THIRUVALLUVAR UNIVERSITY
MASTER OF SCIENCE
DEGREE COURSE
M.Sc. MATHEMATICS
UNDER CBCS
(with effect from 2017 - 2018)

The Course of Study and the Scheme of Examinations

S.NO.	Study Components		Ins. hrs /week	Credit	Title of the Paper	Maximum Marks		
	Course Title							
	SEMESTER I					**CIA**	**Uni. Exam**	**Total**
1	MAIN	Paper-1	6	5	Algebra I	25	75	100
2	MAIN	Paper-2	6	5	Real Analysis I	25	75	100
3	MAIN	Paper-3	6	4	Ordinary Differential Equations	25	75	100
4	MAIN	Paper-4	6	5	Differential Geometry	25	75	100
5	ELECTIVE	Paper-1	6	3	**(to choose 1 out of 4)** A. Finite Element Method B. Discrete Mathematics C. Graph Theory D. Reliability & Queueing Theory	25	75	100
			30	**22**		**125**	**375**	**500**
	SEMESTER II					**CIA**	**Uni. Exam**	**Total**
6	MAIN	Paper-5	5	4	Algebra II	25	75	100
7	MAIN	Paper-6	6	5	Real Analysis II	25	75	100
8	MAIN	Paper-7	6	5	Partial Differential Equations	25	75	100
9	MAIN	Paper-8	6	4	Mechanics	25	75	100
10	**Compulsory Paper**		2	2	**Human Rights**	25	75	100
11	ELECTIVE	Paper-2	5	3	**(to choose 1 out of 4)** A. *Programming in C++ - Practical B. Fuzzy Mathematics C. Calculus of Variations and Integral Equations D. Mathematical Modelling	25	75	100
			30	**23**		**150**	**450**	**600**

SEMESTER III						CIA	Uni. Exam	Total
12	MAIN	Paper-9	6	5	Complex Analysis I	25	75	100
13	MAIN	Paper-10	6	5	Topology	25	75	100
14	MAIN	Paper-11	6	5	Operations Research	25	75	100
15	MAIN	Paper-12	6	5	Probability Theory	25	75	100
16	ELECTIVE	Paper-3	6	3	**(to choose 1 out of 4)** A. Tensor Analysis and Relativity Theory B. Analytic Number Theory C. Fluid Dynamics D. Algebraic Topology	25	75	100
			30	**23**		**125**	**375**	**500**
SEMESTER IV						**CIA**	**Uni. Exam**	**Total**
17	MAIN	Paper-13	6	5	Complex Analysis II	25	75	100
18	MAIN	Paper-14	6	5	Functional Analysis	25	75	100
19	MAIN	Paper-15	6	5	Mathematical Statistics	25	75	100
20	MAIN	Paper-16	6	4	Difference Equations	25	75	100
21	ELECTIVE	Paper-4	6	3	**(to choose 1 out of 4)** A. Number Theory and Cryptography B. Algebraic Number Theory C. Stochastic Processes D. *Mathematical Softwares – Practical	25	75	100
			30	**22**		**125**	**375**	**500**

***Programming in C++ and Mathematical Software Practical's:**

External = 75 Marks = 60 (Practical) + 15 (Record)

Internal (CIA) = 25 Marks = 20 (Test) + 5 (Observation)

Subject	Papers	Credit	Total Credit	Marks	Total Marks
Main	16	4 - 5	76	100	1600
Elective	4	3	12	100	400
Compulsory Paper	1	2	2	100	100
Total	**21**	**---**	**90**	**---**	**2100**

THIRUVALLUVAR UNIVERSITY
M.Sc. MATHEMATICS
SYLLABUS
UNDER CBCS
(with effect from 2017 - 2018)
SEMESTER - I
PAPER - 1
ALGEBRA - I

Objectives : To introduce the concepts and to develop working knowledge on class equation, finite abelian groups, linear transformations, real quadratic forms.

UNIT-I

Another counting principle - class equation for finite groups and its applications - Sylow's theorems (For theorem 2.12.1, Only First proof).

Chapter 2: Sections 2.11 and 2.12

UNIT-II

Direct products - Finite abelian groups- Modules

Chapter 2: Sections 2.13 and 2.14 (Only Theorem 2.14.1)
Chapter 4: Section 4.5

UNIT-III

Linear Transformations: Canonical forms - Triangular form - Nilpotent transformations.

Chapter 6: Sections 6.4 , 6.5

UNIT-IV

Jordan form - rational canonical form.

Chapter 6 : Sections 6.6 and 6.7

UNIT-V

Trace and transpose - Hermitian, unitary, normal transformations, real quadratic form.

Chapter 6 : Sections 6.8, 6.10 and 6.11

Recommended Text

I.N. Herstein. *Topics in Algebra* (II Edition) Wiley Eastern Limited, New Delhi, 1975.

Reference Books

1. M.Artin, *Algebra,* Prentice Hall of India, 1991.
2. P.B.Bhattacharya, S.K.Jain, and S.R.Nagpaul, *Basic Abstract Algebra* (II Edition) Cambridge University Press, 1997. (Indian Edition)
3. I.S.Luther and I.B.S.Passi, *Algebra*, Vol. I –Groups(1996); Vol. II Rings, Narosa Publishing House , New Delhi, 1999
4. D.S.Malik, J.N. Mordeson and M.K.Sen, *Fundamental of Abstract Algebra*, McGraw Hill (International Edition), New York. 1997.
5. N.Jacobson, *Basic Algebra,* Vol. I & II W.H.Freeman ; also published by Hindustan Publishing Company, New Delhi, 1980.

PAPER - 2
REAL ANALYSIS - I

Objectives : To work comfortably with functions of bounded variation, Riemann - Stieltjes Integration, convergence of infinite series, infinite product and uniform convergence and its interplay between various limiting operations.

UNIT-I : FUNCTIONS OF BOUNDED VARIATION

Introduction - Properties of monotonic functions - Functions of bounded variation - Total variation - Additive property of total variation - Total variation on [a, x] as a function of x - Functions of bounded variation expressed as the difference of two increasing functions - Continuous functions of bounded variation.

Chapter - 6 : Sections 6.1 to 6.8

UNIT-II : THE RIEMANN - STIELTJES INTEGRAL

Introduction - Notation - The definition of the Riemann - Stieltjes integral - Linear Properties - Integration by parts- Change of variable in a Riemann - Stieltjes integral - Reduction to a Riemann Integral - Euler’s summation formula - Monotonically increasing integrators, Upper and lower integrals - Additive and linearity properties of upper and lower integrals - Riemann's condition.

Chapter - 7 : Sections 7.1 to 7.13

UNIT-III : THE RIEMANN-STIELTJES INTEGRAL

Integrators of bounded variation-Sufficient conditions for the existence of Riemann-Stieltjes integrals-Necessary conditions for the existence of Riemann-Stieltjes integrals-Mean value theorems for Riemann - Stieltjes integrals - The integrals as a function of the interval - Second fundamental theorem of integral calculus-Change of variable in a Riemann integral-Second Mean Value Theorem for Riemann integral-Riemann-Stieltjes integrals depending on a parameter-Differentiation under the integral sign.

Chapter - 7 : 7.15 to 7.25

UNIT-IV : INFINITE SERIES AND INFINITE PRODUCTS

Absolute and conditional convergence - Dirichlet's test and Abel's test - Rearrangement of series - Riemann's theorem on conditionally convergent series. Double sequences - Double series - Rearrangement theorem for double series - A sufficient condition for equality of iterated series - Multiplication of series - Cesaro summability - Infinite products.

Chapter 8 : Sections 8.8, 8.15, 8.17, 8.18, 8.20, 8.21 to 8.26

UNIT-V: SEQUENCES OF FUNCTIONS

Pointwise convergence of sequences of functions - Examples of sequences of real - valued functions - Definition of uniform convergence - Uniform convergence and continuity - The Cauchy condition for uniform convergence - Uniform convergence of infinite series of functions - Uniform convergence and Riemann - Stieltjes integration - Uniform convergence and differentiation - Sufficient condition for uniform convergence of a series - Mean convergence.

Chapter - 9 Sec 9.1 to 9.6, 9.8, 9.10,9.11, 9.13

Recommended Text

Tom M. Apostol : *Mathematical Analysis*, 2nd Edition, Addison-Wesley Publishing Company Inc. New York, 1997.

Reference Books

1. Bartle, R.G. *Real Analysis*, John Wiley and Sons Inc., 1976.
2. Rudin,W. *Principles of Mathematical Analysis*, 3rd Edition. McGraw Hill Company, New York, 1976.
3. Malik,S.C. and Savita Arora. *Mathematical Anslysis*, Wiley Eastern Limited.New Delhi, 1991.
4. Sanjay Arora and Bansi Lal, *Introduction to Real Analysis*, Satya Prakashan, New Delhi, 1991.
5. A.L.Gupta and N.R.Gupta, *Principles of Real Analysis*, Pearson Education, (Indian print) 2003.

PAPER - 3
ORDINARY DIFFERENTIAL EQUATIONS

Objectives : To develop strong background on finding solutions to linear differential equations with constant and variable coefficients and also with singular points, to study existence and uniqueness of the solutions of first order differential equations.

UNIT-I : LINEAR EQUATIONS WITH CONSTANT COEFFICIENTS

Second order homogeneous equations-Initial value problems-Linear dependence and independence - Wronskian and a formula for Wronskian -Non-homogeneous equation of order two.

Chapter - 2 : Sections 1 to 6

UNIT-II : LINEAR EQUATIONS WITH CONSTANT COEFFICIENTS

Homogeneous and non-homogeneous equation of order n - Initial value problems-Annihilator method to solve non-homogeneous equation - Algebra of constant coefficient operators.

Chapter - 2 : Sections 7 to 12.

UNIT-III : LINEAR EQUATION WITH VARIABLE COEFFICIENTS

Initial value problems - Existence and uniqueness theorems - Solutions to solve a non-homogeneous equation - Wronskian and linear dependence - reduction of the order of a homogeneous equation - homogeneous equation with analytic coefficients -The Legendre equation.

Chapter - 3 Sections 1 to 8

UNIT-IV : LINEAR EQUATION WITH REGULAR SINGULAR POINTS

Euler equation - Second order equations with regular singular points -Exceptional cases - Bessel Function.

Chapter 4 : Sections 1 to 4 and 6 to 8

UNIT-V: **EXISTENCE AND UNIQUENESS OF SOLUTIONS TO FIRST ORDER EQUATIONS**

Equation with variable separated - Exact equation - method of successive approximations - the Lipschitz condition - convergence of the successive approximations and the existence theorem.

Chapter 5 : Sections 1 to 6

Recommended Text

E.A.Coddington, *An introduction to ordinary differential equations* (3^{rd} Reprint) Prentice-Hall of India Ltd.,New Delhi, 1987.

Reference Books

1. Williams E. Boyce and Richard C. DI Prima, *Elementary differential equations and boundary value problems*, John Wiley and sons, New York, 1967.
2. George F Simmons, *Differential equations with applications and historical notes,* Tata McGraw Hill, New Delhi, 1974.
3. N.N. Lebedev, *Special functions and their applications*, Prentice Hall of India, New Delhi, 1965.
4. W.T. Reid. *Ordinary Differential Equations*, John Wiley and Sons, New York, 1971
5. M.D.Raisinghania, *Advanced Differential Equations*, S.Chand & Company Ltd. New Delhi 2001
6. B.Rai, D.P.Choudary and H.I. Freedman, *A Course in Ordinary Differential Equations,* Narosa Publishing House, New Delhi, 2002.

PAPER - 4
DIFFERENTIAL GEOMETRY

Objectives : This course introduces space curves and their intrinsic properties of a surface and geodesics. Further the non-intrinsic properties of surfaces are explored.

UNIT-I : SPACE CURVES

Definition of a space curve - Arc length - tangent - normal and binormal - curvature and torsion - contact between curves and surfaces - tangent surface - involutes and evolutes - Intrinsic equations - Fundamental Existence Theorem for space curves - Helics.

Chapter I : Sections 1 to 9

UNIT-II : INTRINSIC PROPERTIES OF A SURFACE

Definition of a surface - curves on a surface - Surface of revolution - Helicoids - Metric - Direction coefficients - families of curves - Isometric correspondence - Intrinsic properties.

Chapter II: Sections 1 to 9

UNIT-III : GEODESICS

Geodesics - Canonical geodesic equations - Normal property of geodesics - Existence Theorems - Geodesic parallels

Chapter II: Sections 10 to 14

UNIT-IV : GEODESICS (Contd . . .)

Geodesics curvature - Gauss - Bonnet Theorem - Gaussian curvature - surface of constant curvature.

Chapter II: Sections 15 to 18

UNIT-V : NON INTRINSIC PROPERTIES OF A SURFACE

The second fundamental form - Principal curvature - Lines of curvature - Developable - Developable associated with space curves and with curves on surface - Minimal surfaces - Ruled surfaces.

Chapter III: Sections 1 to 8

Recommended Text

T.J.Willmore, *An Introduction to Differential Geometry,* Oxford University Press,(17th Impression) New Delhi 2002. (Indian Print)

Reference Books

1. Struik, D.T. *Lectures on Classical Differential Geometry*, Addison - Wesley, Mass. 1950.
2. Kobayashi. S. and Nomizu. K. *Foundations of Differential Geometry*, Interscience Publishers, 1963.
3. Wilhelm Klingenberg: *A course in Differential Geometry*, Graduate Texts in Mathematics, Springer-Verlag 1978.
4. J.A. Thorpe *Elementary topics in Differential Geometry*, Under - graduate Texts in Mathematics, Springer - Verlag 1979.

ELECTIVE: PAPER - 1
(to choose any 1 out of the given 4)
A. FINITE ELEMENT METHOD

Objective: To give a basic expertise in the use of Finite Element Method Techniques.

Unit–I: SECOND ORDER DIFFERENTIAL EQUATIONS IN ONE DIMENSION

Finite element models Background – Basic steps of finite element analysis– Model boundary value problem–Discretization of the domain–Derivation of element equations– Connectivity of elements–Imposition of- boundary conditions–Solution of equations– Post computation of the solution–Some Remarks. (Numerical Example 3.2.1only).
Chapter 3: Sections: 3.1 to 3.3

Unit – II: SECOND ORDER DIFFERENTIAL EQUATIONS IN ONE DIMENSION: APPLICATIONS

Axi-symmetric problems–Model equation–weak form–finite element model– preliminary comments–Discrete systems–Linear elastic spring– Torsion of circular shafts–Electrical resistor circuits –Fluid flow through pipes– Heat transfer – Governing equations –Finite element models – Fluid mechanics – Governing equations – Finite element model. (Numerical Examples 3.4.1, 4.2.1, 4.2.2, 4.3.1, 4.4.1 only)
Chapter 3: Section: 3.4 , Chapter 4: Sections: 4.1– 4.4.

Unit – III: SECOND ORDER DIFFERENTIAL EQUATIONS IN ONE DIMENSION: APPLICATIONS

Solid and Structural Mechanics–Preliminary Comments–Finite Element Model of Bars and cables – Plane trusses: Introduction – Basic truss element–General truss element – Constraint equations – Penalty approach – Direct approach. (Numerical Examples4.6.1,4.6.2,4.6.5only)

Chapter4: Sections: 4.5 to 4.6

Unit–IV: BEAMS AND FRAMES

Introduction–Euler-Bernoulli beam element–Governing equation–Discretization of the domain – Derivation of element equations – Assembly of Element Equations – Imposition of boundary conditions– Post processing of solution – Timoshenko beam elements–Governing equations – Weak form–General finite element model.

Chapter5: Sections:5.1,5.2 (5.2.1to5.2.6),5.3 (5.3.1to 5.3. 3)

Unit–V: EIGEN VALUE AND TIME DEPENDENT PROBLEMS

Eigen value problems: Introduction – Formulation of Eigen value problems – Finite element formulation.Time dependent problems: Introduction–Semi discrete finite element models– Parabolic equations–Time Approximation (Numerical Example 6.1.1 only).

(Chapter 6: Sections: 6.1 (6.1.1to 6.1.3), 6.2 (6.2.1 to 6.2.3)

Book for Study:

J.N.Reddy, An Introduction to the Finite Element Method (Third Edition) Tata McGraw - Hill Publishing Company Limited, New Delhi, 2005.

Books for Reference

1. George R.Buchanan, Finite element analysis,Tata McGraw Hill company Limited, New Delhi, 2006.
2. David V.Hutton, Fundamentals of Finite element Analysis, Tata McGraw Hill company Limited, New Delhi, 2005.
3. Klaus Jurgen Bathe, Edward L. Wilson, Numerical methods in finite element Analysis, Prentice Hall of India private Limited, New Delhi,1987.
4. C.S.Krishnamoorthy, Finite element Analysis Theory and Programming (Eighteenth Reprint), Tata McGraw Publishing company Limited, New Delhi, 2007.

ELECTIVE: PAPER - 1
B. DISCRETE MATHEMATICS

Objectives: This course aims to explore the topics like lattices and their applications in switching circuits, finite fields, polynomials and coding theory.

UNIT - I: LATTICES

Properties and examples of Lattices - Distributive lattices - Boolean algebras - Boolean polynomials - Minimal Forms of Boolean Polynomials.
Chapters: 1 to 4 and 6.

UNIT - II: APPLICATIONS OF LATTICES

Switching Circuits - Applications of Switching Circuits
Chapters: 7 and 8.

UNIT - III: FINITE FIELDS AND POLYNOMIALS

Finite fields
Chapter: 13.

UNIT - IV: FINITE FIELDS AND POLYNOMIALS

Irreducible Polynomials over Finite fields - Factorization of Polynomials over Finite fields.
Chapters: 14 and 15.

UNIT - V: CODING THEORY

Introduction to Coding - Linear Codes.
Chapters: 16 and 17.

Recommended Text

Rudolf Lidl & Gunter Pilz. APPLIED ABSTRACT ALGEBRA, Second Indian Reprint 2006, Springer Verlag, NewYork.

Reference Books

1. A.Gill, *Applied Algebra for Computer Science*, Prentice Hall Inc., New Jersey.
2. J.L.Gersting, *Mathematical Structures for Computer Science*(3^{rd} Edn.), Computer Science Press, New York.
3. S.Wiitala, *Discrete Mathematics- A Unified Approach*, McGraw Hill Book Co.

ELECTIVE: PAPER - 1
C. GRAPH THEORY

Objectives : To study and develop the concepts of graphs, subgraphs, trees, connectivity, Euler tours, Hamilton cycles, matching, coloring of graphs, independent sets, cliques, vertex coloring, and planar graphs

UNIT-I : GRAPHS, SUBGRAPHS AND TREES

Graphs and simple graphs - Graph Isomorphism - The Incidence and Adjacency Matrices - Subgraphs - Vertex Degrees - Paths and Connection - Cycles - Trees - Cut Edges and Bonds - Cut Vertices.

Chapter 1 (Section 1.1 - 1.7) ; Chapter 2 (Section 2.1 - 2.3)

UNIT-II : CONNECTIVITY, EULER TOURS AND HAMILTON CYCLES

Connectivity - Blocks - Euler tours - Hamilton Cycles.

Chapter 3 (Section 3.1 - 3.2) ; Chapter 4 (Section 4.1 - 4.2)

UNIT-III : MATCHINGS, EDGE COLOURINGS

Matchings - Matchings and Coverings in Bipartite Graphs - Edge Chromatic Number - Vizing's Theorem.

Chapter 5 (Section 5.1 - 5.2) ; Chapter 6 (Section 6.1 - 6.2)

UNIT-IV : INDEPENDENT SETS AND CLIQUES, VERTEX COLOURINGS

Independent sets - Ramsey's Theorem - Chromatic Number - Brooks' Theorem - Chromatic Polynomials.

Chapter 7 (Section 7.1 – 7.2); Chapter 8 (Section 8.1 – 8.2, 8.4)

UNIT-V: PLANAR GRAPHS

Plane and planar Graphs - Dual graphs - Euler's Formula - The Five-Colour Theorem and the Four-Colour Conjecture.

Chapter 9 (Section 9.1 - 9.3, 9.6)

Recommended Text

J.A.Bondy and U.S.R. Murthy, *Graph Theory and Applications*, Macmillan, London, 1976.

Reference Books

1. J.Clark and D.A.Holton , *A First look at Graph Theory*, Allied Publishers, New Delhi, 1995.
2. R. Gould. *Graph Theory*, Benjamin/Cummings, Menlo Park, 1989.
3. A.Gibbons, *Algorithmic Graph Theory*, Cambridge University Press, Cambridge, 1989.
4. R.J.Wilson and J.J.Watkins, *Graphs : An Introductory Approach*, John Wiley and Sons, New York, 1989.
5. R.J. Wilson, *Introduction to Graph Theory*, Pearson Education, 4th Edition, 2004, Indian Print.
6. S.A.Choudum, *A First Course in Graph Theory*, MacMillan India Ltd. 1987.

ELECTIVE: PAPER - 1
D. RELIABILITY AND QUEUEING THEORY

Objectives : To study applications of Mathematics.

UNIT - I : RELIABILITY DEFINITION AND FAILURE DATA ANALYSIS

Introduction – Definition of Probability – Failure Data – Mean Failure Rate – Mean Time To Failure (MTTF) – Mean Time Between Failure (MTBF) – Graphical Plots.

Chapter-2: 2.1 - 2.2
Chapter-3: 3.2 - 3.6

UNIT - II : FAILURE DATA ANALYSIS

Four important points – MTTF in terms of Failure density – Generalization – Reliability in terms of Hazard rate and failure density – MTTF in integral form. Introduction – Definition of Probability – Failure Data – Mean Failure Rate – Mean Time To Failure – Mean Time Between Failure – Graphical Plots.

Chapter-3: 3.7 - 3.11

UNIT - III : SYTEM RELIABILITY

Introduction – Series Configuration – Parallel Configuration – Mixed Configuration – Application to specific hazard Models – An r out of n structure – Systems not reducible to mixed configuration.

Chapter-6: 6.1 - 6.6 and 6.8

UNIT - IV : INTRODUCTION TO QUEUEING PROCESS

Measuring system performance – Some general results Simple data book keeping for queues - Poisson process and the exponential distribution – Markovian Property of the exponential distribution.

Chapter-1: 1.4 - 1.8

UNIT - V : SIMPLE MARKOVIAN BIRTH-DEATH QUEUEING MODELS

Steady state solution for the M / M / 1 model – Methods of solving steady state difference equations – Queues with parallel channels and truncation (M / M / c / K).

Recommended Text

1. Srinath. L. S., Reliability Engineering, East West Press, New Delhi. (for Units I , II and III)
2. Donald Gross, Carl M. Harris, Fundamentals of Queueing Theory, Wiley India. (for Units IV and V)

Reference Books

1. Cox. D. R. and H.D. Miller, Theory of Stochastic Processes, Methuen, London, 1965.
2. Cramer. H. and M. Leadbetter, Stationary and Related Stochastic Processes, Wiley, New York, 1966.
3. Karlin. S and H. Taylor, A First Course in Stochastic Processes, 2^{nd} edition, Academic Press, New York, 1975.

SEMESTER - II
PAPER - 5
ALGEBRA - II

Objectives : To study field extension, roots of polynomials, Galois Theory, finite fields, division rings, solvability by radicals and to develop computational skill in abstract algebra.

UNIT-I

Extension fields - Transcendence of e.

Chapter 5: Section 5.1 and 5.2

UNIT-II

Roots or Polynomials.- More about roots

Chapter 5: Sections 5.3 and 5.5

UNIT-III

Elements of Galois theory.

Chapter 5 : Section 5.6

UNIT-IV

Solvability by Radicals - Finite fields - Wedderburn's theorem on finite division rings.

Chapter 5: Section 5.7.
Chapter 7: Sections 7.1 and 7.2 (Only Theorem 7.2.1)

UNIT-V

Solvability by radicals - A theorem of Frobenius - Integral Quaternions and the Four - Square theorem.

Chapter 7 : Sections 7.3 and 7.4

Recommended Text

I.N. Herstein. *Topics in Algebra* (II Edition) Wiley Eastern Limited, New Delhi, 1975.

Reference Books

1. M.Artin, *Algebra,* Prentice Hall of India, 1991.
2. B.Bhattacharya, S.K.Jain, and S.R.Nagpaul, *Basic Abstract Algebra* (II Edition) Cambridge University Press, 1997. (Indian Edition)
3. I.S.Luther and I.B.S.Passi, *Algebra,* Vol. I - Groups (1996); Vol. II *Rings,* Narosa Publishing House , New Delhi, 1999
4. D.S.Malik, J.N. Mordeson and M.K.Sen, *Fundamental of Abstract Algebra*, McGraw Hill (International Edition), New York. 1997.
5. N.Jacobson, *Basic Algebra,* Vol. I & II Hindustan Publishing Company, New Delhi.

PAPER - 6
REAL ANALYSIS II

Objectives : To introduce measure on the real line, Lebesgue measurability and integrability, Fourier Series and Integrals, in-depth study in multivariable calculus.

UNIT - I : FOURIER SERIES AND FOURIER INTEGRALS

Introduction - Orthogonal system of functions - The theorem on best approximation - The Fourier series of a function relative to an orthonormal system - Properties of Fourier Coefficients - The Riesz-Fischer Thorem - The convergence and representation problems in trigonometric series - The Riemann - Lebesgue Lemma - The Dirichlet Integrals - An integral representation for the partial sums of Fourier series - Riemann's localization theorem - Sufficient conditions for convergence of a Fourier series at a particular point - Cesaro summability of Fourier series- Consequences of Fejes's theorem - The Weierstrass approximation theorem

Chapter 11 : Sections 11.1 to 11.15 (Apostol)

UNIT - II : MULTIVARIABLE DIFFERENTIAL CALCULUS

Introduction - The Directional derivative - Directional derivative and continuity - The total derivative - The total derivative expressed in terms of partial derivatives - The matrix of linear function - The Jacobian matrix - The chain rule - Matrix form of chain rule - The mean - value theorem for differentiable functions - A sufficient condition for differentiability - A sufficient condition for equality of mixed partial derivatives - Taylor's theorem for functions of R^n to R^1

Chapter 12 : Section 12.1 to 12.14 (Apostol)

UNIT - III : IMPLICIT FUNCTIONS AND EXTREMUM PROBLEMS

Functions with non-zero Jacobian determinants - The inverse function theorem -The Implicit function theorem - Extrema of real valued functions of severable variables - Extremum problems with side conditions.

Chapter 13 : Sections 13.1 to 13.7 (Apostol)

UNIT - IV THE LEBESGUE INTEGRAL

Length of open sets and closed sets - Inner and outer measure : Measurable sets - Properties of measurable sets - Measurable functions - Definition and existence of the Lebesgue integral for bounded function.

Chapter 11 : Section 11.1 to 11.5 [R. R. Goldberg]

UNIT - V THE LEBESGUE INTEGRAL (Contd . . .)

Properties of the Lebesgue integral for bounded measurable functions - The Lebesque integral for unbounded functions - Some fundamental theorems - The metric space L^2 [a, b] - The integral on $(-\infty, \infty)$ and int plane.

Chapter 11 : Section 11.6 to 11.10 [R. R. Goldberg]

Recommended Texts

1. Tom M. Apostol : *Mathematical Analysis*, 2nd Edition, Addison-Wesley Publishing Company Inc. New York, 1974. (for Units I, II and III)
2. Richard R. Goldberg, Methods f Real Analysis, Oxford & IBH Publishing, New Delhi, 1975. (for Unit IV and V)

Reference Books

1. Burkill,J.C. *The Lebesgue Integral*, Cambridge University Press, 1951.
2. Munroe,M.E. *Measure and Integration*. Addison-Wesley, Mass.1971.
3. Roydon,H.L.*Real Analysis*, Macmillan Pub. Company, New York, 1988.
4. Rudin, W. *Principles of Mathematical Analysis*, McGraw Hill Company, New York,1979.
5. Malik,S.C. and Savita Arora. *Mathematical Analysis*, Wiley Eastern Limited. New Delhi, 1991.
6. Sanjay Arora and Bansi Lal, *Introduction to Real Analysis*, Satya Prakashan, New Delhi, 1991

PAPER - 7
PARTIAL DIFFERENTIAL EQUATIONS

Objectives : The aim of the course is to introduce to the students the various types of partial differential equations and how to solve these equations.

UNIT - I : PARTIAL DIFFERENTIAL EQUATIONS OF FIRST ORDER

Formation and solution of PDE- Integral surfaces - Cauchy Problem order equation - Orthogonal surfaces - First order non-linear - Characteristics - Compatible system - Charpits method.

Chapter 0: 0.4 to 0.11 (omit 0.1, 0.2, 0.3 and 0.11.1)

UNIT - II : FUNDAMENTALS

Introduction – Classification of Second Order PDE - Canonical forms – Adjoint Operators - Riemann's method.

Chapter 1 : 1.1 to 1.5

UNIT - III : ELLIPTIC DIFFERENTIAL EQUATIONS

Derivation of Laplace and Poisson equation - BVP - Separation of Variables - Dirichlet's Problem and Newmann Problem for a rectangle - Solution of Laplace equation in Cylindrical and spherical coordinates - Examples.

Chapter 2 : 2.1, 2 2 , 2.5 to 2.7, 2.11, 2.12(omit 2.3, 2.4, 2.8, 2.9, 2.10 and 2.13)

UNIT - IV : PARABOLIC DIFFERENTIAL EQUATIONS

Formation and solution of Diffusion equation - Dirac-Delta function - Separation of variables method - Solution of Diffusion Equation in Cylindrical and spherical coordinates - Examples.

Chapter 3 : 3.1 to 3.7.

UNIT - V : HYPERBOLIC DIFFERENTIAL EQUATIONS

Formation and solution of one-dimensional wave equation - canocical reduction – IVP - D'Alembert's solution - IVP and BVP for two-dimensional wave equation - Periodic solution of one-dimensional wave equation in cylindrical and spherical coordinate systems - Uniqueness of the solution for the wave equation - Duhamel's Principle - Examples.

Chapter 4: 4.1 to 4.12 (omit 4.5, 4.6 & 4.10)

Recommended Text

K. Sankar Rao, *Introduction to Partial Differential Equations*, 2nd Edition, Prentice Hall of India, New Delhi. 2005

Reference Books

1. R.C.McOwen, *Partial Differential Equations*, 2nd Edn. Pearson Eduction, New Delhi, 2005.
2. I.N.Sneddon, *Elements of Partial Differential Equations*, McGraw Hill, New Delhi, 1983.
3. R. Dennemeyer, *Introduction to Partial Differential Equations and Boundary Value Problems*, McGraw Hill, New York, 1968.
4. M.D.Raisinghania, *Advanced Differential Equations*, S.Chand & Company Ltd., New Delhi, 2001.

PAPER - 8
MECHANICS

Objectives : To study mechanical systems under generalized coordinate systems, virtual work, energy and momentum, to study mechanics developed by Newton, Langrange, Hamilton Jacobi and Theory of Relativity due to Einstein.

UNIT-I : MECHANICAL SYSTEMS

The Mechanical system - Generalised coordinates - Constraints - Virtual work - Energy and Momentum.

Chapter 1 : Sections 1.1 to 1.5

UNIT-II : LAGRANGE'S EQUATIONS

Derivation of Lagrange's equations- Examples - Integrals of motion.

Chapter 2 : Sections 2.1 to 2.3 (Omit Section 2.4)

UNIT-III : HAMILTON'S EQUATIONS

Hamilton's Principle - Hamilton's Equation - Other variational principle.

Chapter 4 : Sections 4.1 to 4.3 (Omit section 4.4)

UNIT-IV : HAMILTON-JACOBI THEORY

Hamilton Principle function - Hamilton-Jacobi Equation - Separability

Chapter 5 : Sections 5.1 to 5.3

UNIT-V : CANONICAL TRANSFORMATION

Differential forms and generating functions - Special Transformations - Lagrange and Poisson brackets.

Chapter 6 : Sections 6.1, 6.2 and 6.3 (omit sections 6.4, 6.5 and 6.6)

Recommended Text

D. T. Greenwood, *Classical Dynamics*, Prentice Hall of India, New Delhi, 1985.

Reference Books

1. H. Goldstein, *Classical Mechanics*, (2^{nd} Edition) Narosa Publishing House, New Delhi.
2. N.C.Rane and P.S.C.Joag, *Classical Mechanics*, Tata McGraw Hill, 1991.
3. J.L.Synge and B.A.Griffth, *Principles of Mechanics* (3^{rd} Edition) McGraw Hill Book Co., New York, 1970.

HUMAN RIGHTS
COMPULSORY PAPER

UNIT – I

Definition of Human Rights – Nature, Content, Legitimacy and Priority – Theories of Human Rights – Historical Development of Human Rights.

UNIT – II

International Human Rights – Prescription and Enforcement upto World War II – Human Rights and the U. N. O. – Universal Declaration of Human Rights – International Covenant on Civil and Political Rights – International Covenant or Economic, Social and Cultural Rights and Optional Protocol.

UNIT – III

Human Rights Declarations – U.N. Human Rights Declarations – U.N. Human Rights Commissioner.

UNIT – IV

Amnesty International – Human Rights and Helsinki Process – Regional Developments – European Human Rights System – African Human Rights System – International Human Rights in Domestic courts.

UNIT – V

Contemporary Issues on Human Rights: Children's Rights – Women's Rights – Dalit's Rights – Bonded Labour and Wages – Refugees – Capital Punishment.
Fundamental Rights in the Indian Constitution – Directive Principles of State Policy – Fundamental Duties – National Human Rights Commission.

Reference Magazines:

1. The Lawyer, Bombay.
2. Human Rights Today, Columbia University.
3. International Instruments of Human Rights, UN Publication.
4. Human Rights Quarterly, John Hopkins University, U.S.A.

Books for Reference:

1. International Bill of Human Rights, Amnesty International Publication, 1988.
2. Human Rights, Questions and Answers, UNESCO, 1982.
3. Mausice Cranston - What is Human Rights.
4. Desai, A.R - Violation of Democratic Rights in India.
5. Pandey - Constitutional Law.
6. Timm R.W - Working for Justice and Human Rights.
7. Human Rights - A Selected Bibliography, USIS.
8. J.C. Johari - Human Rights and New World order.
9. G.S. Bajwa - Human Rights in India.
10. Amnesty International - Human Rights in India.
11. P.C. Sinha & K. Cheous (Ed) - International Encyclopedia of Peace, Security, Social Justice and Human Rights (Vols. 1 - 7).
12. Devasia, V.V - Human Rights and Victimology.

ELECTIVE: PAPER-2
(to choose any 1 out of the given 4)
A. PROGRAMMING IN C++ PRACTICALS

Objectives: This courses introduces a higher level language C++ and numerical methods for hands-on experience on computers. Stress is also given on the error analysis.

- Functions in C++ - Classes and Objects.
- Constructors and destructors - Operator Overloading
- Inheritance : Pointers and Polymorphism.

Recommended Text

Balagurusamy, *Object Oriented Programming with* C++, Tata McGraw Hill, New Delhi, 1999.

Reference Books

D. Ravichandran, *Programming with* C++, Tata McGraw Hill, New Delhi, 1996.

COMPUTER LABORATORY PRACTICE EXERCISES

COMPUTER LANGUAGE EXERCISES FOR PROGRAMMING IN C++

1. Write a class to represent a vector (a series of float values). Include member functions to perform the following tasks: To create the vector, To modify the value of a given element, To multiply by a scalar value, To display the vector in the form (10, 20, 30,…). Write a program to test your class.
2. Create a class FLOAT that contains one float data member. Overload all the four arithmetic operators so that they operate on the objects of FLOAT.
3. Write a program which shows the days from the start of year to date specified. Hold the number of days for each month in an array. Allow the user to enter the month and the day of the year. Then the program should display the total days till the day.
4. Write a program to include all possible binary operator overloading using friend function.
5. Write a program to read an array of integer numbers and sort it in descending order. Use readdata, putdata, and arraymax as member functions in a class.
6. Write a program to read two character strings and use the overloaded '+' operator to append the second string to the first.
7. Develop a program Railway Reservation System using Hybrid Inheritance and Virtual Function.
8. Using overloaded constructor in a class write a program to add two complex numbers.
9. Create a class MAT of size(m,n). Define all possible matrix operations for MAT type objects.
10. Write a program that determines whether a given number is a prime number or not and then prints the result using polymorphism.
11. Write a program to illustrate the dynamic initialization of constructors.
12. Write a program to illustrate the use of pointers to objects.
13. Write a program to illustrate how to construct a matrix of size m x n .
14. Write a program to arrange the given data in ascending / descending order using various sorting algorithms
15. Write a program to find the biggest /smallest number in the given data using various search algorithms

ELECTIVE: PAPER-2
B. FUZZY MATHEMATCS

Objectives : To introduce the basic notions and study the techniques of Fuzzy Mathematics.

UNIT - I : FUZZY SETS

Fuzzy sets – Basic Types – Basic concepts – Characteristics – Significance of the paradigm shift – Additional properties of α – cuts.

Chapter 1 : Sections 1.3 to 1.5 and Chapter 2 : Section 2.1

UNIT - II : FUZZY SETS VERSUS CRISP SETS

Representation of Fuzzy sets – Extension principle of Fuzzy sets – Operation on Fuzzy sets – Types of operation – Fuzzy complements.

Chapter 2 : Sections 2.2 and 2.3 and Chapter 3 : Sections 3.1 and 3.2

UNIT - III : OPERATIONS ON FUZZY SETS

Fuzzy intersection – t-norms – Fuzzy unions – t-conorms.

Chapter 3 : Sections 3.3 and 3.4.

UNIT - IV : FUZZY ARITHMETIC

Fuzzy number – Linguistic variables – Arithmetic operation on intervals – Lattice of Fuzzy numbers.

Chapter 4 : Sections 4.1 to 4.4

UNIT - V : FUZZY RELATIONS

Crisp Versus fuzzy relations – Projection and Cylindric extension – binary fuzzy relations – binary relations on a single set.

Chapter 5 : Sections 5.1 to 5.4

Recommended Text

G. J. Klir and Bo Yuan, *Fuzzy Sets and Fuzzy Logic : Theory and Applications*, PHI, New Delhi, 2005.

Reference Books

1. H. J. Zimmerman, *Fuzzy Set Theory and its Applications*, Allied Publishers, 1996.
2. A. Kaufman, Introduction to the theory of Fuzzy Subsets, Academic Press, 1975.
3. V. Novak, Fuzzy Sets and their Applications, Adam Hilger, Bristol, 1969.

ELECTIVE: PAPER-2
C. CALCULUS OF VARIATIONS AND INTEGRAL EQUATIONS

Objectives : The aim of the course is to introduce to the students the concept of calculus of variation and its applications and second to introduce various types of integral equations and how to solve these equations.

UNIT-I : VARIATIONAL PROBLEMS WITH MOVING BUNDARIES

The concept of Variation and its properties – Euler's equation – Variational problems for functional – Functionals dependent on higher order derivatives – Functions of several independent variables – Some applications to problems of mechanics.

Chapter 1 : 1.1 to 1.7

UNIT - II : VARIATIONAL PROBLEMS WITH MOVING BOUNDARIES

Movable boundary for a functional dependent on two functions – One sided variations – Reflection and Refraction of extremals – Diffraction of light rays.

Chapter 2 : 2.1 to 2.5

UNIT - III INTEGRAL EQUATIONS

Introduction – Definition – Regularity conditions – Special kinds of Kernals – Eigen values and eigen functions – Convolution integral – Reduction to a system of algebraic equations – Examples – Fredholm alternative – Examples – An approximation method.

Chapter 1 : 1.1 to 1.5
Chapter 2 : 2.1 to 2.5

UNIT - IV METHOD OF SUCCESSIVE APPROXIMATIONS AND FREDHOLM THEORY

Method of successive approximations – Iterative scheme – Examples – Volterra integral equations – Examples – Some results about the resolvent kernel – The method of solution of Fredholm equation – Fredholm first theorem – Examples.

Chapter 3 : 3.1 to 3.5
Chapter 4 : 4.1 to 4.3

UNIT - V APPLICATIONS TO ORDINARY DIFFERENTIAL EQUATIONS

Initial value problems – Boundary value problems – Examples – Singular integral equations – The Abel integral equations - Examples.

Chapter 5 : 5.1 to 5.3
Chapter 8 : 8.1 to 8.2

Recommended Text

1. A. S. Gupta, *Calculus of Variations with Applications*, PHI, New Delhi, 2005. (for Units I and II)
2. Ram P. Kanwal, *Linear Integral Equations,* Theory and Techniques, Academic Press, New York, 1971. (for Units III, IV and V)

Reference Books

1. M. D. Raisinghania, Integral Equations and Boundary Value Problems, S. Chand & Co., New Delhi, 2007.
2. Sudir K. Pundir and Rimple Pundir, Integral Equations and Boundary Value Problems, Pragati Prakasam, Meerut. 2005.

ELECTIVE: PAPER-2
D. MATHEMATICAL MODELLING

Objective of the course:

This course aims at introducing mathematical modeling through differential equations, systems of ordinary differential equations, difference equations, graphs, calculus of variations and dynamical programming.

Unit – I: MATHEMATICAL MODELLING THROUGH SYSTEMS OF ORDINARY DIFFERENTIAL EQUATIONS OF THE FIRST ORDER

Mathematical modelling in Population Dynamics – Mathematical Modelling of Epidemics Through Systems of Ordinary Differential Equations of First Order– Mathematical Models in Medicine, Arms Race, Battles and International Trade in Terms of Systems of Ordinary Differential Equations – Mathematical Modelling in Dynamics Through Systems of Ordinary Differential Equations of First Order.
(Chapter 3:3.1, 3.2, 3.5, 3.6)

Unit – II: MATHEMATICAL MODELLING THROUGH DIFFERENCE EQUATIONS

The Need for Mathematical Modelling Through Difference Equations: Some Simple Models – Basic Theory of Linear Difference Equations with Constant Coefficients – Mathematical Modelling Through Difference Equations in Economics and Finance.
(Chapter 5: 5.1 – 5.3)

Unit – III: MATHEMATICAL MODELLING THROUGH DIFFERENCE EQUATIONS

Mathematical Modelling Through Difference Equations in Population Dynamics and Genetics – Mathematical Modelling Through Difference Equations in Probability Theory –Miscellaneous Examples of Mathematical Modelling Through Difference Equations.
(Chapter 5: 5.4 – 5.6)

Unit – IV: MATHEMATICAL MODELLING THROUGH GRAPHS

Situations that can be Modelled Through Graphs – Mathematical Models in Terms of Directed Graphs – Mathematical Models in Terms of Signed Graphs – Mathematical Modelling in Terms of Weighted Digraphs.

(Chapter 7: 7.1 – 7.4)

Unit – V: MATHEMATICAL MODELLING THROUGH CALCULUS OF VARIATIONS AND DYNAMIC PROGRAMMING

Optimization Principles and Techniques – Mathematical Modelling Through Calculus of Variations – Mathematical Modelling Through Dynamic Programming. (Chapter 9: 9.1 – 9.3)

Recommended Text:

J.N. Kapur, Mathematical Modelling, Wiley Eastern Limited, Reprint 2000.

Reference Books:

1. **D.J. G. James** and **J.J. Macdonald,** Case studies in Mathematical modelling, Stanly Thames, Cheltonham.
2. **J.N. Kapur,** Maximum entropy models.
3. **M. Cross and AO. Moscrcadini,** The Art of Mathematical Modelling, Ellis Harwood and John Wiley.
4. **C. Dyson, Elvery,** Principles of Mathematical Modelling, Academic Press, New York.
5. **D.N. Burghes,** Modelling with Difference Equations, Ellis Harwood and John Wiley.

SEMESTER - III
PAPER - 9
COMPLEX ANALYSIS - I

Objectives : To Study Cauchy integral formula, local properties of analytic functions, general form of Cauchy's theorem and evaluation of definite integral and harmonic functions

UNIT-I : ANALYTIC FUNCTIONS AS MAPPINGS

Analytic functions in regions- conformal mapping-Fundamental Theorems: Line integrals-Rectifiable arcs-line integrals as functions of arcs-Cauchy's theorem for a rectangle- Cauchy's theorem in a disk.

Chapter3: Section 2 : 2.2 and 2.3;
Chapter 4 : Section 1 : 1.1 to 1.5;

UNIT-II : CAUCHY'S INTEGRAL FORMULA

The Index of a point with respect to a closed curve - The Integral formula - Higher derivatives. Local Properties of Analytic Functions: Removable Singularities - Taylors's Theorem - Zeros and poles - The local Mapping - The Maximum Principle.

Chapter 4 : Section 2 : 2.1 to 2.3;
Chapter 4 : Section 3 : 3.1 to 3.4

UNIT-III : THE GENERAL FORM OF CAUCHY'S THEOREM

Chains and cycles- Simple Continuity - Homology - The General statement of Cauchy's Theorem - Proof of Cauchy's theorem - Locally exact differentials- Multilply connected regions - Residue theorem - The argument principle.

Chapter 4 : Section 4 : 4.1 to 4.7;
Chapter 4 : Section 5: 5.1 and 5.2

UNIT-IV : EVALUATION OF DEFINITE INTEGRALS AND HARMONIC FUNCTIONS

Evaluation of definite integrals - Definition of Harmonic function and basic properties - Mean value property - Poisson formula.

Chapter 4 : Section 5 : 5.3 ;
Chapter 4 : Sections 6 : 6.1 to 6.3

UNIT-V : HARMONIC FUNCTIONS AND POWER SERIES EXPANSIONS

Schwarz theorem - The reflection principle - Weierstrass theorem - Taylor's Series - Laurent series .

Chapter 4 : Sections 6.4 and 6.5 ; Chapter 5 : Sections 1.1 to 1.3

Recommended Text

- Lars V. Ahlfors, Complex Analysis, (3rd edition) McGraw Hill Co., New York, 1979

Reference Books

1. H.A. Presfly, Introduction to complex Analysis, Clarendon Press, oxford, 1990.
2. J.B. Conway, Functions of one complex variables Springer - Verlag, International student Edition, Naroser Publishing Co.1978
3. E. Hille, Analytic function Thorey (2 vols.), Gonm & Co, 1959.
4. M.Heins, Complex function Theory, Academic Press, New York,1968.

PAPER - 10
TOPOLOGY

Objectives : To study topological spaces, continuous functions, connectedness, compactness, countability and separation axioms.

UNIT-I : TOPOLOGICAL SPACES

Topological spaces - Basis for a topology - The order topology - The product topology on X x Y - The subspace topology - Closed sets and limit points.

Chapter 2 : Sections 12 to 17

UNIT-II : CONTINUOUS FUNCTIONS

Continuous functions - the product topology - The metric topology.

Chapter 2 : Sections 18 to 21 (Omit Section 22)

UNIT-III : CONNECTEDNESS

Connected spaces - connected subspaces of the Real line - Components and local connectedness.

Chapter 3 : Sections 23 to 25

UNIT-IV : COMPACTNESS

Compact spaces - compact subspaces of the Real line - Limit Point Compactness - Local Compactness.

Chapter 3 : Sections 26 to 29

UNIT-V: COUNTABILITY AND SEPARATION AXIOM

The Countability Axioms - The separation Axioms - Normal spaces - The Urysohn Lemma - The Urysohn metrization Theorem - The Tietz extension theorem.

Chapter 4 : Sections 30 to 35

Recommended Text

James R. Munkres, *Topology* (2nd Edition) Pearson Education Pve. Ltd., Delhi-2002 (Third Indian Reprint)

Reference Books

1. J. Dugundji , *Topology* , Prentice Hall of India, New Delhi, 1975.
2. George F.Sinmons, *Introduction to Topology and Modern Analysis*, McGraw Hill Book Co., 1963
3. J.L. Kelly, *General Topology*, Van Nostrand, Reinhold Co., New York
4. L.Steen and J.Subhash, Counter Examples in Topology, Holt, Rinehart and Winston, New York, 1970.
5. S.Willard, *General Topology*, Addison - Wesley, Mass., 1970

PAPER - 11
OPERATIONS RESEARCH

Objectives: This course aims to introduce decision theory, PERT, CPM, deterministic and probabilistic inventory systems, queues, replacement and maintenance problems.

UNIT – I: INTEGER LINEAR PROGRAMMING

Types of Integer Linear Programming Problems - Concept of Cutting Plane - Gomory's All Integer Cutting Plane Method - Gomory's mixed Integer Cutting Plane method - Branch and Bound Method.

Chapter-7: 7.1 - 7.6

UNIT – II: DYNAMIC PROGRAMMING

Characteristics of Dynamic Programming Problem - Developing Optimal Decision Policy - Dynamic Programming Under Certainty - DP approach to solve LPP.

Chapter-20: 20.1 - 20.5

UNIT - III:

CLASSICAL OPTIMIZATION METHODS : Unconstrained Optimization - Constrained Multi-variable Optimization with Equality Constraints - Constrained Multi-variable Optimization with inequality Constraints.
NON-LINEAR PROGRAMMING METHODS: Examples of NLPP - General NLPP - Graphical solution - Quadratic Programming - Wolfe's modified Simplex Methods.

Chapter-23: 23.1 - 23.4 and Chapter-24: 24.1 - 24.4

UNIT-IV

REVISED SIMPLEX METHOD : Standard forms for Revised simplex Method - Computational procedure for Standard form I - comparison of simplex method and Revised simplex Method.
BOUNDED VARIABLES LP PROBLEM: The simplex algorithm

Chapter-26: 26.1 - 26.4
Chapter-28: 28.1, 28.2

UNIT-V : DECISION THEORY

Steps in Decision theory Approach - Types of Decision-Making Environments - Decision Making Under Uncertainty - Decision Making under Risk - Posterior Probabilities and Bayesian Analysis - Decision Tree Analysis - Decision Making with Utilities.

Chapter-11 : 11.1 - 11.8

Recommended Text

J. K. Sharma, *Operations Research*, Theory and Applications, Third Edition (2007) Macmillan India Ltd.

Reference Books

1. Hamdy A. Taha, *Operations Research*, (seventh edition) Prentice - Hall of India Private Limited, New Delhi, 1997.
2. F.S. Hillier & J.Lieberman *Introduction to Operation Research* (7^{th} Edition) Tata-McGraw Hill ompany, New Delhi, 2001.
3. Beightler. C, D.Phillips, B. Wilde ,*Foundations of Optimization* (2^{nd} Edition) Prentice Hall Pvt Ltd., New York, 1979
4. S.S. Rao - *Optimization Theory and Applications*, Wiley Eastern Ltd. New Delhi. 1990

PAPER - 12
PROBABILITY THEORY

Objectives : To introduce axiomatic approach to probability theory, to study some statistical characteristics, discrete and continuous distribution functions and their properties, characteristic function and basic limit theorems of probability.

UNIT-I : RANDOM EVENTS AND RANDOM VARIABLES

Random events - Probability axioms - Combinatorial formulae - conditional probability - Bayes Theorem - Independent events - Random Variables - Distribution Function - Joint Distribution - Marginal Distribution - Conditional Distribution - Independent random variables - Functions of random variables.

Chapter 1: Sections 1.1 to 1.7
Chapter 2 : Sections 2.1 to 2.9

UNIT-II : PARAMETERS OF THE DISTRIBUTION

Expectation- Moments - The Chebyshev Inequality - Absolute moments - Order parameters - Moments of random vectors - Regression of the first and second types.

Chapter 3 : Sections 3.1 to 3.8

UNIT-III: CHARACTERISTIC FUNCTIONS

Properties of characteristic functions - Characteristic functions and moments - semi-invariants - characteristic function of the sum of the independent random variables - Determination of distribution function by the Characteristic function - Characteristic function of multidimensional random vectors - Probability generating functions.

Chapter 4 : Sections 4.1 to 4.7

UNIT-IV : SOME PROBABILITY DISTRIBUTIONS

One point , two point , Binomial - Polya - Hypergeometric - Poisson (discrete) distributions - Uniform - normal gamma - Beta - Cauchy and Laplace (continuous) distributions.

Chapter 5 : Section 5.1 to 5.10

UNIT - V: LIMIT THEOREMS

Stochastic convergence - Bernoulli law of large numbers - Convergence of sequence of distribution functions - Levy-Cramer Theorems - de Moivre-Laplace Theorem - Lindberg Theorem - Lyapunov Theroem.

Chapter 6 : Sections 6.1 to 6.4, 6.6 to 6.9.

Recommended Text

M. Fisz, Probability Theory and Mathematical Statistics, John Wiley and Sons, New York, 1963.

Reference Books

1. R.B. Ash, Real Analysis and Probability, Academic Press, New York, 1972
2. K.L.Chung, A course in Probability, Academic Press, New York, 1974.
3. R.Durrett, Probability : Theory and Examples, (2nd Edition) Duxbury Press, New York, 1996.
4. V.K.Rohatgi An Introduction to Probability Theory and Mathematical Statistics, Wiley Eastern Ltd., New Delhi, 1988(3rd Print).
5. S.I.Resnick, A Probability Path, Birhauser, Berlin,1999.
6. B. R. Bhat, Modern Probability Theory (3^{rd} Edition), New Age International (P)Ltd, New Delhi, 1999

ELECTIVE: PAPER - 3
(to choose any 1 out of the given 4)
A. TENSOR ANALYSIS AND RELATIVITY THEORY

Objectives : The course aims to introduce vector algebra and vector calculus and special relativity and relativistic kinematics, dynamics and accelerated systems.

UNIT-I : TENSOR ALGEBRA

Systems of Different orders - Summation Convention - Kronecker Symbols - Transformation of coordinates in S_n - Invariants - Covariant and Contravariant vectors - Tensors of Second Order - Mixed Tensors - Zero Tensor - Tensor Field - Algebra of Tensors - Equality of Tensors - Symmetric and Skew –symmetric tensors - Outer multiplication, Contraction and Inner Multiplication - Quotient Law of Tensors - Reciprocal Tensor of Tensor - Relative Tensor - Cross Product of Vectors.

Chapter I : I.1 - I.3, I.7 and I.8 and Chapter II : II.1 - II.19

UNIT-II : TENSOR CALCULUS

Riemannian Space - Christoffel Symbols and their properties

Chapter III: III.1 and III.2

UNIT-III : TENSOR CALCULUS (Contd . . .)

Covariant Differentiation of Tensors - Riemann - Christoffel Curvature Tensor - Intrinsic Differentiation.

Chapter III: III.3 - III.5

UNIT-IV : SPECIAL THEORY OF RELATIVITY

Galilean Transformation - Maxwell's equations - The ether Theory - The Principle of Relativity.

Relativistic Kinematics : Lorentz Transformation equations - Events and simultaneity - Example - Einstein Train - Time dilation - Longitudinal Contraction - Invariant Interval - Proper time and Proper distance - World line - Example - twin paradox - addition of velocities - Relativistic Doppler effect.

Chapter 7 : Sections 7.1 and 7.2

UNIT-V : RELATIVISTIC DYNAMICS

Momentum - Energy - Momentum - energy four vector - Force - Conservation of Energy - Mass and energy - Example - inelastic collision - Principle of equivalence - Lagrangian and Hamiltonian formulations.

Accelerated Systems : Rocket with constant acceleration - example - Rocket with constant thrust

Chapter 7 : Sections 7.3 and 7.4

Recommended Texts

1. U.C. De, Absos Ali Shaikh and Joydeep Sengupta, *Tensor Calculus*, Narosa Publishing House, New Delhi, 2004. (**For Units I,II and III**)
2. D. Greenwood, *Classical Dynamics*, Prentice Hall of India, New Delhi, 1985. (**For Units IV and V**)

Reference Books

1. J.L.Synge and A.Schild, *Tensor Calculus*, Toronto, 1949.
2. A.S.Eddington. *The Mathematical Theory of Relativity*, Cambridge University Press, 1930.
3. P.G.Bergman, *An Introduction to Theory of Relativity*, New York, 1942
4. C.E.Weatherburn, *Riemannian Geometry and the Tensor Calculus*, Cambridge, 1938.

ELECTIVE: PAPER - 3
B. ANALYTIC NUMBER THEORY

Objectives : This course introduces arithmetic function and Dirichlet multiplication, averages of arithmetic function, congruence and quadratic residues

UNIT-I

Arithmetical function and Dirichlet multiplication.

Chapter 2

UNIT-II

Averages of Arithmetical function.

Chapter 3

UNIT-III

Congruence - Finite Abelian Groups and their characters

Chapter 5 (Omit 5.10 and 5.11) ; Chapter 6: 6.1 to 6.4

UNIT-IV

Finite Abelian Groups and their characters (contd. . .) - Dirichlet's theorem on Primes in Arithmetic Progressions

Chapter 6: 6.5 to 6.10; Chapter 7: All sections except 7.9

UNIT-V

Quadratic residues and quadratic reciprocity law.

Chapter 9 (Omit 9.10 and 9.11)

Recommended Text

Tom Apostol, *Introduction to Analytic Number theory*, Narosa Publications, New Delhi,

Reference Books

1. I. Niven and Zuckermann H.S. : *An Introduction to the theory of numbers,* Wiley Eastern Ltd. 1972
2. C.Y. Hsiung : *Elementary Theory of Numbers*, Allied Publishers.
3. W.W. Adams and L. J. Goldstein, *Introduction to Number Theory*, Prentice Hall Inc.
4. S.G. Telang, *Number Theory*.

ELECTIVE: PAPER - 3
C. FLUID DYNAMICS

Objectives : This course aims to discuss kinematics of fluids in motion, Equations of motion of a fluid, three dimensional flows, two dimensional flows and viscous flows.

UNIT-I

Kinematics of Fluids in motion. Real fluids and Ideal fluids - Velocity of a fluid at a point, Stream lines , path lines , steady and unsteady flows- Velocity potential - The vorticity vector- Local and particle rates of changes - Equations of continuity - Worked examples - Acceleration of a fluid - Conditions at a rigid boundary.

Chapter 2. Sections 2.1 to 2.10.

UNIT-II: EQUATIONS OF MOTION OF A FLUID

Pressure at a point in a fluid at rest. - Pressure at a point in a moving fluid - Conditions at a boundary of two inviscid immiscible fluids- Euler's equation of motion - Discussion of the case of steady motion under conservative body forces.

Chapter 3. Sections 3.1 to 3.7

UNIT-III

Some three dimensional flows. Introduction- Sources, sinks and doublets - Images in a rigid infinite plane - Axis symmetric flows - stokes stream function

Chapter 4 Sections 4.1, 4.2, 4.3, 4.5.

UNIT-IV : SOME TWO DIMENSIONAL FLOWS

Meaning of two dimensional flow - Use of Cylindrical polar coordinate - The stream function - The complex potential for two dimensional, irrotational incompressible flow - Complex velocity potentials for standard two dimensional flows - Some worked examples - Two dimensional Image systems - The Milne Thompson circle Theorem.

Chapter 5. Sections 5.1 to 5.8

UNIT-V : VISCOUS FLOWS

Stress components in a real fluid. - Relations between Cartesian components of stress- Translational motion of fluid elements - The rate of strain quadric and principal stresses - Some further properties of the rate of strain quadric - Stress analysis in fluid motion - Relation between stress and rate of strain - The coefficient of viscosity and Laminar flow - The Navier - Stokes equations of motion of a Viscous fluid.

Chapter 8. Sections 8.1 to 8.9

Recommended Text

F. Chorlton, *Text Book of Fluid Dynamics* ,CBS Publications. Delhi ,1985.

Reference Books

1. R.W.Fox and A.T.McDonald. *Introduction to Fluid Mechanics*, Wiley, 1985.
2. E.Krause, *Fluid Mechanics with Problems and Solutions*, Springer, 2005.
3. B.S.Massey, J.W.Smith and A.J.W.Smith, *Mechanics of Fluids,* Taylor and Francis, New York, 2005
4. P.Orlandi, *Fluid Flow Phenomena,* Kluwer, New Yor, 2002.
5. T.Petrila, *Basics of Fluid Mechanics and Introduction to Computational Fluid Dynamics,* Springer, berlin, 2004.

ELECTIVE: PAPER-3
D. ALGEBRAIC TOPOLOGY

Objectives: To introduce the ideas of algebraic topology to other branches of Mathematics.

UNIT – I : CALCULUS IN THE PLANE: PATH INTEGRALS

Angles and Deformations – Differntial forms and path Integrals – Independence of Path – Criterion for exactness. Angles and Deformations: Angle functions and Winding numbers – Reparametrizing and Deforming the Paths. Winding Numbers: Definition – Homotopy and Reparametrization – Varying the point – Degrees and Local Degrees.

Chapter – 1: (a) to (c); Chapter – 2: (a) to (b); Chapter – 3: (a) to (d).

UNIT – II: COHOMOLOGY AND HOMOLOGY

De Rham Cohomology and the Jordan Curve Theorem. Definition of the De Rham Graphs – The Coboundary map – the Jordon Curve Theorem – Applications and Variations.

Homology: Chains, Cycles, and H_0U – Boundaries, H_1U, and Winding Numbers – Chains on Grids – Maps and Homology – The First Homology Group for General Spaces.

Chapter 5: (a) to (d); Chapter 6: (a) to (e)

UNIT – III: HOLES AND INTEGRALS

Multiply connected regions – Integrations over continuous Paths and Chains – Periods of Integrals – Complex Integration.

Mayer – Victoris: The Boundary map – Mayer – Victoris for Homology – Variations and applications – Mayer – Victoris for Cohomology.

Chapter 9: (a) to (d); Chapter 10: (a) to (d)

UNIT – IV: COVERING SPACES AND FUNDAMENTAL GROUPS

Covering spaces: Definition – Lifting paths and Homotopies – G-coverings – Covering Transformations. The Fundamental Groups: Definitions and Basic Properties – Homotopy – Fundamental group and Homology. Fundamental Groups and Covering Spaces: Fundamental Group and Coverings – Automorphisms of Coverings – The Universal Covering – Coverings and Subgroups of the Fundamental Group.

Chapter 11: (a) to (d); Chapter 12: (a) to (c); Chapter 13: (a) to (d)

UNIT – V: THE VAN KAMPEN THEOREM

G-Coverings from the Universal Covering – Patching Coverings together – The Van Kampen Theorem.

Cohomology: Patching Coverings and Cech cohomology – Cech Cohomology and Homology – De Rham Cohomology and Homology – Proof of Mayer – Victoris fro De Rham Cohomology.

Chapter 14: (a) to (d); Chapter 15: (a) to (d)

Recommended Text:

William Fulton, Algebraic Topology – A First Course, Springer – Verlag, New York, 1995.

Reference Books:

1. M. K. Agoston, Algebraic Topology – A First Course. Marcel Dekker, 1992.
2. Satya Deo, Algebraic Topology, Hindustan Book Agency, New Delhi, 2003.
3. M. Greenberg and Harper, Algebraic Topology – A First Course, Benjamin / Cummings, 1981.
4. C. F. Maunder, Algebraic topology, Van Nastrand, New York, 1970.
5. J. R. Munkres, Topology, Prentica Hall of India, New Delhi, 2002, [3rd Indian Print].

SEMESTER - IV
PAPER - 13
COMPLEX ANALYSIS - II

Objectives : To study Riemann Theta Function and normal families, Riemann mapping theorem, Conformal mapping of polygons, harmonic functions, elliptic functions and Weierstrass Theory of analytic continuation.

UNIT - I: PARTIAL FRACTIONS AND ENTIRE FUNCTIONS

Partial fractions - Infinite products - Canonical products - Gamma Function - Jensen's formula - Hadamard's Theorem

Chapter 5 : Sections 2.1 to 2.4 ; Chapter 5 : Sections 3.1 and 3.2

UNIT - II: RIEMANN THETA FUNCTION AND NORMAL FAMILIES

Product development - Extension of $\zeta(s)$ to the whole plane - The zeros of zeta function - Equicontinuity - Normality and compactness - Arzela's theorem - Families of analytic functions - The Classical Definition

Chapter 5 : Sections 4.1 to 4.4 ; Chapter 5 : Sections 5.1 to 5.5

UNIT - III: RIEMANN MAPPING THEOREM

Statement and Proof - Boundary Behavior - Use of the Reflection Principle.
Conformal mappings of polygons : Behavior at an angle - Schwarz-Christoffel formula - Mapping on a rectangle.
Harmonic Functions : Functions with mean value property - Harnack's principle.

Chapter 6 : Sections 1.1 to 1.3 (Omit Section1.4) ;
Sections 2.1 to 2.3 (Omit section 2.4)
Section 3.1 and 3.2

UNIT-IV : ELLIPTIC FUNCTIONS

Simply periodic functions: Representation by exponentials-The Fourier development-Functions of finite order- Doubly periodic functions:The Period Module-Unimodular transformations-The Canonical basis-General properties of Elliptic functions.

Chapter 7 : Sections 1.1 to 1.3 ; Sections 2.1 to 2.4

UNIT-V : WEIRSTRASS THEORY

The Weierstrass ρ-function - The functions $\zeta(z)$ and $\sigma(z)$- The differential equation -The modular function $\lambda(\tau)$ - The Conformal mapping by $\lambda(\tau)$.

Chapter 7 : Sections 3.1 to 3.5

Recommended Text:

Lars V. Ahlfors, Complex Analysis, (3rd Edition) McGraw Hill Book Company, New York, 1979.

Reference Books

1. H.A. Presfly, Introduction to complex Analysis, Clarendon Press, oxford, 1990.
2. J.B. Corway, Functions of one complex variables, Springer - Verlag, International student Edition, Narosa Publishing Co.
3. E. Hille, Analytic function Thorey (2 vols.), Gonm & Co, 1959.
4. M.Heins, Complex function Theory, Academic Press, New York,1968.

PAPER - 14
FUNCTIONAL ANALYSIS

Objectives : To study the details of Banach and Hilbert Spaces and to introduce Banach algebras.

UNIT-I : BANACH SPACES

Definition - Some examples - Continuous Linear Transformations - The Hahn -Banach Theorem - The natural embedding of N in N**

Chapter 9 : Sections 46 to 49

UNIT-II : BANACH SPACES AND HILBERT SPACES

Open mapping theorem - conjugate of an operator - Definition and some simple properties - Orthogonal complements - Orthonormal sets

Chapter 9 : Sections 50 and 51 ; Chapter 10 : Sections 52, 53 and 54

UNIT-III : HILBERT SPACE

Conjugate space H* - Adjoint of an operator - Self-adjoint operator - Normal and Unitary Operators - Projections

Chapter 10 : Sections 55, 56,57,58 and 59

UNIT-IV : PRELIMINARIES ON BANACH ALGEBRAS

Definition and some examples - Regular and single elements - Topological divisors of zero - spectrum - the formula for the spectral radius - the radical and semi-simplicity.

Chapter 12 : Sections 64 to 69

UNIT-V: STRUCTURE OF COMMUTATIVE BANACH ALGEBRAS

Gelfand mapping - Applications of the formula $r(x) = \lim \| x^n \|^{1/n}$ - Involutions in Banach Algebras - Gelfand-Neumark Theorem.

Chapter 13 : Sections 70 to 73

Recommended Text:

G.F.Simmons , *Introduction to topology and Modern Analysis*, McGraw Hill International Book Company, New York, 1963.

Reference Books

1. W. Rudin *Functional Analysis*, Tata McGraw-Hill Publishing Company, New Delhi, 1973
2. G. Bachman & L.Narici, *Functional Analysis* Academic Press, New York, 1966.
3. H.C. Goffman and G.Fedrick, *First course in Functional Analysis*, Prentice Hall of India, New Delhi, 1987
4. E. Kreyszig *Introductory Functional Analysis with Applications*, John wiley & Sons, New York.,1978.

PAPER - 15
MATHEMATICAL STATISTICS

Objectives : This course introduces sampling theory, significance tests ,estimation, testing of hypotheses, ANOVA and sequential analysis with rigorous mathematical treatment.

UNIT-I : SAMPLE MOMENTS AND THEIR FUNCTIONS

Notion of a sample and a statistic - Distribution of the arithmetic mean of independent normally distributed random variables – The χ^2 - distribution – The distribution of the statistics ($\bar{X}$, S) – Student's t - distribution - Fisher's Z - distribution - Snedecor's F - distribution - Distribution of sample mean from non-normal populations.

Chapter 9 : Sections 9.1 to 9.8

UNIT-II : SIGNIFICANCE TEST

Kolmogorov Theorem 10.11.1 - Smirnov Theorem 10.11.2 - Concept of a statistical test - Parametric tests for small samples and large samples - χ^2 test - Tests of Kolmogorov and Smirnov type - The Wald-Wolfovitz and Wilcoxon -Mann-Whitney tests - Independence Tests by contingency tables.

Chapter 10 : Section 10.11; Chapter 12 :Sections 12.1 to 12.7

UNIT-III : ESTIMATION

Preliminary notion - Consistent estimation - Unbiased estimates - Sufficiency of an estimate - Efficiency of an estimate - Asymptotically most efficient estimates - methods of finding estimates - confidence Interval.

Chapter 13 : Sections 13.1 to 13.8

UNIT-IV : Analysis of Variance

One way classification and two-way classification. **Hypotheses Testing:** The Power functions and OC function - Most Powerful test - Uniformly most powerful test - unbiased test.

Chapter 15 : Sections 15.1 and 15.2
Chapter 16 : Sections 16.1 to 16.5

UNIT-V : SEQUENTIAL ANALYSIS

SPRT - Auxiliary Theorem - Wald's fundamental identity - OC function and SPRT – The expected value of $E(n)$ - Determination of A and B - Testing a hypothesis concerning p of zero – one distribution - Testing a hypothesis concerning the expected value m of a Normal population.

Chapter 17 : Sections 17.1 to 17.9

Recommended Text:

M. Fisz , *Probability Theory and Mathematical Statistics,* John Wiley and sons, New Your, 1963.

Reference Books:

1. E.J.Dudewicz and S.N.Mishra , *Modern Mathematical Statistics*, John Wiley and Sons, New York, 1988.
2. V.K.Rohatgi *An Introduction to Probability Theory and Mathematical Statistics,* Wiley Eastern New Delhi, 1988(3rd Edn)
3. G.G.Roussas, *A First Course in Mathematical Statistics,* Addison Wesley Publishing Company, 1973
4. B.L.Vander Waerden, *Mathematical Statistics,* G.Allen & Unwin Ltd., London, 1968.

PAPER - 16
DIFFERENCE EQUATIONS

Objectives : To introduce the process of discretization, Discrete version of Differential Equations, Discrete oscillation and the asymptotic behaviour of solutions of certain class of difference equations for linear cases only. Solution of difference equations using z-transforms is stressed.

UNIT-I : LINEAR DIFFERENCE EQUATIONS OF HIGHER ORDER

Difference Calculus - General Theory of Linear Difference Equations - Linear Homogeneous Equations with Constant coefficients - Linear non-homogeneous equations - Method of Undetermined coefficients, the method of variation of constants - Limiting behavior of solutions.

Chapter 2: Sections 2.1 to 2.5

UNIT-II : SYSTEM OF DIFFERENCE EQUATIONS

Autonomous System - The Basic Theory - The Jordan form - Linear periodic system.

Chapter 3: Section 3.1 to 3.4

UNIT-III : THE Z-TRANSFORM METHOD

Definition, Example and properties of Z-transform - The Inverse Z-transform and solution of Difference Equations: Power series method, partial fraction method, the inverse integral method - Volterra Difference Equation of convolution types - Volterra systems.

Chapter 5: Sections 5.1 to 5.3, 5.5 (omit 5.4)

UNIT-IV : ASYMPTOTIC BEHAVIOUR OF DIFFERENCE EQUATION

Tools and Approximations - Poincare's Theorem - Second order difference equations - Asymptotic diagonal systems - Higher order Difference Equations.

Chapter 8 : Sections 8.1 to 8.5

UNIT-V : OSCILLATION THEORY

Three-term difference Equation - Non-linear Difference Equations - Self-Adjoint second order equations.

Chapter 7 : Sections 7.1 to 7.3

Recommended Text:

Saber N. Elaydi, *An Introduction to Difference Equations*, Springer Verlag, New York, 1996.

Reference Books:

1. R.P.Agarwal., *Difference Equations and Inequalities*, Marcel Dekker, 1999.
2. S. Goldberg, *Introduction to Difference Equations*, Dover Publications, 1986
3. V. Lakshmi kantham and Trigiante, *Theory of Difference Equations*, Academic Press, New York, 1988.
4. Peterson, A *Difference Equations, An Introduction with Applications,* Academic Press, New York, 1991.

ELECTIVE: PAPER - 4
(to choose any 1 out of the given 4)
A. NUMBER THEORY AND CRYPTOGRAPHY

Objectives : This course aims to give elementary ideas from number theory which will have applications in cryptology.

UNIT-I : Elementary Number Theory

Time Estimates for doing arithmetic - Divisibility and Euclidean algorithm - Congruences - Applications to factoring.

Chapter – I Sec – 1.1 to 1.4

UNIT-II : Cryptography

Some simple crypto systems - Enciphering matrices

Chapter – III Sec – 3.1 and 3.2

UNIT-III : Finite Fields and quadratic Residues

Finite fields - Quadratic residues and Reciprocity

Chapter – II Sec – 2.1 and 2.2

UNIT-IV : Public Key Cryptography

The idea of public key cryptography - RSA - Discrete log - Knapsack

Chapter-IV Sec – 4.1 to 4.4

UNIT-V : Primality and Factoring

Pseudo primes - The rho method - Fermat factorization and factor bases - The Continued fraction method.

Chapter – V Sec – 5.1 to 5.4

Recommended Text:

Neal Koblitz, *A Course in Number Theory and Cryptography*, Springer-Verlag, New York, 2002, Second Edition.

Reference Books:

1. Niven and Zuckermann, *An Introduction to Theory of Numbers* (Edn. 3), Wiley Eastern Ltd., New Delhi, 1976.
2. David M.Burton, *Elementary Number Theory*, Wm C.Brown Publishers, Dubuque, Iowa, 1989.
3. K.Ireland and M.Rosen, *A Classical Introduction to Modern Number Theory*, Springer Verlag, 1972.

ELECTIVE: PAPER – 4
B. ALGEBRAIC NUMBER THEORY

Objectives : The course aims to provide a study on modules over rings, finite fields, algebraic extensions, number fields and cyclotomic fields, Noetherian rings and modules and Dedekind rings.

UNIT-I : ALGEBRAIC BACKGROUND

Rings and Fields- Factorization of Polynomials - Field Extensions - Symmetric Polynomials - Modules - Free Abelian Groups.

Chapter 1: Sec. 1.1 to 1.6

UNIT-II : ALGEBRAIC NUMBERS

Algebraic numbers - Conjugates and Discriminants - Algebraic Integers - Integral Bases - Norms and Traces - Rings of Integers.

Chapters 2: Sec. 2.1 to 2.6

UNIT-III : QUADRATIC AND CYCLOTOMIC FIELDS

Quadratic fields and cyclotomatic fields : Factorization into Irreducibles : Trivial factorization - Factroization into irreducibles - Examples of non-unique factorization into irreducibles.

Chapter 3: Sec. 3.1 and 3.2 ; Chapter 4: Sec. 4.2 to 4.4

UNIT-IV

Prime Factroization - Euclidean Domains - Euclidean Quadratic fields - Consequences of unique factorization - The Ramanujan -Nagell Theorem.

Chapter 4: Sec. 4.5 to 4.9

UNIT-V : IDEALS

Prime Factorization of Ideals - The norms of an Ideal - Non-unique Factorization in Cyclotomic Fields..

Chapter 5 : Sec. 5.2 to 5.4

Recommended Text

I. Steward and D.Tall. *Algebraic Number Theory and Fermat's Last Theorem* (3rd Edition) A.K.Peters Ltd., Natrick, Mass. 2002.

Reference Books

1. Z.I.Bosevic and I.R.Safarevic, *Number Theory*, Academic Press, New York, 1966.
2. J.W.S.Cassels and A.Frohlich, *Algebraic Number Theory*, Academic Press, New York, 1967.
3. P.Ribenboim, *Algebraic Numbers*, Wiley, New York, 1972.
4. P. Samuel, *Algebraic Theory of Numbers*, Houghton Mifflin Company, Boston, 1970.
5. A.Weil. *Basic Number Theory*, Springer, New York, 1967.

ELECTIVE: PAPER – 4
C. STOCHASTIC PROCESSES

Objectives : This course aims to introduce advanced topics in Markov process, Markov chains and Renewal theory.

UNIT - I : STOCHASTIC PROCESSES

Specification of stochastic processes – stationary processes – Markv Chains : Definitions and Examples – Higher transition probabilities – Generalization of independent Bernoulli trials.

Chapter 2 : 2.1 to 2.4; Chapter 3 : 3.1 to 3.3

UNIT - II : MARKOV CHAINS

Stability of Markov system – Graph theoretic approach – Markov chain with denumerable number of state – Reducible chains – Statistical inference for Markov chains.

Chapter 3 : 3.6 to 3.10

UNIT - III : MARKOV PROCESS WITH DISCRETE STATE SPACE

Poisson process: Poisson process and related distributions – Generalizations of Poisson process – Birth and death process – Markov process with discrete state space (Continuous time Markov chain).

Chapter 4 : 4.1 to 4.5

UNIT - IV : MARKOV PROCESS WITH CONTINUOUS STATE SPACE

Brownian motion – Weiner process – Differential equations for Weiner Process – Kolmogorov equations – First passage time distribution for Weiner process.

Chapter 5 : 5.1 to 5.5

UNIT - V : RENEWAL PROCESS AND THEORY

Renewal process and renewal equation – Stopping time – Wald's equation – Renewal theorem – Delayed and equilibrium renewal process.

Chapter 6 : 6.1 to 6.6

Recommended Text

J. Medhi, Stochastic Processes (2^{nd} Edition), New Age International, 1992.

Reference Books

1. S. Karlin, A first course in Stochastic Processes, (2nd Edition), Academic Press, 1958.
2. U.N. Bhat, Elements of Applied Stochastic Prcesses, John Wiley Sons, 1972.
3. E. Cinlar, Introduction to Stochastic Processes, PHI, 1975
4. S.K. Srinivasan and A. Vijayakumar, Stochastic Processes, Narosa, 2003.

ELECTIVE: PAPER – 4
D. MATHEMATICAL SOFTWARES PRACTICAL

Objectives : This course aims to practice the students in Mathematics document preparation and utilizing the software facility available for tedious computations.

- **CREATING A DOCUMENT USING LATEX**
  - Simple Typesetting
  - Page Layout (page size, margins, page style)
  - Formatting (Font size, Text Alignment)
  - Tables and Figures
  - Typesetting Mathematics
  - Bibliography Management.

- **MATLAB BASICS**
  - Algebra and Arithmetic
  - Calculus, Graphics and Linear Algebra
  - Curve Fitting and Interpolation
  - Ordinary Differential Equations

Reference Books

1. Latex Tutorials – A PRIMER Indian TEX Users Group, 2002, 2003 Indian TEX Users Group Floor III SJP Buildings, Cotton Hills Trivandrum 695014, India.
2. Brain R. Hunt, Ronald R. Lipsman and Jonathan M. Rosenberg, A Guide to MATLAB for Beginners and experienced users, Cambridge University Press, 2003.
3. Getting Started with MATLAB 7, Rudra Pratap, Oxford University Press, India, 2006.
4. Rose L. Spencer, Introduction to MATLAB.

COMPUTER LABORATORY PRACTICE EXERCISES

LATEX

1. Create a document file to prepare a Chapter in a Book.
2. Create a document file to prepare a research article.

MATLAB

1. Multiplication of matrices of order 4×4
2. Solution to linear non-homogeneous equations (4 unknowns)
3. Rank of a matrix of order atleast 4
4. Solving ordinary differential equations
5. Plotting of two and three dimensional graphs SPSS
6. Drawing Histograms, frequency curves and frequency polygons
7. Finding central measures and measures of dispersion
8. Finding correlation and rank correlation
9. Finding partial and multiple correlation
10. Calculation of ANOVA

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