MANONMANIAM SUNDARANAR UNIVERSITY, TIRUNELVELI

Department of Mathematics

M.Sc. MATHEMATICS (CBCS)

(For those who join during 2017-18 and onwards)

SYLLABUS

1.OBJECTIVES: Mathematics is one of the fundamental disciplines in science. It is the basic for all the disciplines. This two year program, consisting four semesters,aims at providing basic tools and exposure to students who intend to pursue Master Degree in Mathematics at the international level.

2.Eligibility and mode of Admission: Any graduate with an aggregate of 50% marks in Mathematics or Applied Mathematics is eligible to apply for admission to the course. Relaxation for SC/ST students will be given as per norms of the Government of Tamil Nadu.

An entrance examination (objective type questions) will be conducted for eligible applicants. The merit list will be prepared with 50% marks for entrance examination and 50% marks for Part III score in B.Sc. Then admission will be based on merit and reservation policy of the Government of Tamil Nadu.

3. SCHEME OF THE EXAMINATION

This program is under Choice Based Credit System of the University and a successful candidate should score a minimum of 90 credits in 4 semesters. Each paper is evaluated for 100 marks with Internal 25 marks and External 75 marks. The internal assessment comprises of 3 components -15 marks for written test (average of the best two of 3 tests), 5 marks for Seminar and 5 marks for Assignment.

The semester Question paper pattern for external examination is as follows :

Section A - 10 x 1 = 10 (no choice)

Section B - 5 x 5 = 25 (Internal choice questions)

Section C - 5 x 8 = 40 (Internal choice questions)

The duration of the examination is 3 hours. In order to train the students for National level examinations and Research, End semester examination question paper for each course shall contain 20% questions from problems and 80% questions from theory in Part B and Part C.

Passing minimum in the external examination is 38 out of 75 (that is 50 %). Passing minimum in the aggregate (internal and external marks put together) is 50 out of 100 (that is 50 %). No passing minimum for the internal marks.

Examination, evaluation and classification will be made as per the rules and regulations of the University in force.

Semester	Course Code	Paper Title	Hours Per Week	Exam Hours	Credits	Marks		
						Internal	External	Total
I	1	GROUP THEORY	4	3	4	25	75	100
	2	ANALYSIS I	4	3	4	25	75	100
	3	ORDINARY DIFFERENTIAL EQUATIONS	4	3	4	25	75	100
	4	NUMBER THEORY	4	3	4	25	75	100
	5	ELECTIVE I	3	3	3	25	75	100
	6	PRACTICAL	2	3	2	25	75	100
II	1	RINGS AND MODULES	4	3	4	25	75	100
	2	ANALYSIS II	4	3	4	25	75	100
	3	GRAPH THEORY	4	3	4	25	75	100
	4	PROBABILITY AND STATISTICS	4	3	4	25	75	100
	5	ELECTIVE II	3	3	3	25	75	100
	6	SUPPORTIVE COURSE I	3	3	3	25	75	100
III	1	TOPOLOGY	4	3	4	25	75	100
	2	COMPLEX ANALYSIS	4	3	4	25	75	100
	3	LINEAR ALGEBRA	4	3	4	25	75	100
	4	MEASURE THEORY AND INTEGRATION	4	3	4	25	75	100
	5	ELECTIVE III	3	3	3	25	75	100
	6	SUPPORTIVE COURSE II	3	3	3	25	75	100
IV	1	FUNCTIONAL ANALYSIS	4	3	4	25	75	100
	2	DIFFERENTIAL GEOMETRY	4	3	4	25	75	100
	3	FIELD THEORY AND LATTICES	4	3	4	25	75	100
	4	COMBINATORIAL THEORY	4	3	4	25	75	100
	5	ELECTIVE VII	3	3	3	25	75	100
	6	PROJECT	4	-	6	25	75	100
		TOTAL			**90**			**2400**

INTERNAL - Continuous Internal Assessment External – End Semester Examination

.**LIST OF ELECTIVE PAPERS**

1. Programming in C++
2. Partial Differential Equations

3. Design and Analysis of Algorithms

4. Calculus of variations and Integra Equations
5. Mechanics

6. Representation theory of finite groups

7. Coding Theory
6. Graph Algorithms

8.MATLAB Programming

9. Cryptography

10. Numerical Analysis

SUPPORTIVE COURSE FOR OTHER DEPARTMENT STUDENTS

1. Numerical Methods
2. Introduction to Mathematical Biology
3. Discrete Mathematics
4. Mathematics for Competitive Examinations

First Semester

1. Group Theory

Unit I: Introduction to groups – Dihedral groups –Symmetric groups – Matrix groups- The Quaternion group - Homomorphisms and Isomorphisms – Group actions.

Unit II: Subgroups: Definition and Examples – Centralizers and Normalizer, Stabilizers and Kernels - Cyclic groups and Cyclic subgroups of a group – Subgroups generated by subsets of a group - Quotient Groups and Homomorphisms: Definitions and Examples – more on cosets and Lagrange's Theorem.

Unit III: The isomorphism theorems - Transpositions and the Alternating group -Group Actions: Group actions and permutation representations – Groups acting on themselves by left multiplication- Cayley's theorem. Groups acting on themselves by conjugation – The class equation - Automorphisms.

Unit IV: The Sylow theorems – The simplicity of A_n – Further topics in group theory: p-groups, Nilpotent groups and Solvable groups – Applications in groups of Medium order.

Unit V: Direct and semi-direct products and abelian groups: Direct Products – The fundamental theorem of finitely generated abelian groups – Table of groups of small order – semi direct products.

Text Book: Abstract Algebra (Second Edition) by **David S. Dummit and Richard M. Foote**, Wiley Student Edition (1999),

Unit 1: Chapter 1: (Sections 1.2, 1.3. 1.4, 1.5, 1.6, and 1.7)
Unit 2: Chapter 2: (Sections 2.1, 2.2, 2.3, 2.4) and Chapter 3: (Sections 3.1, 3.2)
Unit 3: Chapter 3: (Sections 3.3, 3.5) and Chapter 4: (Sections 4.1, 4.2, 4.3, 4.4)
Unit 4: Chapter 4: (Sections 4.5, 4.6) and Chapter 6: (Sections 6.1, 6.2)
Unit 5: Chapter 5: (Sections 5.1, 5.2, 5.3, 5.4, 5.5)

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2. Analysis – I

Unit I: Basic Topology: Finite, Countable and uncountable sets – Metric Spaces – Compact Sets – Perfect sets – Connected Sets.

Unit II: Numerical sequences and series: Convergent sequences – Subsequences – Cauchy sequences – Upper and lower limits – Some special sequences - Series – Series of nonnegative terms.

Unit III: The number e – The root and ratio tests – Power series – Summation by parts – Absolute convergence - Addition and multiplication of series – Rearrangements.

Unit IV: Continuity: Limits of functions – Continuous functions – Continuity and compactness – Continuity and connectedness - Discontinuities – Monotonic functions – Infinite limits and limits at infinity.

Unit V: Differentiation: The Derivative of a real function – Mean value theorems - The continuity of derivatives – L'Hospital's rule – Derivatives of Higher order – Taylor's theorem – Differentiation of vector valued functions.

Text Book: Principles of Mathematical Analysis (Third edition) by **Walter Rudin**, McGraw Hill, 1976. Chapters 2, 3, 4 and 5.

3. Differential Equations

Unit I: Linear equations with constant co-efficients – Introduction - Second Order non-homogeneous Equations –Initial value problems – linear dependence and independence – formula for Wronskian.

Unit II: Nonhomogeneous equations of order two - Homogeneous and Non-homogeneousequations of order n –Initial value problems – annihilator method to solve anon-homogeneous equation.

Unit III: Linear equations with variable co-efficents – Initial value problems for the homogeneous equation – solution of the homogeneousequations –Wronskian and linear independence – reduction of the order of a homogeneous equation irst order.

Unit IV: Linear equations with regular singlular points–Euler equation – Second order equations with regular singular points – solutions and properties of Legendre and Bessles equation.

Unit V: Existence and uniqueness of solutions of first order equations –introduction – Equations with variables separated – Exact equations – method of successive approximations – Lipschitz condition – convergence of successive approximations.

Text Book E.A.Codington, An introduction to Ordinary Differential Equations, Prentice Hall of India, New Delhi, 2007. Chapter 2 (Sections 1-8, 10 &11), Chapter 3 (Sections 1-5 & 8) Chapter 4 (Sections1-5) Chapter 5 (Sections 1-6)

4. Number Theory

Unit I: Divisibility and Congruence: Divisibility, Primes, Congruence.

Unit II: Solutions of congruence – the Chinese Remainder theorem-Congruence of degree two, the function $\varphi(n)$ - Congruence of higher degree.

Unit III: Congruence and Quadratic Reciprocity: Prime power Moduli - Prime modulus-congruence of degree two - Power Residues - Quadratic residues - Quadratic reciprocity-The Jacobi symbol.

Unit IV: Some functions of number theory: Greatest integer function - Arithmetic functions -The Moebius inversion formula -The multiplication of Arithmetic functions - Recurrence functions.

Unit V: Primes and Multiplicative Number Theory: Elementary prime number estimates – Dirichlet series – Estimates of arithmetic functions.

Text Book : Content and treatment as in **An Introduction to the Theory of Numbers**, by Ivan Niven and H. S. Zuckerman, Fifth Edition, Wiley Eastern Limited, New Delhi,1994.

Chapter 1(Sections 1 to 3), Chapter 2 (Sections 1 to 3, 5 to 9), Chapter 3 (Sections 1 to 3) Chapter 4 (Sections 1 to 4) and Chapter 8 (Sections1 to 3).

5. Elective – I

6. Practical

Second Semester

1. Rings and modules

Unit I: Introduction to Rings: Examples: Polynomial rings- Matrix rings and group rings -Ring Homomorphisms and quotient rings - Properties of Ideals - Rings of fractions.

Unit II: The Chinese remainder theorem – Euclidean domains, principal ideal domains and unique factorization domains: Euclidean domain - Principal ideal domains.

Unit III: Unique factorization domains - Polynomial rings: Definitions and basic properties – Polynomial rings over fields.

Unit IV: Polynomial rings that are unique factorization domains – Irreducibility criteria – Polynomial ring over fields.

Unit V: Introduction to Module Theory: Basics definitions and examples – Quotient modules and Module homomorphism – Generation of modules, Direct sums, and free modules.

Text Book: Abstract Algebra (Second Edition) by **David S. Dummit and Richard M. Foote**, Wiley Student Edition (1999),

Unit 1: Chapter 7: (Sections 7.2, 7.3. 7.4, 7.5 and 1.6)
Unit 2: Chapter 7: (Sections 7.6) and Chapter 8: (Sections 8.1, 8.2)
Unit 3: Chapter 8: (Section 8.3) and Chapter 9: (Sections 9.1, 9.2)
Unit 4: Chapter 9: (Sections 9.3.5, 9.4, 9.5)
Unit 5: Chapter 10: (Sections 10.1, 10.2, 10.3)

2. **Analysis – II**

Unit I: The Riemann-Stielitjes integral: Definition and existence of the integral- Properties of the integral - Integration and Differentiation - Integration of vector - Valued functions-Rectifiable Curves.

Unit II: Sequences and Series of functions: Discussion of Main problem - Uniform convergence - Uniform convergence and continuity-Uniform convergence and Integration.

Unit III: Uniform convergence and differentiation- Equicontinuous families of functions-The Stone-Weierstrass theorem.

Unit IV: Functions of Several Variables: Linear transformations - Differentiation -The Contraction Principle –The Inverse function theorem-The Implicit function theorem.

Unit V: Determinants - Derivatives of higher order – Differentiation of Integrals -Integration of Differential forms: Integration - Primitive Mappings-Partitions of unity - Change of Variables.

Text Book: Principles of Mathematical Analysis (Third Edition) by **Walter Rudin,** Mc Graw Hill, 1976, Chapters 6, 7, 9 (except 9.1-9.5, 9.30, 9.31 and 9.32) and Chapter 10 (10.1 to 10.9 only).

3. Graph Theory

Unit I: Graphs - Graph isomorphism-Incidence and adjacency matrices – Subgraphs - Vertex degrees - Path and Connection cycles -Trees - Cut edges and bonds - Cut vertices - Cayley's formula.

Unit II: Connectivity - Blocks - Euler tours – Hamilton cycles.

Unit III: Matchings - Matching and coverings in bipartite graphs-Perfect matchings –. Edge colorings: Edge chromatic number - Vizing's theorem.

Unit IV: Independent sets-Ramsey's theorem-Vertex colorings: Chromatic number-Brook's theorem-Hajos' conjecture-Chromatic polynomials-Girth and chromatic number.

Unit V: Plane and planar graphs -Dual graphs-Euler's formula- The Five Color theorem and The Four Color conjecture -Directed graphs.

Text Book: Graph Theory with Applications by **J.A.Bondy and U.S.R.Murty**, The Macmillan Press Ltd, (1976)Sec. 1.1 - 1.7 2.1 - 2.4, Sec.3.1 &3.2, 4.1& 4.2, Sec. 5.1- 5.3, 6.1 &6.2, Sec. 7.1, 7.2, 8.1 – 8.5, Sec,9.1 - 9.3 & 9.6 and 10.1.

4. Probability and Statistics

Unit I: The probability set function – Random variables – Probability density function – Distribution function – Mathematical expectation – Special mathematical expectations – Chebyshev's Inequality.

Unit II: Conditional probability – Marginal and conditional distributions – Stochastic independence Some special distributions: The Binomial, Trinomial and Multinomial distributions – The Poisson distribution.

Unit III: The Gamma and Chi-Square Distributions – The Normal distribution- The Bivariate normal distribution. Distributions of functions of random variables - Sampling theory – Transformations of variables of the discrete type – Transformations of variables of the continuous type.

Unit IV: The β, t and F distributions- Distributions of order statistics- The moment generating function technique. The distributions of $\overline{X}$ and nS^2/σ^2 - Expectations of functions of random variables.

Unit V: Limiting distributions, Stochastic convergence- Limiting moment generating functions – The Central limit theorem – Some theorems on limiting distributions.

Text Book: Introduction to Mathematical Statistics (Fourth Edition) by Robert V. Hogg and Allen T. Craig. Chapters 1, 2 (except 1.1, 1.2, 1.3, 1.8 and 2.3), Chapters 3, 4 (except 4.5) and Chapter 5.

5. Elective – II

6. Supportive course

Third Semester

1. Topology

Unit I: Topological spaces - Basis for a topology – The order topology – The product topology on X x Y – The subspace topology - Closed sets and limit points - Continuous functions.

Unit II: The product topology – connected spaces, components and local connectedness.

Unit III: Compact spaces - Local compactness.

Unit IV: The Countability axioms – The Separation axioms - Normal spaces.

Unit V: The Uryshon lemma- The Tietze Extension theorem - Tychonoff theorem .

Text Book: Topology (second edition) by **J. R. Munkres**, Pearson Prentice hall, (2000), Sections 12 to 19, 23, 25, 26, 29 to 33, 35 and 37.

2. Complex Analysis

Unit I: Analytic Functions-Power Series.

Unit II: Conformality -Linear Transformation - Elementary Conformal mapping.

Unit III: Fundamental Theorems-Cauchy's Integral formula-Local properties of Analytic Functions.

Unit IV: General form of Cauchy's theorem (except proof of Cauchy's theorem) -Calculus of Residues – Harmonic functions.

Unit V: Power Series Expansions – Partial fractions and factorizations.

Text Book: Complex Analysis (Third edition) by **Lars V. Ahlfors**, MacGraw Hill, 1979, Chapters 2 to 4 (except section 4.5) and Chapter 5 (Sections 5.1, 5.2 (except 5.2.4and 5.2.5)).

3. Linear Algebra

Unit I : Systems of linear Equations – Matrices and Elementary Row operations – Row - Reduced echelon Matrices – Matrix Multiplication – Invertible Matrices – Vector spaces – Subspaces – Bases and Dimension – Computations concerning Subspaces.

Unit II : The algebra of linear transformations – Isomorphism of Vector Spaces – Representations of Linear Transformations by Matrices - Linear Functionals - The Double Dual – The Transpose of a Linear Transformation.

Unit III : Commutative rings – Determinant functions – Permutations and the uniqueness of determinants – Classical Adjoint of a (Square) matrix – Inverse of an invertible matrix using determinants.

Unit IV: Characteristic values – Annihilating polynomials, Invariant subspaces.

Unit V: Simultaneous triangulation and simultaneous Diagonalization – Direct-sum Decompositions - Invariant Direct sums – The Primary Decomposition Theorem.

TEXT BOOK : Kenneth Hoffman and Ray Kunze, **Linear Algebra**, Second Edition, Prentice – Hall of India Private Limited, New Delhi :1975.

Chapters 1 to 3, Chapter 5 (5.1 to 5.4) and Chapter 6.

4. Measure Theory and Integration

Unit I: Lebesgue Measure: Introduction-Outer measure-Measurable sets and Lebesgue measure- The non-measurable set - Measurable functions-Littlewood's three principles.

Unit II: The Lebesgue Integral: The Riemann integral-The Lebesgue integral of a bounded function over a set of finite measure-The integral of a nonnegative function-The general Lebesgue integral.

Unit III: Differentiation and Integration: Differentiation of monotone functions-Functions of bounded variation-Differentiation of an integral-Absolute continuity.

Unit IV: Measure and Integration-Measure spaces-Measurable functions-Integration-Signed measures-The Radon-Nikodym theorem.

Unit V: Measure and Outer Measure: Outer measure and measurability-The Extension Theorem-Product measures.

Text Book: Real Analysis by H.L. Royden,Third Edition, Macmillan, New York, 1988

Chapters 3,4 (except 4.5),5 (except 5.5),11(except 11.4 and 11.7) and 12 (Sections 12.1, 12.2 and 12.4 only).

5. Elective – III

6. Supportive course – II

Fourth Semester

1. Functional Analysis

Unit I : Normed Spaces, Banach Spaces – Further properties of normed spaces – finite dimensional normed spaces and Compactness - Linear operators – bounded linear operators .

Unit II : Linear functionals – linear operators and functionals on finite dimensional spaces – normed spaces of operators and dual spaces - Inner product space, Hilbert space – Further properties of inner product spaces.

Unit III : Orthogonal complements and direct sums – Orthonormal sets and sequences – series related to orthonormal sets and sequences – Total orthonormal sets and sequences – Representation of functionals on Hilbert spaces – Hilbert Adjoint operator - self adjoint operators, unitary and normal operators.

Unit IV : Hahn-Banach theorem for complex vector spaces and normed spaces – Adjoint operator - Self adjoint, Unitary and Normal operators - reflexive spaces – Uniform boundedness theorem.

Unit V : Strong and weak convergence – Convergence of sequences of operators and functional - Open mapping theorem - Closed graph theorem.

Text Book : Introductory Functional Analysis with Applications by **Erwin Kreyszig**, John Wiley & Sons Publication (2006). Chapter 2, Chapter 3 (except 3.7) and Chapter 4 (except 4.4, 4.10 and 4.11).

2. Differential Geometry

Unit I: Graphs and Level sets - Vector fields-Tangent space.

Unit II: Surfaces - Vector field on surfaces.

Unit III: Gauss map - Geodesics.

Unit IV: Parallel Transport - Weingarten map.

Unit V: Curvature of plane curves-Curvature of surface - Arc length and Line Integrals.

Text Book: Elementary topics in Differential Geometry by A. Thorpe, Chapters 1 to 12.

3. Field Theory and Lattices

Unit I: Field theory: Basic Theory of field extensions - Algebraic Extensions.

Unit II: Splitting fields and Algebraic closures - Separable and inseparable extensions - Cyclotomic polynomials and extensions.

Unit III: Galois Theory: Basic definitions - The fundamental theorem of Galois Theory - Finite Fields.

Unit IV: Composite extensions and simple extensions - Cyclotomic extensions and abelian extensions over Q.

Unit V: Lattices and Boolean algebra - posets – semilattices – sublattices -distributive lattices – modular lattices.

Text Book:

1. Abstract Algebra (Second Edition) by **David S. Dummit and Richard M. Foote**, Wiley Student Edition (1999) for Units I to IV.
2. Applied Modern Algebra, by Birkhoff and Bartee for Unit V

Unit I: Chapter 13: (Sections 13.1, 13.2)
Unit II: Chapter 13: (Sections 13.4,13.5, 13.6)
Unit III: Chapter 14: (Sections 14.1,14.2, 14.3)
Unit IV: Chapter 14: (Sections 14.4, 14.5)
Unit V: Chapter 9 (Sections 9.1- 9.6)

4. Combinatorial Theory

Unit I: Permutations and Combinations - rule of sum and product – distributions of distinct objects – Distributions of non-distinct objects.

Unit II - Generating functions for combinations – Enumerators for permutations – Distributions of distinct objects into non-distinct cells – partitions of integers – Ferrers graph – elementary relations.

Unit III: Recurrence relations – Linear recurrence relations with constant co-efficients – solution by the technique of generating functions – a special class of non-linear difference equation - recurrence relations with two indices.

Unit IV: The principle of inclusion and exclusion – general formula – derangements – rook polynomials – permutations with forbidden positions.

Unit V: Polya's theory of counting Equivalence classes under a permutation groups – Equivalence classes of functions – Weights and inventories of functions – Polya's fundamental theorem – Generalization of Polya's theorem. .

Text Book: Introduction to Combinatorial Mathematics by C.L. Liu, McGraw Hill(1968) Chapters 1 to 5.

5. Elective – IV

6. Project

Syllabus for Elective Papers

1. Programming in C++

Unit I: Tokens, Expressions and Control structures-Functions in C++.

Unit II: Classes and Objects.

UnitIII: Constructors and Destructors- Operator overloading and type conversions.

Unit IV: Inheritance: Extending classes-Pointers, \virtual Functions and Polymorphism.

Unit V: Working with files.

Text Book: Objected Oriented Programming with C++ by E. Balagurusamy (Third Edition), Chapters 3 to 9 and 11.

2. Partial Differential Equations

Unit I : Non-linear partial differential equations of the first order – Cauchy's method of characteristics – compatible system of first order equations –Charpits method –special types of first order equations –Jacobi'smethod.

Unit II: Partial differential equations of second order – the origin of second orderequations – linear partial differential equations with constant co-effieients – Equations with variable coefficients –Characteristic curves of second order equations –characteristics of equations in three variables.

Unit III: The solution of linear hyperbolic equations – separation of variables – the method of integral transform – non-linear equations of the second

Unit IV: Laplace's equation – the occurrence of Laplace's equation in Physics – Elementary solutions of Laplace's equation – Families of equipotential surfaces Boundary value problems – separation of variables – Problems with axial symmetry.

Unit V: The wave equation: the occurrence of wave equation in Physics – elementary solutions of the one dimensional wave equation –Vibrating membranes: Applications of the calculus of

variations – three dimensional problems. The diffusion equations: Elementary solutions of the diffusion equation – separation of variables – the use of integral transform

Text Book:

Ian N. Sneddon, Elements of Partial Differential Equations, International edition, McGraw Hill, Singapore 1957.
Chapter 2 (Sections7-11 &13), Chapter 3 Sections 1,4- 11) Chapter 4 (Sections 1-6), Chapter5 (Section 1,2,4 &5), Chapter 6 (Sections 3-5)

3. MATLAB Programming

Unit I: MATLAB ENVIRONMENT: MATLAB windows - Variables - Working with Matrices - Saving Variables - Script M-files. PREDEFINED MATLAB FUNCTIONS: Elementary Math functions - Trigonometric functions - Data analysis functions - Defining matrices - Using the colon operator - Special values and functions.

Unit II: PLOTTING: Two dimensional plots - Basic plotting - Line, color, and mark style- Axes scaling - Other types of two dimensional plot - Three dimensional plotting - Three dimensional line plot - Surface plots.

Unit III: PROGRAMMING IN MATLAB: Problems with two variables - Input/output - User defined Input - Output options - Functions - Statement level control structures - Relational and logical operators – Loops.

Unit IV: MATRIX COMPUTATIONS: Matrix operations and functions -Solutions to system of linear equations - Special Matrices. SYMBOLIC MATHEMATICS: Symbolic Algebra - Equation Solving - Differentiation and Integration.

Unit V: NUMERICAL TECHNIQUES: Interpolation - Numerical Integration - Numerical Differentiation.

Text Books: Delores M. Etter, David C. Kuncicky and Holly Moore, Introduction to MATLAB, Dorling Kindersley (India) Pvt. Ltd. New Delhi (2009).

Sec. 1.1 - 1.5, Sec. 2.1 to 2.7, Sec. 3.1 - 3.9, Sec. 4.1 - 4.9Sec. 5.1 - 5.3, Sec. 6.1 - 6.3,Sec. 7.1 - 7.3.

4. Design and Analysis of Algorithms

Unit I: Growth of functions-Recurrences

Unit II: Heap sort- Quick sort.

Unit III: Elementary data structures-Binary search trees-Red black trees.

Unit IV: Elementary graph algorithms-Minimum spanning trees.

Unit V: Single source shortest paths–All-pairs shortest paths.

Text Book: Introduction to Algorithms by Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein, Chapters 3 , 4, 6 (6.1 to6.4) 7 (7.1, 7.2), 10 (except 10.3), 12 (12.1-12.3), 13, 22, 23, 24 (except 24.5) and 25.

5. Numerical Analysis

Unit I: Number Systems and Errors: The Representation of Integers-The Representation of Fractions-Floating point arithmetic- Loss of Significance and Error Propagation – Computational Methods for error estimation-Some comments on convergence of sequences-Some mathematical preliminaries

Unit II: Interpolation by polynomials: Polynomial forms- Existence and Uniqueness of the Interpolating polynomial-The divided difference table- The error of the interpolating polynomial-Interpolation in a function table based on equally spaced points.

Unit III: The solution of nonlinear equations: A survey of iterative methods-Fixed point iteration-Polynomial Equations: Real roots-Complex roots and Muller's Method.

Unit IV: Matrices and Systems of Linear equations: The solution of linear systems by elimination-The pivoting strategy - The triangular factorization.

Unit V: Differentiation and Integration: Numerical differentiation-Numerical Integration: Some basic rules-Composite rules.

Text Book: Elementary Numerical Analysis-An algorithmic approach by Samuel D. Conte and Carl de Boor, Sections 1.1 to 1.7, 2.1 to 2.3, 2.5, 2.6, 3.1, 3.3, 3.6, 3.7, 4.2 to 4.4, 7.1, 7.2 and 7.4.

6. Mechanics

Unit I: Statics in space.

Unit II: Kinematics, Kinetic Energy and Angular Momentum.

Unit III: Methods of Dynamics in space.

Unit IV: Applications in Dynamics in space-Motion of a particle.

Unit V: Applications in Dynamics in space-Motion of a rigid body.

Text Book: Principles of Mechanics by John A. Synge and Byron A. Griffith, Chapters 10 to 14.

7. Representation Theory of finite groups

Unit I: Foundations: Introduction – Group characters – Representation modules – Regular representation. Representation theory of rings with identity: Some fundamental lemmas.

Unit II: The principle indecomposable representations – The radical of a ring – Semi-simple rings – The Wedderburn structure theorems for semi-simple rings – Interwining numbers.

Unit III: Multiplicities of the indecomposable representation – The generalized Burnside theorem. The representation theory of finite groups: The group algebra – The regular representation of a group- Semi-simplicity of the group algebra- The centre of the group algebra.

Unit IV: The number of in-equivalent irreducible representations – relations on the irreducible characters – The module of characters over the integers – The Kronecker product of two presentations – Linear characters – Induced representations and induced characters.

Unit V: Applications of the theory of characters: Algebraic numbers – Some results from the theory of characters – Normal subgroups and the character table – Some classical groups.

Text book: Representation Theory of Finite groups by Martin Burrow, Chapters 1(except section 4), 2, 3, and 4.

8. Coding Theory

Unit I: Mathematical Background: Algebra – Krawtchouk Polynomials – Combinatorial theory- Shannon's Theorem: Introduction - Shannon's Theorem.

Unit II: Linear codes: Block codes – Linear codes – Hamming codes - Majority logic decoding – Weight Enumerators – The Lee metric.

Unit III: Some good codes: Hadamard codes and generalizations – The binary Golay code – The ternary Golay code- Constructing codes from other codes - Reed-Muller code – Kerdock codes.

Unit IV:. Bound on codes: The Gilbert bound – Upper bounds – Cyclic codes: Definitions- Generator matrix and check polynomial – Zeros of a cyclic code.

Unit V: The idempotent of a cyclic code – Other Representations of cyclic codes – BCH codes – Decoding BCH codes- Binary cyclic codes of length 2n (n odd).

Text Book: Introduction to Coding Theory by J. H. Van Lint, Chapters 1 (except 1.4), 2 (Sections 2.1 and 2.2 only), 3, 4, 5 (except 5.3), and Chapter 6 (except 6.8, 6.9 and 6.11).

9. Graph Algorithms

Unit I: An introduction to algorithms: Algorithmic complexity. Trees: Depth-First search- DFS: a tool for finding blocks – Breath - First search.

Unit II: Minimum spanning tree problem - Paths and Distance in graphs: Distance in graphs – Distance in weighted graphs.

Unit III: Matchings and factorizations : An introduction to matching – Maximum Matchings in bipartite graphs – Maximum matchings in general graphs.

Unit IV: Eulerian graphs : An introduction to Eulerian graphs – Characterizing Eulerian graphs again – The Chinese Postman problem – Eulerian Digraphs.

Unit V: Hamiltonian graphs: An introduction to Hamiltonian graphs – Characterizing Hamiltonian graphs- The Travelling salesman problem

Text Book: Applied and Algorithmic Graph Theory by Gary Chartrand and Ortrud R. Oellermann, Sections 2.1, 3.2 - 3.6, 4.1, 4.2, 6.1 - 6.3, 7.1 - 7.4, 8.1 to 8.3.

10. Cryptography

Unit I: Euclidian Algorithm, Extended Euclidian Algorithm and itsefficiency for huge numbers. Factoring in primes. Congruences and Residue Class Rings, Order of group elements, Multiplicative group of residues mod n (large). Euler-FermatTheorem, Fast Exponentiation.(Chapter 1 & 2).

Unit II: Encryption, Symmetric and Asymmetric Cryptosystems, Linear Block Ciphers and its Crypto analysis.Probability and Perfect Secrecy, One-Time-Pad.Prime Number Generation with probabilistic algorithm for huge primes: Fermat Test, Carmichael Numbers, Miller-Rabin-Test. (Chapters 3, 4 & 7).

Unit III: Public Key Encryption: Idea, Security, RSA-Cryptosystem, Diffie-Hellmann Key Exchange. (Chapter 8).

Unit IV: Cryptographic Hash functions, Compression functions: Birthday attack, Message Authentification Code (MAC) (Chapter 11)

Unit V: Digital Signatures: Idea, Security, RSA signatures. Elliptic curves over a finite field. (Chapters 12 & 13).

Text Book : Johannes A. Buchmann, Introduction to Cryptography, Second edition, Springer, 2001.

11. Calculus of Variations and Integral Equations

Unit I: Calculus of Variations and Applications: Maxima and Minima - The Simplest case-Illustrative examples-Natural boundary conditions and transition conditions – The variational notation-The more general case.

Unit II: Constraints and Lagrange multipliers-Variable end points - Sturm- Liouville problems-Hamilton's principle-Lagrange's equations

Unit III: Integral Equations: Introduction – Relations between differential and integral equations – The Green's function – Alternative definition of the Green's function.

Unit IV: Linear equation in cause and effect: The influence function – Fredholm equations with separable kernels – Illustrative example.

Unit V: Hilbert – Schmidt theory – Iterative methods for solving equations of the second kind – Fredholm theory.

Text Book: Methods of Applied Mathematics by Francis B. Hildebrand (Second Edition) Sections 2.1 to 2.11, 3.1 to 3.9 and 3.11.

Syllabus for Practical

List of programs for Practical (Programming in C++)

1. Programs to evaluate sin x, cos x, e^{-x} to 0.0001% accuracy.
2. Program to calculate the variance and standard deviation of a set of numbers.
3. Program to find product of matrices, inverse of a matrix using functions.
4. Macro that obtains largest of three numbers.
5. Define a class of students and prepare a statement containing name, total marks of Ranks(using functions).
6. Program to check whether a number/ string is a palindrome without using the corresponding standard function.
7. Define a class string and exhibit the use of string manipulations.
8. Create a class FLOAT that contains one float data. Overload all the four arithmetic operators so that they operate on the objects of FLOAT.

9. Define a class String. Use overload = = operator to compare two strings.
10. Program to illustrate interpolation of constructors when the classes are inherited.
11. Program to illustrate multilevel and multiple inheritance.
12. Program using array of functions.
13. Program using function pointers.
14. Create a data file showing how to add a new item to the file, how to modify the details of an item and how to display the contents of the file.
15. Program that reads a text file and creates another file that is identical except that every sequence of consecutive blank spaces is replaced by a single space.

Syllabus for Supportive Course

(for other Department students)

1.Numerical Methods

Unit I: Introduction: Errors in numerical calculations – Mathematical preliminaries – Solution of Algebraic and Transcendental equations: The Bisection method – The method of false position.

Unit II: Newton-Raphson method – Introduction - The Iteration method - Muller's method – Graffes' root squaring method

Unit III: Interpolation: Newton's Formulae for interpolation – Central difference interpolation formulae.

Unit IV: Numerical Differentiation and integration: Numerical differentiation – Numerical integration

Unit V: Matrices and Linear systems of equations: Solution of Linear systems – Iterative methods - The Eigen value problem

Text Book: Introductory Method of Numerical Analysis (Third Edition) by S.S. Sastry, Sections 1.3, 2.1 to 2.5, 2.7, 2.8, 3.6, 3.7, 5.2, 5.4(5.4.1 to 5.4.3 only), 6.4 and 6.5.

2. Introduction to Mathematical Biology

Unit I: Cell growth-Exponential growth and Decay – Determination of growth or decay rates-The method of least squares – Nutrient Uptake by a cell –Inhomogeneous Differential equations.

Unit II: Growth of a Microbial colony – Growth in a Chemo stat – Interacting Populations – Mutation and Reversion in Bacterial growth.

Unit III: Enzyme Kinematics: The Michaelis – Menton Theory – Enzyme Substrate – Inhibitor system – Cooperative dimmer – Allosteric enzymes – Other alloseteric theories.

Unit IV: The Cooperative dimmer – Allosteric enzymes – Other alloseteric theories.

Unit V: Hemoglobin – Graph theory and Steady state Enzyme Kinetics – Enzyme – Substrate – Modifier system – Enzyme Substrate – Activator system.

Text Book: Introduction Mathematical Biology by S.I. Rubinow (Dover publications), Chapter I and Chapter 2 (Sections 2.1,2.3, to 2.11).

3. Discrete Mathematics

Unit I: Sets and Relations.

Unit II: Functions.

Unit III: Logic

Unit IV: Algebra of propositions.

Unit V: Boolean algebra.

Text Book: Seymour Lipschutz and Marc Lipson, Discrete Mathematics (Second Edition, 1999), Chapter 1 - 4, and 15.

4. Mathematics for Competitive Examinations

Unit I: Problems on Ages – Percentage.

Unit II: Profit and Loss – Ratio and Proportion.

Unit III: Time and Work – Simple Interest.

Unit IV: Compound Interest – Calendar.

Unit V: Stocks and Shares – Bankers' Discount.

Text Book: Quantitative Aptitude by R.S. Aggarwal (Edition 1996), Chapters 8, 10 to 12, 15, 21, 22, 27, 29 and 31.

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