formula - Local properties of analytic functions – Schwartz lemma – Maximum Modulus principle.

2. CALCULUS OF RESIDUES
   Homology – Homologous form of Cauchy’s theorem – Calculus of Residues – Contour integration through residues.

3. DOMAIN CHANGING MAPPINGS
   Conformality – Normal family – Riemann mapping theorem

4. HARMONIC FUNCTIONS
   Properties – The mean-value property - Poisson’s Formula - Schwarz’s theorem - Harnack’s principle

5. MEROMORPHIC AND ENTIRE FUNCTIONS
   Meromorphic functions – Mittag Leffler’s theorem – Infinite partial fraction of \( \cot(\pi z) \)- Infinite product – Canonical Product – Gamma Functions – Jensen’s formula- Order and Genus of an Entire function - Hadamard’s theorem – Riemann Zeta function

BOOK FOR STUDY:

REFERENCES:
1. **FIRST ORDER EQUATIONS**

   Integral surfaces passing through a given curve – Surfaces orthogonal to a given system of surfaces – Compatible system of equations – Charpit’s method.

2. **SECOND ORDER EQUATIONS**

   Classification of second order Partial Differential Equations – Reduction to canonical form – Adjoint operators – Riemann’s method.

3. **HYPERBOLIC EQUATIONS**


4. **PARABOLIC EQUATIONS**

   Diffusion equation – Solution of Diffusion equation in cylindrical and spherical polar coordinates by method of Separation of variables – Solution of Diffusion equation by Fourier transform.

5. **ELLIPTIC EQUATIONS**


**BOOK FOR STUDY:**


**REFERENCES:**

1. TOPOLOGICAL SPACES

Topological spaces – Basis for a topology – Product topology on finite cartesian products – Subspace topology.

2. CLOSED SETS AND CONTINUOUS FUNCTIONS


3. CONNECTEDNESS AND COMPACTNESS

Connected spaces – Components – Path components – Compact spaces – Limit point compactness – Local compactness.

4. COUNTABILITY AND SEPARATION AXIOMS


5. URYSOHN LEMMA AND TYCHONOFF THEOREM


BOOK FOR STUDY:
   Chapter 2, sections 12, 13, 15, 16, 17, 18, 20, 21 Chapter 3 sections 23, 25, 26, 28, 29, Chapter 4, sections 30, 31, 32, 33, 34, 35, 37.

REFERENCES:
1. **BANACH SPACES**
   
   Banach Spaces - Continuous linear transformations.

2. **FUNDAMENTAL THEOREMS IN NORMED LINEAR SPACES**
   

3. **HILBERT SPACES**
   

4. **OPERATOR ON A HILBERT SPACE**
   
   The adjoint of an operator – Self-adjoint operators – Normal and unitary operators – Projections.

5. **SPECTRAL AND FIXED POINT THEORIES**
   
   Matrices – Determinants and the spectrum of an operator – spectral theorem – Fixed point theorems and some applications to analysis.

**BOOK FOR STUDY:**


**REFERENCES:**

1. SYSTEMS OF LINEAR EQUATIONS AND ALGEBRAIC EIGENVALUE PROBLEMS 9


2. INTERPOLATION, DIFFERENTIATION AND INTEGRATION 9


3. APPROXIMATION OF FUNCTIONS 9

Norms of functions – Best Approximations: Least squares polynomial approximation – Approximation with Chebyshev polynomials – Piecewise Linear & Cubic Spline approximation.

4. ORDINARY DIFFERENTIAL EQUATIONS 9


5. PARTIAL DIFFERENTIAL EQUATIONS 9

Elliptic equations: Five point finite difference formula in rectangular region – truncation error; One-dimensional Parabolic equation: Explicit and Crank-Nicholson schemes; Stability of the above schemes - One-dimensional Hyperbolic equation: Explicit scheme;

BOOKS FOR STUDY:


REFERENCES:

1. LINEAR PROGRAMMING
   Formulation and Graphical solutions – Simplex method – Transportation and Assignment problems.

2. ADVANCED LINEAR PROGRAMMING

3. INTEGER PROGRAMMING
   Cutting plane algorithm – Branch and bound technique – Applications of Integer programming.

4. NON-LINEAR PROGRAMMING
   Classical optimization theory : Unconstrained problems – Constrained problems – Quadratic programming.

5. DYNAMIC PROGRAMMING
   Principle of optimality – Forward and backward recursive equations – Deterministic dynamic programming applications.

BOOKS FOR STUDY:

REFERENCES:
1. TENSORS:


2. KINEMATICS OF A CONTINuum:

Material and Spatial descriptions – Material derivative – Deformation – Principal Strain – Rate of deformation – Conservation of mass – Compatibility conditions.

3. STRESS

Stress vector and tensor – Components of a stress tensor – Symmetry – Principal Stresses – Equations of motion – Boundary conditions.

4. LINEAR ELASTIC SOLID

Isotropic solid – Equations of infinitesimal theory – Examples of elastodynamics elastostatics.

5. NEWTONIAN VISCOS FLUID


BOOK FOR STUDY:


REFERENCES:

1. VARIATIONAL PROBLEMS

Variation of a functional and its properties – Euler’s equations – Functionals with several arguments, higher order derivatives – Functionals dependent on functions of several independent variables – Variational Problems in Parametric form.

2. VARIATIONAL PROBLEMS WITH MOVING BOUNDARIES AND WITH SUBSIDIARY CONDITIONS

Variation problems with a movable boundary for functionals dependent on one and two functions - One-sided variations – Constraints – Isoperimetric Problems - Applications.

3. INTEGRAL EQUATIONS WITH SEPARATE KERNELS AND NEUMANN SERIES

Integral equations with degenerate kernels – Solution by reduction to algebraic equations – Fredholm Alternative – Method of successive approximaion for equation of second kind – Neumann series and Resolvent kernel - Fredholm Theorems (without proof) - Applications.

4. EQUATIONS WITH SYMMETRIC KERNELS


5. APPROXIMATE METHODS


BOOKS FOR STUDY:

REFERENCES:
Introduction to MATLAB Fundamentals


Lab Exercises on Numerical Methods:

**Numerical Linear Systems**
Gaussian Elimination method with pivoting
Gauss-Seidel iterative methods, Power methods

**Interpolation, Approximations and Quadratures**
Newton divided-difference and finite difference Interpolation, Composite Simpson and Composite Gaussian quadratures
Cubic Spline Approximation

**Numerical methods for ordinary Differential Equations**
Euler’s method. Fourth order Runge-Kutta Method, Adams-Bashforth
Multi-Step method

**Finite Difference Methods for BVP s**
Two-Point BVP, Elliptic Equations, Parabolic Equations, Hyperbolic Equations.

Introduction to TORA Package

Lab exercises on Mathematical Programming:

**Linear Programming Models**
Simplex Method, Big M method – Bounded Variables method

**Integer Programming Models**
Cutting plane method, Branch and Bound method

Network Problems

REFERENCES:


1. **METRIC CONTRACTION PRINCIPLES**


2. **HYPERCONVEX SPACES AND NORMAL STRUCTURES IN METRIC SPACES**


3. **CONTINUOUS MAPPING IN BANACH SPACES**


4. **METRIC FIXED POINT THEOREY**

   Contraction mappings – Basic theorem for nonexpansive mapping – Structure of the fixed point set - Asymptotically regular mapping – Set valued mappings.

5. **BANACH SPACE ULTRAPOWERS**

   Some fixed point theorem – Asymptotically nonexpansive mappings – The demiclosedness principle.

BOOK FOR STUDY:


REFERENCES:

1. **LOGIC**
   

2. **NUMBER THEORY**
   
   The Integers and Division – Integers and Algorithms – Applications of Number Theory.

3. **COUNTING**
   

4. **RECURRENCE RELATIONS**
   

5. **BOOLEAN ALGEBRA**
   

**BOOK FOR STUDY:**

   [Sections: 1.1 to 1.5, 3.3; 2.4 to 2.6; Chapter 4 and 6.5, 6.6; 6.1 to 6.4; Chapter 10]

**REFERENCES:**

1. DIVISIBILITY


2. CONGRUENCES


3. APPLICATION OF CONGRUENCE AND QUADRATIC RECIPROCITY

Public – Key cryptography – Prime power moduli – Prime modulus - Primitive roots and power residues – Quadratic residues – The Gaussian reciprocity law.

4. FUNCTIONS OF NUMBER THEORY

Greatest integer function – Arithmetic functions – Mobius inversion formula – Recurrence functions – Combinational number theory

5. DIOPHAUTIN EQUATIONS AND FAREY FRACTIONS

The equations ax + by = c Pythagorean triangle – Shortest examples – Farey sequences – Rational approximations.

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BOOK FOR STUDY:
1. Niven I., Zuckerman H.S., and Montgomery, H.L., "An introduction to the theory of numbers", John Wiley & Sons (Asia) Pte. Ltd, Singapore, 5th Edition, 2004. Sections 1.1, 1.2, 1.3, through theorem 1.18, 1.4 through theorem1.21; 2.1, 2.2, 2.3, 2.4 thorough example 9: 2.5, 2.6 through example12, 27through theorem 2.29, 2.8 through corollary 2.38, 3.1, 2.3; 4.1, 4.5; 5.1, 5.3, 5.4, 6.1, 6.2

REFERENCES:
1. SAMPLING DISTRIBUTIONS AND ESTIMATION THEORY
   Sampling distributions – Characteristics of good estimators – Method of Moments – Maximum Likelihood Estimation – Interval estimates for mean, variance and proportions.

2. TESTING OF HYPOTHESIS
   Type I and Type II errors - Tests based on Normal, t, \( \chi^2 \) and F distributions for testing of mean, variance and proportions – Tests for Independence of attributes and Goodness of fit.

3. CORRELATION AND REGRESSION
   Method of Least Squares - Linear Regression – Normal Regression Analysis – Normal Correlation Analysis – Partial and Multiple Correlation - Multiple Linear Regression.

4. DESIGN OF EXPERIMENTS
   Analysis of Variance – One-way and two-way Classifications – Completely Randomized Design – Randomized Block Design – Latin Square Design.

5. MULTIVARIATE ANALYSIS
   Covariance matrix – Correlation Matrix – Normal density function –Principal components – Sample variation by principal components – Principal components by graphing.

BOOKS FOR STUDY:

REFERENCE:
1. MARKOV AND STATIONARY PROCESSES


2. RENEWAL PROCESSES


3. MARKOV RENEWAL AND SEMI–MARKOV PROCESSES

Definition and preliminary results – Markov renewal equation – Limiting behaviour - First passage time.

4. BRANCHING PROCESSES

Generating functions of branching processes – Probability of extinction – Distribution of total number of progeny – Generalization of classical Galton – Watson process – Continuous time Markov branching process – Age dependent branching process – Bellman - Harris process

5. MARKOV PROCESSES WITH CONTINUOUS STATE SPACE


BOOK FOR STUDY:

REFERENCES:
1. REGULAR SETS AND FINITE STATE AUTOMATA


2. CONTEXT FREE LANGUAGES


3. PUSH DOWN AUTOMATA AND PROPERTIES AND CONTEXT FREE LANGUAGES

Pushdown automata – Push down automata and Context free languages – Pumping lemma for context free languages.

4. TURING MACHINE AND UNDECIDABILITY

Turing Machine model – Computational languages and functions – Modifications of Turing machines (only description, no proof for theorems on equivalence of the modification) – Problems – Properties of recursive and recursively enumerable languages – Universal Turing Machine and the undecidable problem.

5. THE CHOMSKY HIERARCHY


REFERENCES:

1. Hopcroft, J.E., Rajeev Motwani and Ullman, J.D. “Introduction to Automata, Languages and Computation”, Narosa Publishing House, 1987 (Sections 2.1 to 2.5, 3.1, 4.1 to 4.6, 5.1 to 5.3, 6.1, 7.1 to 7.5, 8.1 to 8.3, 9.1 to 9.4)


1. STACKS AND RECURSION

Arrays, Structures and Stacks in C – Recursion in C.

2. QUEUES AND LISTS

Queue and its sequential representation, Linked lists, Lists in C, Circular linked lists.

3. TREES

Binary Trees – Binary tree representation – Lists as binary trees – Application of trees.

4. SORTING


5. SEARCHING

Basic search Technique – Tree searching – Hashing.

BOOK FOR STUDY:
   (Chapter 1: Sections 1.2-1.4, Chapter 2, Chapter 3: Sections 3.1 to 3.3, Chapter 4: Sections 4.1-4.3 and 4.5, Chapter 5: Sections 5.1, 5.2 and 5.5, Chapter 6, Chapter 7: Sections 7.1,7.2 and 7.4).

REFERENCE:
MT 9158  Fuzzy Set Theory

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1. BASICS

Fuzzy sets - Basic types – Fuzzy sets – Basic concepts – Additional properties of \( \alpha \)-cuts – Representations of fuzzy sets – Extension principle for fuzzy sets.

2. OPERATIONS ON FUZZY SETS


3. FUZZY ARITHMETIC

Fuzzy numbers – Linguistic variables – Arithmetic operations on Intervals – Arithmetic operations on fuzzy numbers.

4. FUZZY RELATIONS

Crisp and fuzzy relations – Binary fuzzy relations – Binary relations on a single set – Fuzzy equivalence relations – Fuzzy compatibility relations – Fuzzy ordering relations.

5. FUZZY RELATION EQUATIONS

Partition – Solution method – Fuzzy relation equations based on sup-i compositions and inf-w compositions.

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BOOK FOR STUDY:

1. George J. Klir and Yuan B., “Fuzzy Sets and Fuzzy Logic, Theory and Applications”, Prentice Hall of India Private Limited, 1997. (Sections 1.3, 1.4, 2.1, 2.2, 2.3, Sections 3.1 to 3.5, Sections 4.1 to 4.4 and Sections 5.1, 5.3 to 5.7 and Sections 6.2 to 6.5).

REFERENCES:

1. INTRODUCTION


2. CONNECTIVITY AND TRAVERSIBILITY

Connectivity – Whitney’s theorems – Blocks – Applications of connectivity – Euler’s tour – Hamilton Cycles – The Chinese Postman Problem – The traveling Salesman Problem (only a brief introduction on these problems.)

3. MATCHING

Matching and covering bipartite graphs – perfect matchings – Independent sets.

4. COLORING

Vertex chromatic number – k-critical graphs – Brook’s theorem – Chromatic polynomials – Girth and Chromatic number.

5. PLANAR GRAPHS

Planar graphs – Euler’s formula – Kurwalski’s theorem – Five color theorem.

BOOK FOR STUDY:

REFERENCES:
1. INTEGRAL FORMULATIONS AND VARIATIONAL METHODS


2. FINITE ELEMENT ANALYSIS OF ONE-DIMENSIONAL PROBLEMS


3. EIGENVALUE AND TIME DEPENDENT PROBLEMS IN ONE DIMENSION

Formulation of eigenvalue problem – Finite element models – Applications of semi-discrete finite element models for time-dependent problems – Applications to parabolic and hyperbolic equations.

4. FINITE ELEMENT ANALYSIS OF TWO-DIMENSIONAL PROBLEMS


5. FINITE ELEMENT ERROR ANALYSIS

Various measures of errors – Convergence of solution – Accuracy of solution.

BOOK FOR STUDY:

REFERENCES:
1. ANALYZING ALGORITHMS 7


2. SORTING 8


3. GRAPH ALGORITHMS 11


4. STRING MATCHING 6


5. POLYNOMIALS, MATRICES AND NP COMPLETENESS 13


BOOK FOR STUDY:

REFERENCES:
1. INTRODUCTION TO NUMBER THEORY

Time estimates for doing arithmetic - Divisibility and the Euclidean algorithm – Congruences - Modular exponentiation - Some applications to factoring

2. QUADRATICS RESIDUES AND RECIPROCITY

Finite Fields - Multiplicative generators – Uniqueness of fields with prime power elements - Quadratic residues and reciprocity

3. CRYPTOSYSTEMS


4. PRIMALITY AND FACTORING - I

Pseudoprimes - Strong pseudo primes - Solovay-Strassen Primality test – Miller - Rabin test - Rho method - Fermat factoring and factor bases - Quadratic sieve method

5. PRIMALITY AND FACTORING - II

Elliptic Curves - Elliptic curve primality test - Elliptic Curve factoring - Pollard’s p - 1 method -Elliptic curve reduction modulo n - Lenstras Method.

BOOK FOR STUDY:

REFERENCE:
1. **VB.NET FUNDAMENTALS** 9

   Introduction to .NET Framework - Controls – Menus and Dialog Boxes – Variables and Operators – Decision Structures – Loops and Timers – Debugging -Trapping and Handling Errors

2. **VB.NET PROGRAMMING** 9


3. **VB.NET UI DESIGN AND DATABASE APPLICATIONS** 9


4. **VC++ FUNDAMENTALS** 9


5. **VC++ UI DESIGN AND DATABASE APPLICATIONS** 9


**BOOKS FOR STUDY:**


**REFERENCES:**

3. MSDN Library
1. PROBABILITY AND RANDOM VARIABLES

2. PRESENT VALUE ANALYSIS AND ARBITRAGE
Interest rates – Present value analysis – Rate of return – Continuously varying interest rates – Pricing contracts via Arbitrage – An example in options pricing.

3. ARBITRAGE THEOREM AND BLACK-SCHOLES FORMULA

4. EXPECTED UTILITY

5. EXOTIC OPTIONS

BOOK FOR STUDY:

REFERENCES:
MT 9165  APPROXIMATION THEORY  L T P C 3 0 0 3

1. APPROXIMATION IN NORMED LINEAR SPACES  

2. CHEBYSHEV POLYNOMIALS  

3. INTERPOLATION  

4. BEST APPROXIMATION IN NORMED LINEAR SPACES  
   Introduction – Approximative properties of sets – Characterization and Duality.

5. PROJECTION  
   Continuity of metric projections – Convexity, Solarity and Chebyshevity of sets – Best simultaneous approximation.

BOOK FOR STUDY:
1. Hrushikesh N. Mhaskar and Devidas V. Pai., “Fundamentals of approximation theory”, Narosa Publishing House, New Delhi, 2000, Chapter II (Except 2.6), IV (except 4.5,4.6 & 4.7) and VIII (except8.6 & 8.7).

REFERENCES:
1. **KINEMATICS OF FLUIDS IN MOTION**


2. **EQUATIONS OF MOTION OF A FLUID**

Pressure at a point in a fluid – Boundary conditions of two inviscid immiscible fluids – Euler’s equations of motion – Bernoulli’s equation – Some potential theorems – Flows involving axial symmetry.

3. **TWO DIMENSIONAL FLOWS**

Two-Dimensional flows – Use of cylindrical polar co-ordinates – Stream function, complex potential for two-dimensional flows, irrotational, incompressible flow – Complex potential for standard two-dimensional flows – Two dimensional image systems – Milne-Thomson circle theorem – Theorem of Blasius.

4. **CONFORMAL TRANSFORMATION AND ITS APPLICATIONS**

Use of conformal transformations – Hydrodynamical aspects of conformal mapping - Schwarz Christoffel transformation – Vortex rows.

5. **VISCOUS FLOWS**


**BOOK FOR STUDY:**


**REFERENCES:**

1. NECESSARY BASICS


2. ONE DIMENSIONAL PARABOLIC EQUATIONS

Explicit and Crank-Nicolson Schemes for \( u_t = u_{xx} \) – Weighted average approximation - Derivative boundary conditions – Truncation errors – Consistency, Stability and convergence - Lax Equivalence theorem.

3. MATRIX NORMS & TWO DIMENSIONAL PARABOLIC EQUATION


4. HYPERBOLIC EQUATIONS


5. ELLIPTIC EQUATIONS

Solution of Laplace and Poisson equations in a rectangular region – Finite difference in Polar coordinate Formulas for derivatives near a curved boundary when using a square mesh – Discretisation error – Mixed Boundary value problems.

BOOK FOR STUDY:

REFERENCES:
1. NETWORK MODELS
   Scope and definition of network models - Minimal spanning tree algorithm –
   Shortest-route problem – Maximal-flow Model.

2. CPM AND PERT
   Network representation – Critical path (CPM) computations – Construction of the
   time schedule – Linear programming formulation of CPM – PERT calculations.

3. GAME THEORY
   Optimal solution of two-person zero-sum games – Mixed strategies – Graphical
   solution of (2 x n) and (m x 2) games – Solution of m x n games by linear
   programming.

4. DECISION ANALYSIS
   Decision making under certainty: analytic hierarchy process (AHP) – Decision
   making under risk – Decision under uncertainty.

5. MARKOVIAN DECISION PROCESS
   Scope of the Markovian decision problem – Finite stage dynamic programming
   model – Infinite stage model – Linear programming solution.

BOOK FOR STUDY:
   2007. [Chapters: 6, 13 & 23]

REFERENCES:
1. THE BANACH FIXED POINT THEOREM AND ITERATIVE METHODS

   The Banach fixed point theorem – The significance of Banach fixed point theorem – Applications to nonlinear equations – The Picard-Lindelof theorem – The Main theorem for iterative methods for linear operator equation – Applications to systems of linear equations and to linear integral equations.

2. THE SCHAUDER FIXED POINT THEOREM AND COMPACTNESS


3. FIXED POINTS OF MULTIVALUED MAPS

   Generalized Banach fixed point theorem – Upper and lower semi continuity of multi-valued maps – Generalized Schauder fixed point theorem – Variational inequalities and Brouwer fixed point theorem.

4. NONEXPANSIVE OPERATORS AND ITERATIVE METHODS


5. CONDENSING MAPS

   A noncompactness measure – Condensing maps – Operators with closed range and an approximation technique for constructing fixed points – Sadovskii’s fixed point theorem for condensing maps – Fixed point theorem for perturbed operators – Application to differential equations in Banach spaces.

BOOK FOR STUDY:

REFERENCES:
1. ELEMENTARY THEORY OF UNIVALENT FUNCTIONS

The Area theorem - Growth and Distortion Theorems - Coefficient Estimates - Convex and Starlike functions - Close to Convex functions - Spirallike functions - Typically Real functions.

2. VARIATIONAL METHODS


3. SUBORDINATION

Basic Principles - Coefficient Inequalities - Sharpened Forms of the Schwartz Lemma – Majorization - Univalent Subordinate Functions.

4. GENERAL EXTREMAL PROBLEMS

Functionals of Linear Spaces - Representation of Linear Functionals - Extreme Points and Support Points - Properties of Extremal Functions - Extreme Points of $S$, Extreme Points of $Σ$.

5. COEFFICIENT CONJECTURE

Preliminaries – Proof of the Coefficient Conjecture

BOOKS FOR STUDY:

REFERENCE:
MT 9171  WAVELET ANALYSIS  

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1. FOURIER ANALYSIS  

Fourier and inverse Fourier transforms – Continuous time convolution and the delta function – Fourier transform of square integrable functions – Poisson’s summation formula.

2. WAVELET TRANSFORMS AND TIME - FREQUENCY ANALYSIS  


3. MULTI RESOLUTION ANALYSIS AND WAVELETS  

The Haar wavelet construction – Multi resolution analysis – Riesz basis to orthonormal basis – Sealing function and scaling identity – Construction of wavelet basis.

4. COMPACTLY SUPPORTED WAVELETS  

Vanishing moments property – Meyer’s wavelets – Construction of a compactly supported wavelet – Smooth wavelets.

5. APPLICATIONS  

Digital Filters – Discrete wavelet transforms and Multi resolution analysis – Filters for perfect reconstruction – Para unitary filters and orthonormal wavelets – Filter design for orthonormal wavelets – Biorthogonal filters.

BOOKS FOR STUDY:  

1. DERIVATION AND PROPERTIES OF NAVIER-STOKES EQUATIONS 10


2. EXACT SOLUTIONS 8

Exact solutions of the Navier-Stokes equations – Parallel flow – Other exact solutions.

3. BOUNDARY LAYER EQUATIONS AND THEIR PROPERTIES 9

Derivation of boundary layer equations – Separation – Skin friction – Boundary layer along a flat plate – Similar solutions – Transformation of the boundary layer equations – Momentum and integral equations.

4. EXACT AND APPROXIMATE METHODS 9

Exact solutions of boundary layer equations – Flow past a wedge – Approximate methods – Application of the momentum equation – Von Karman and Pohlhausen method – Comparison – Methods of boundary layer control.

5. TURBULENT BOUNDARY LAYERS 9

Turbulent flow – Introduction – Mean motion and fluctuations – Apparent stresses – Derivation of the stress tensor – Assumptions for turbulent flows – Prandtl’s mixing theory.

BOOK FOR STUDY:
1. Schlichting H., "Boundary Layer Theory", Mc Graw Hill, 7th Edition, 1979. Chapter 3(a,b,c,d,e,g), Chapter 4(a,c,d,e), Chapter 5 a(1,2,3,4,7), b(9,9a,10), Chapter 7(a,b,d,e), Chapter 8(b,c,d), Chapter 9(a), Chapter 10(a,b,c), Chapter 14 a(1,2,3,4,5,6), b(1,1,1,2), Chapter 18(a,b,c,d) and Chapter 19(a,b).

REFERENCES:
1. FLOW ALONG SURFACES AND IN CHANNELS

Boundary layer and turbulence – Momentum equation – Laminar flow boundary layer equation – Plane plate in longitudinal flow – Pressure gradients along a surface – Exact solutions for a flat plate.

2. FORCED CONVECTION IN LAMINAR FLOW


3. FORCED CONVECTION IN TURBULENT FLOW


4. FREE CONVECTION

Laminar heat transfer on a vertical plate and horizontal tube – Turbulent heat transfer on a vertical plate – Free convection in a fluid enclosed between two plane walls – Mixed free and forced convection.

5. MASS TRANSFER

Diffusion – Flat plate with heat and mass transfer – Integrated boundary layer equations of mass transfer – Similarity relations for mass transfer - Evaporation of water into air.

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BOOK FOR STUDY:

REFERENCES:
1. **BASIC CONCEPTS**


2. **SOBOLEV SPACES**

   Review of Lebesgue integration theory, Weak derivatives, Sobolev norms and associated spaces, Inclusion relations and Sobolev’s inequality, Trace Theorems, Negative norms and duality.

3. **VARIATIONAL FORMULATIONS**


4. **CONSTRUCTION OF FINITE ELEMENT SPACE AND APPROXIMATION THEORY IN SOBOLEV SPACES**

   The Finite Element, Triangular finite elements, Lagrange element, Hermite element, Rectangular elements, Interpolant, Averaged Taylor polynomials, Error representation, Bounds for the Interpolation error, Inverse estimates

5. **HIGHER DIMENSIONAL VARIATIONAL PROBLEMS**

   Variational formulation and approximation of Poisson’s and Neumann equations, Coercivity of the variational problem, Elliptic regularity estimates, Variational approximations of general Elliptic and Parabolic problems, Negative – Norm estimates.

**BOOKS FOR STUDY:**


**REFERENCES:**

1. **ANALYSIS OF STRAIN**

   Deformation, strain tensor in rectangular Cartesian coordinates, Geometric interpretation of infinitesimal strain, rotation, compatibility of strain components, properties of strain tensor, strain in spherical and cylindrical polar coordinates.

2. **ANALYSIS OF STRESS**

   Stresses, laws of motion, Cauchy’s formula, equations of equilibrium, transformation of coordinates, Plane state of stresses, Cauchy’s stress quadric, shearing stress, Mohr’s circle, stress deviation, stress tensor in general coordinates, physical components of a stress tensor in general coordinates, equation of equilibrium in curvilinear coordinates.

3. **LINEAR THEORY OF ELASTICITY**

   Generalized Hooke’s law, Stress-Strain relationship for an isotropic elastic material, Basic equation of elasticity for homogeneous isotropic bodies, boundary value problems, the problem of equilibrium and the uniqueness of solution of elasticity, Saint-Venant’s principle.

4. **TORSION**

   Torsion of prismatic bars, torsion of circular, elliptic and rectangular bars, membrane analogy, torsion of rectangular section and hollow thin walled sections.

5. **SOLUTION OF TWO AND THREE DIMENSIONAL PROBLEMS IN ELASTICITY**


**BOOKS FOR STUDY:**


**REFERENCES:**

1. INTRODUCTION TO GRAPHS AND ALGORITHMIC COMPLEXITY  

2. PLANAR GRAPHS AND NETWORK FLOW  

3. GRAPH TRAVERSALS AND MATCHINGS  

4. GRAPH COLOURING  
Dominating sets, independence cliques – Coloring graphs – Edge – Coloring – Vertex – Coloring – Chromatic polynomials – Face coloring of embedded graphs – Five colour theorem – Four colour theorem.

5. GRAPH PROBLEMS AND INTRACTABILITY  
Introduction to NP - Completeness – Classes P and NP – NP - Completeness and Cook’s theorem. NP - Complete graph problems – Problems of vertex cover, independent set and clique – Problems of Hamiltonian paths and circuits and the traveling salesman problem – Problems concerning the coloring of graphs.

BOOK FOR STUDY:

REFERENCE:
1. **PERFECT GRAPHS**

   The Perfect graph theorem – Chordal graphs – Other class of Perfect graphs – Imperfect Graphs – The Strong Perfect Graph Conjecture.

2. **RAMSEY THEORY**

   Ramsey’s Theorem – Ramsey Numbers – Graph Ramsey Theory – Sperner’s Lemma and Bandwidth.

3. **EXTREMAL GRAPHS**


4. **CONNECTEDNESS IN DIGRAPHS**

   Digraphs – Connected and Disconnected graphs – Strong digraphs – Digraphs and matrices.

5. **TOURNAMENTS**

   Properties of tournaments – Hamiltonian tournaments – Score Sequences.

**BOOKS FOR STUDY:**


**REFERENCES:**

1. MARKOVIAN QUEUES:

Arrival and Departure processes, single and multiple channel queues, Queues with finite waiting room, Little's formula, waiting time distributions, busy period analysis, Erlang's loss formula (Transient solutions for M/M/1 model) and Self-serving queues.

2. QUEUES WITH SPECIAL CHARACTERISTICS

Finite source queue, State-dependent queues, Balking and reneging, Bulk input and bulk service models, Erlangian Models, Priority queues.

3. NON-MARKOVIAN QUEUES

M/G/1 queueing model, Pollaczek-Khintchine formula, steady-state system size probabilities, waiting time distributions, Generalization of Little's formula, Busy period analysis.

4. RELIABILITY CHARACTERISTICS

Reliability and hazard functions – exponential, normal, log-normal, weibull and Gamma failure distributions – Time-dependent hazard models, Reliability of series, stand by and parallel systems, k-out-of-m systems.

5. SYSTEM RELIABILITY

Redundancy techniques in system design, Optimal Design – Availability and maintainability concepts, Markovian models for reliability and availability of repairable two-unit systems, Preventive maintenance.

BOOKS FOR STUDY:


REFERENCES: