BHARATHIDASAN UNIVERSITY, TIRUCHIRAPPALLI – 620 024.

M.Sc. Mathematics - Course Structure under CBCS

(applicable to the candidates admitted from the academic year 2008-2009 onwards)

Semester	Course	Course Title	Ins. Hrs / Week	Credit	Exam Hrs	Marks		Total
						Int.	Extn.	
I	Core Course – I (CC)	Algebra	6	5	3	25	75	100
	Core Course – II (CC)	Real Analysis	6	5	3	25	75	100
	Core Course – III (CC)	Numerical Methods	6	4	3	25	75	100
	Core Course – IV (CC)	Ordinary Differential Equations	6	5	3	25	75	100
	Core Course – V (CC)	Integral Equations, Calculus of Variations and Fourier Transforms	6	5	3	25	75	100
		Total	**30**	**24**				**500**
II	Core Course – VI (CC)	Complex Variable	6	5	3	25	75	100
	Core Course – VII (CC)	Measure Theory and Integration	6	5	3	25	75	100
	Core Course – VIII (CC)	Partial Differential Equations	6	4	3	25	75	100
	Core Course – IX (CC)	Classical Dynamics	6	5	3	25	75	100
	Elective – I	Any one from the list	6	4	3	25	75	100
		Total	**30**	**23**				**500**
III	Core Course – X (CC)	Topology	6	5	3	25	75	100
	Core Course – XI (CC)	Functional Analysis	6	4	3	25	75	100
	Core Course – XII (CC)	Differential Geometry	6	5	3	25	75	100
	Elective - II	Any one from the list	6	4	3	25	75	100
	Elective – III	Any one from the list	6	4	3	25	75	100
		Total	**30**	**22**				**500**
IV	Core Course – XIII (CC)	C++ Programming	6	4	3	25	75	100
	Core Course – XIV	C++ Practicals	6	4	3	40	60	100
	Project Work	Dissertation=80 Marks [2 reviews –20+20=40 marks Report Valuation = 40 marks] Viva = 20 Marks	6	5	-	-	-	100
	Elective - IV	Any one from the list	6	4	3	25	75	100
	Elective - V	Any one from the list	6	4	3	25	75	100
		Total	**30**	**21**				**500**
		Grand Total	**120**	**90**				**2000**

ELECTIVE COURSE

Elective – I (any one)

1. Linear Algebra
2. Theory of Numbers
3. Fuzzy Mathematics

Elective – II & III (any Two)

4. Stochastic Processes
5. Nonlinear Differential Equations
6. Tensor Analysis and Special Theory of Relativity
7. Methods of Mathematical Physics
8. Mathematical Modeling

Elective – IV & V (any Two)

9. Financial Mathematics
10. Mathematical Statistics
11. Combinatorics
12. Optimization Techniques
13. Stochastic Differential Equations

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Note:

Core Courses include Theory, Practicals & Project

No. of Courses	14 - 17
Credit per Course	4 - 5
Total Credits	70

Elective Courses

(Major based / Non Major / Internship)

No. of Courses	4 – 5
Credit per Course	4 – 6
Total Credits	20

	Internal	External
Theory	25	75
Practicals	40	60

Project

Dissertation	80 Marks	[2 reviews – 20+20	=	40 marks
		Report Valuation	=	40 marks]
Viva	20 Marks			20 marks

Passing Minimum in a Subject

CIA	40%	Aggregate 50%
UE	40%	

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CORE COURSE I - ALGEBRA

UNIT I

GROUP THEORY: A counting principle – Normal Subgroups and Quotient groups – Homomorphism – Cayley's theorem – Permutation groups – Another counting principle – Sylow's theorems.

UNIT II

RING THEORY : Homomorphism of rings – Ideals and quotient rings – More ideals and quotient rings – Polynomial rings – Polynomials over the rational field – polynomials over commutative rings.

UNIT III

MODULUS: Inner Product Spaces – Orthogonal complement – Orthogonal Basis – Left Module over a Ring – Sub module – Quotient Module – Cyclic Module – Structure theorem for finitely generated Modules over Euclidean Rings.

UNIT IV

FIELDS : Extension fields – Roots of Polynomials – More about roots - The elements of Galois theory – Finite fields.

UNIT V

TRANSFORMATIONS: Triangular form – Hermitian, Unitary and Normal transformations

TEXT BOOK(S)

[1] I.N. Herstein, Topics in Algebra, Second Edn, Wiley Eastern Limited.

UNIT – I −Chaper II : Sec 2.5, 2.6, 2.7, 2.10, 2.11, 2.12
UNIT – II −Chapter III : Sec 3.3, 3.4, 3.5, 3.9, 3.10, 3.11
UNIT – III − Chapter IV : Sec 4.1, 4.2, 4.3, 4.4, 4.5
UNIT – IV −Chapter V : Sec 5.1, 5.3, 5.5, 5.6 and Chapter VII: Sec 7.1
UNIT – V −Chapter VI : Sec 6.4, 6.5 and 6.10

REFERENCE BOOK(S)

[1] Surjeet Singh, Qazi Zameeruddin, Modern Algebra, Vikas Publishing House Pvt Ltd.

[2] John, B. Fraleigh, A First Course in Abstract Algebra, Addison-Wesley Publishing company.
[3] Vijay, K. Khanna, and S.K. Bhambri, A Course in Abstract Algebra, Vikas Publishing House Pvt Limited, 1993.

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CC II - REAL ANALYSIS

UNIT I

Basic Topology: Finite, Countable and Uncountable Sets – Metric spaces – Compact sets – Perfect sets – Connected sets.

Numerical Sequences and Series: Sequences – Convergence – Subsequences - Cauchy Sequences – Upper and Lower Limits - Some Special Sequences – Tests of convergence – Power series – Absolute convergence – Addition and multiplication of series – Rearrangements.

UNIT II

Continuity: Limits of functions – Continuous functions – continuity and Compactness – Continuity and connectedness – Discontinuities – Monotonic functions – Infinite limits and limits at infinity. Differentiation: Derivative of a real function – Mean value Theorems - Intermediate value theorem for derivatives – L'Hospital Rule – Taylor's Theorem – Differentiation of vector valued functions.

UNIT III

Riemann – Stieltjes Integral: Definition and Existence – Properties – Integration and Differentiation – Integration of vector valued functions.

UNIT IV

Sequences and series of functions: Uniform Convergence and Continuity – Uniform Convergence and Differentiation – Equicontinuous families of functions – The Stone – Weierstrass Theorem.

UNIT V

Functions of several variables: Linear Transformations - Differentiation – The Contraction Principle – The Inverse Function Theorem - The Implicit Function Theorem.

TEXT BOOK(S)

[1] Walter Rudin, Principles of Mathematical Analysis Third Edition, Mcgraw Hill, 1976.
UNIT – I -Chapters 2 and 3
UNIT – II -Chapters 4 and 5
UNIT – III -Chapter 6
UNIT – IV -Chapter 7
UNIT – V -Chapter 9 Sections 9.1 to 9.29

REFERENCE(S)

[1] Tom P. Apostol, Mathematical Analysis, Narosa Publishing House, New Delhi, 1985.
[2] A.J. White, Real Analysis : An Introduction, Addison Wesley Publishing Co., Inc. 1968.
[3] Serge Lang, Analysis I & II, Addison-Wesley Publishing Company, Inc. 1969.

CC III: NUMERICAL METHODS

Unit I:

SOLUTION OF NONLINEAR EQUATIONS:

Newton's method – Convergence of Newton's method – Bairstow"s Method for quadratic factors NUMERICAL DIFFERENTIATION AND INTEGRATION: Derivatives from Differences tables – Higher order derivatives – Divided difference, Central-Difference formulas – Composite formula of Trapezoidal rule – Romberg integration – Simpson's rules.

Unit II:

SOLUTION OF SYSTEM OF EQUATIONS:

The Elimination method – Gauss and Gauss Jordan methods – LU Decomposition method – Matrix inversion by Gauss-Jordan method – Methods of Iteration – Jacobi and Gauss Seidal Iteration – Relaxation method – Systems of Nonlinear equations.

Unit III:

SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS:

Taylor series method – Euler and Modified Euler methods – Rungekutta methods – Multistep methods – Milne's method – Adams Moulton method.

Unit IV:

BOUNDARY VALUE PROBLEMS AND CHARACTERISTIC VALUE PROBLEMS: The shooting method – solution through a set of equations – Derivative boundary conditions – Characteristic value problems – Eigen values of a matrix by Iteration – The power method.

Unit V:

NUMERICAL SOLUTION OF PARTIAL DIFFERENTIAL EQUATIONS:

(Solutions of Elliptic, Parabolic and Hyperbolic partial differential equations) Representation as a difference equation – Laplace's equation on a rectangular region – Iterative methods for Laplace equation – The Poisson equation – Derivative boundary conditions – Solving the equation for time-dependent heat flow (i) The Explicit method (ii) The Crank Nicolson method – solving the wave equation by Finite Differences.

Treatment as in:

1. APPLIED NUMERICAL ANALYSIS' by C.F.Gerald and P.O.Wheatley, Fifth Edition, Addison Wesley, (1998).

Reference Book:

1. S.C. Chapra and P.C. Raymond: Numerical Methods for Engineers, tata McGraw Hill, New Delhi, (2000)
2. R.L. Burden and J. Douglas Faires: Numerical Analysis, P.W.S.Kent Publishing Company, Boston (1989), Fourth Edition.
3. S.S. Sastry: Introductory methods of Numerical Analysis, Prentice Hall of India, New Delhi, (1998).

CC IV - ORDINARY DIFFERENTIAL EQUATIONS

UNIT I

The general solution of the homogeneous equation – The use of one known solution to find another – The method of variation of parameters – Power Series solutions. A review of power series – Series solutions of first order equations – Second order linear equations; Ordinary points.

UNIT II

Regular Singular Points – Gauss's hypergeometric equation – The Point at infinity - Legendre Polynomials – Bessel functions – Properties of Legendre Polynomials and Bessel functions.

UNIT III

Linear Systems of First Order Equations – Homogeneous Equations with Constant Coefficients – The Existence and Uniqueness of Solutions of Initial Value Problem for First Order Ordinary Differential Equations – The Method of Solutions of Successive Approximations and Picard's Theorem.

UNIT IV

Oscillation Theory and Boundary value problems – Qualitative Properties of Solutions – Sturm Comparison Theorems – Eigenvalues, Eigenfunctions and the Vibrating String.

UNIT V

Nonlinear equations: Autonomous Systems; the phase plane and its phenomena – Types of critical points; Stability – critical points and stability for linear systems – Stability by Liapunov's direct method – Simple critical points of nonlinear systems.

TEXT BOOK(S)

G.F. Simmons, Differential Equations with Applications and Historical Notes, TMH, New Delhi, 1984.

UNIT – I -Chapter 3: Sections 15, 16, 19 and Chapter 5: Sections 25 to 27
UNIT – II -Chapter 5 : Sections 28 to 31 and Chapter 6: Sections 32 to 35
UNIT – III -Chapter 7: Sections 37, 38 and Chapter 11: Sections 55, 56
UNIT – IV -Chapter 4: Sections 22 to 24
UNIT – V -Chapter 8: Sections 42 to 44

REFERENCE(S)

[1] W.T. Reid, Ordinary Differential Equations, John Wiley & Sons, New York, 1971.
[2] E.A. Coddington and N. Levinson, Theory of Ordinary Differential Equaitons, McGraw Hill Publishing Company, New York, 1955.

CC V - INTEGRAL EQUATIONS, CALCULUS OF VARIATIONS AND FOURIER TRANSFORM

UNIT I

Calculus of variations – Maxima and Minima – the simplest case – Natural boundary and transition conditions - variational notation – more general case – constraints and Lagrange's multipliers – variable end points – Sturm-Liouville problems.

UNIT – II

Fourier transform - Fourier sine and cosine transforms - Properties Convolution - Solving integral equations - Finite Fourier transform - Finite Fourier sine and cosine transforms - Fourier integral theorem - Parseval's identity.

UNIT III

Hankel Transform : Definition – Inverse formula – Some important results for Bessel function – Linearity property – Hankel Transform of the derivatives of the function – Hankel Transform of differential operators – Parsaval's Theorem

UNIT IV

Linear Integral Equations - Definition, Regularity conditions – special kind of kernels – eigen values and eigen functions – convolution Integral – the inner and scalar product of two functions – Notation – reduction to a system of Algebraic equations – examples – Fredholm alternative - examples – an approximate method.

UNIT V

Method of successive approximations: Iterative scheme – examples – Volterra Integral equation – examples – some results about the resolvent kernel. Classical Fredholm Theory: the method of solution of Fredholm – Fredholm's first theorem – second theorem – third theorem.

TEXT BOOK(S)

[1] Ram.P.Kanwal – Linear Integral Equations Theory and Practise, Academic Press 1971.

[2] F.B. Hildebrand, Methods of Applied Mathematics II ed. PHI, ND 1972.

[3] A.R. Vasishtha, R.K. Gupta, Integral Transforms, Krishna Prakashan Media Pvt Ltd, India, 2002.

UNIT – I - Chapter 2: Sections 2.1 to 2.9 of [2]
UNIT – II - Chapter 7 of [3]
UNIT – III - Chapter 9 of [3]; UNIT – IV -Chapters 1 and 2 of [1]
UNIT – V - Chapters 3 and 4 of [1]

REFERENCE(S)

[1] S.J. Mikhlin, Linear Integral Equations (translated from Russian), Hindustan Book Agency, 1960.

[2] I.N. Snedden, Mixed Boundary Value Problems in Potential Theory, North Holland, 1966.

CC V I- COMPLEX VARIABLE

UNIT I

Elementary Point Set Topology: Sets and Elements – Metric Spaces – Connectedness – Compactness – Continuous Functions – Topological Spaces; Conformality: Arcs and Closed Curves – Analytic Functions in Regions – Conformal Mapping – Length and Area; Linear Transformations: The Linear Group – The Cross Ratio – Symmetry

UNIT II

Fundamental theorems in complex integration: Line Integrals – Rectifiable Arcs – Line Integrals as Functions of Arcs – Cauchy's Theorem for a Rectangle – Cauchy's Theorem in a Disk; Cauchy's Integral Formula: The Index of a Point with Respect to a Closed Curve – The Integral Formula – Higher Derivatives.

UNIT III

Local Properties of Analytic Functions - Removable Singularities - Taylor's Theorem – Integral representation of the n^{th} term - Zeros and Poles – Algebraic order of f(z) – Essential Singularity - The Local Mapping – The Open Mapping Theorem - The Maximum Principle.

UNIT IV

The General Form of Cauchy's Theorem: Chains and Cycles – Simple Connectivity – Homology – The General Statement of Cauchy's Theorem – Proof of Cauchy's Theorem – Locally Exact Differentials – Multiply Connected Regions; The Calculus of Residues: The Residue Theorem – The Argument Principle – Evaluation of Definite Integrals

UNIT V

Harmonic Functions: Definition and Basic Properties – The Mean-value Property – Poisson's Formula – Schwarz's Theorem – The Reflection Principle; Power series expansions-Weierstrass's Theorem – The Taylor Series – The Laurent Series;

TEXT BOOK(S)

Lars V. Ahlfors, Complex Analysis, Third Ed. McGraw-Hill Book Company, Tokyo, 1979.

UNIT – I -Chapter 3: 1.1-1.6, 2.1-2.4,3.1-3.3
UNIT – II -Chapter 4: 1.1-1.5, 2.1-2.3
UNIT – III -Chapter 4: 3.1, 3.2, 3.3,3.4
UNIT – IV -Chapter 4: 4.1-4.7, 5.1-5.3
UNIT – V -Chapter 4: 6.1-6.5, and Chapter 5: 1.1-1.3

REFERENCE(S)

[1] Serge Lang, Complex Analysis, Addisn Wesley, 1977.
[2] S. Ponnusamy, Foundations of Complex Analysis, Narosa Publishing House, New Delhi, 1997.
[3] V. Karunakaran, Complex Analysis.

CC VII - MEASURE THEORY AND INTEGRATION

UNIT I

Measure on Real line - Lebesgue outer measure - Measurable sets - Regularity - Measurable function - Borel and Lebesgue measurability.

UNIT II

Integration of non-negative functions - The General integral - Integration of series - Riemann and Lebesgue integrals.

UNIT III

Abstract Measure spaces - Measures and outer measures - Completion of a measure - Measure spaces - Integration with respect to a measure.

UNIT IV

Convergence in Measure- Almost uniform convergence- Signed Measures and Halin Decompostion –The Jordan Decomposition

UNIT V

Measurability in a Product space – The product Measure and Fubini's Theorem.

TEXT BOOK(S)

[1] G.De Barra, Measure Theory and Integration, New age international(p) Limited.

UNIT – I -Chapter II: Sections 2.1 to 2.5
UNIT – II -Chapter III : Sections 3.1 to 3.4
UNIT – III -Chapter V: Sections 5.1 to 5.6
UNIT – IV -Chapter VII: Sections 7.1 and 7.2, Chapter VIII: Sections 8.1 and 8.2
UNIT – V -Chapter X: Sections 10.1 and 10.2

REFERENCE(S)

[1] Measure and Integration, by M.E. Munroe, Addison - Wesley Publishing Company, Second Edition, 1971.
[2] P.K. Jain, V.P. Gupta, Lebesgue Measure and Integration, New Age International Pvt Limited Publishers, New Delhi, 1986. (Reprint 2000)
[3] Richard L. Wheeden and Antoni Zygmund, Measure and Integral: An Introduction to Real Analysis, Marcel Dekker Inc. 1977.
[4] Inder, K. Rana, An Introduction to Measure and Integration, Narosa Publishing House, New Delhi, 1997.

CC VIII - PARTIAL DIFFERENTIAL EQUATIONS

UNIT I

First Order P.D.E. – Curves and Surfaces – Genesis of First Order P.D.E. – Classification of Integrals – Linear Equations of the First Order – Pfaffian Differential Equations – Compatible Systems – Charpit's Method – Jacobi's Method

UNIT II

Integral Surfaces Through a Given Curve – Quasi-Linear Equations – Non-linear First Order P.D.E.

UNIT III

Second Order P.D.E.: Genesis of Second Order P.D.E. – Classification of Second Order P.D.E. One-Dimensional Wave Equation – Vibrations of an Infinite String

– Vibrations of a Semi-infinite String –Vibrations of a String of Finite Length (Method of Separation of Variables)

UNIT IV

Laplace's Equation: Boundary Value Problems – Maximum and Minimum Principles – The Cauchy Problem – The Dirichlet Problem for the Upper Half Plane – The Neumann Problem for the Upper Half Plane – The Dirichlet Interior Problem for a Circle - The Dirichlet Exterior Problem for a Circle – The Neumann Problem for a Circle – The Dirichlet Problem for a Rectangle – Harnack's Theorem – Laplace's Equation – Green's Function

UNIT V

Heat Conduction Problem – Heat Conduction –Infinite Rod Case – Heat Conduction Finite Rod Case – Duhamel's Principle – Wave Equation – Heat Conduction Equation

TEXT BOOK(S)

An Elementary Course in Partial Differential Equations by T.Amarnath, Narosa, 1997.

UNIT – I -Chapter 1: Sections 1.1 to1.8
UNIT – II -Chapter 1: Sections 1.9 to1.11
UNIT – III -Chapter 2: Sections 2.1 to2.3.5 , except 2.3.4
UNIT – IV -Chapter 2: Sections 2.4 to 2.4.11
UNIT – V -Chapter 2: Sections 2.5 to 2.6.2

REFERENCE(S)

[1] l.c. Evans, Partial Differential Equaitons, Graduate Studies in Mathematics, Vol. 19 AMS, 1998.
[2] I.N. Snedden, Elements of Partial Differential Equations.
[3] F. John, P. Prasad, Partial Differential Equations.

CC IX CLASSICAL DYNAMICS

UNIT I

Introductory concepts: The mechanical system - Generalised Coordinates - constraints - virtual work - Energy and momentum.

UNIT II

Lagrange's equation: Derivation and examples - Integrals of the Motion - Small oscillations.

UNIT III

Special Applications of Lagrange's Equations: Rayleigh's dissipation function - impulsive motion - Gyroscopic systems - velocity dependent potentials.

UNIT IV

Hamilton's equations: Hamilton's principle - Hamilton's equations - Other variational principles - phase space.

UNIT V

Hamilton - Jacobi Theory: Hamilton's Principal Function – The Hamilton - Jacobi equation - Separability.

TEXT BOOK(S)

[1] Classical Dynamics, Donald T. Greenwood, PHI Pvt. Ltd., New Delhi-1985.

UNIT – I -Chapter 1: Sections 1.1 to 1.5
UNIT – II -Chapter 2: Sections 2.1 to 2.4
UNIT – III -Chapter 3 : Sections 3.1 to 3.4
UNIT – IV -Chapter 4: Sections 4.1 to 4.4
UNIT – V -Chapter 5: Sections 5.1 to 5.3

REFERENCE(S)

[1] H. Goldstein, Classical Mechanics, (2nd Edition), Narosa Publishing House, New Delhi.
[2] Narayan Chandra Rana & Promod Sharad Chandra Joag, Classical Mechanics, Tata McGraw Hill, 1991.

CC X - TOPOLOGY

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.

UNIT II

CONTINUOUS FUNCTIONS : Continuous functions - the product topology - The metric topology.

UNIT III

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

UNIT IV

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

UNIT V : COUNTABILITY AND SEPARATION AXIOMS

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

TEXT BOOK(S)

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

UNIT – I -Chapter 2: Sections 12 to 17
UNIT – II -Chapter 2 : Sections 18 to 21 (Omit Section 22)
UNIT – III -Chapter 3 : Sections 23 to 25.
UNIT – IV -Chapter 3 : Sections 26 to 29.
UNIT – V -Chapter 4 : Sections 30 to 35.

REFERENCE(S)

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.Seeback, Counter examples in Topology, Holt, Rinehart and Winston, New York, 1970.

CC XI - FUNCTIONAL ANALYSIS

UNIT I

Algebraic Systems: Groups – Rings – The structure of rings – Linear spaces – The dimension of a linear space – Linear transformations – Algebras – Banach Spaces : The definition and some examples – Continuous linear transformations – The Hahn-Banach theorem – The natural imbedding of N in N^{**} - The open mapping theorem – The conjugate of an operator

UNIT II

Hilbert Spaces: The definition and some simple properties – Orthogonal complements – Orthonormal sets - The conjugate space H^* - The adjoint of an operator – Self-adjoint operators – Normal and unitary operators – Projections

UNIT III

Finite-Dimensional Spectral Theory: Matrices – Determinants and the spectrum of an operator – The spectral theorem – A survey of the situation

UNIT IV

General Preliminaries on Banach Algebras: The definition and some examples – Regular and singular elements – Topological divisors of zero – The spectrum – The formula for the spectral radius – The radical and semi-simplicity

UNIT V

The Structure of Commutative Banach Algebras : The Gelfand mapping – Applications of the formula $r(x) = \lim \| x^n \|^{1/n}$ - Involutions in Banach Algebras – The Gelfand-Neumark theorem

TEXT BOOK(S)

Introduction to Topology and Modern Analysis, G.F.Simmons, McGraw-Hill International Ed. 1963.

UNIT – I -Chapters 8 and 9
UNIT – II -Chapter 10
UNIT – III -Chapter 11
UNIT – IV -Chapter 12
UNIT – V -Chapter 13

REFERENCE(S)

[1] Walter Rudin, Functional Analysis, TMH Edition, 1974.
[2] B.V. Limaye, Functional Analysis, Wiley Eastern Limited, Bombay, Second Print, 1985.
[3] K. Yosida, Functional Analysis, Springer-Verlag, 1974.
[4] Laurent Schwarz, Functional Analysis, Courant Institute of Mathematical Sciences, New York University, 1964.

CC XII - DIFFERENTIAL GEOMETRY

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.

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.

UNIT III

GEODESICS: Geodesics - Canonical geodesic equations - Normal property of geodesics- Existence Theorems - Geodesic parallels - Geodesics curvature- Gauss- Bonnet Theorem - Gaussian curvature- surface of constant curvature.

UNIT IV

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.

UNIT V

DIFFERENTIAL GEOMETRY OF SURFACES: Compact surfaces whose points are umblics- Hilbert's lemma - Compact surface of constant curvature - Complete surface and their characterization - Hilbert's Theorem - Conjugate points on geodesics.

TEXT BOOK(S)

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

UNIT – I Chapter I : Sections 1 to 9.

UNIT – II Chapter II: Sections 1 to 9.;UNIT – III Chapter II: Sections 10 to 18.

UNIT – IV Chapter III: Sections 1 to 8.;UNIT – V Chapter IV : Sections 1 to 8

REFERENCE(S)

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. Wihelm 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.

PAPER XIII: COMPUTER PROGRAMMING (C++ THEORY)

Unit I:

Principles of object-Oriented Programming: Software crisis – Software evolution – A look at procedure-oriented Programming – Object-oriented Programming Paradigm – Basic Concept of Object-Oriented Programming – Benefits of OOP – Object-Oriented languages – Applications of OOP.

Unit II:

Tokens, Expressions and Control structure: Introduction – Tokens – Keywords – Identifiers and constants – basic data types – User defined data types - Derived data types – Symbolic constants – type compactability – Declaration of variables – Dynamic insulation of variables – Reference variables – operations in C++ - Scope resolution operator – member Dereferencing operators – memory management operators – Manipulators – typr cast operator – expressions and their types – Special assignment expressions – implicit conversions – operator over loading – operator precedence – Control structures.

Unit III:

Functions in C++: Introduction – The main function – Function prototyping – call by reference – return by reference inline functions – default arguments – constant arguments – function over loading – friend and virtual functions – Math library functions – Managing Console I/O operations: Introduction – C++ streams – C++ stream classes – Unformatted I/O operations - Formatted I/O operations – Managing output with manipulators.

Unit IV:

Classes and Objects: Introduction – C Structures Revisited – Specifying a class – Defining Member Functions – A C++ Program with class – Making an outside Function Inline – Nesting of Member Functions – Private Member Functions – Arrays within a class – Memory Allocation for Objects – Static Data Members – Static Member Functions – Arrays of Objects – Objects as Function Arguments – Friendly functions – Returning Objects – Constant Member Functions.

Constructors and Destructors: Introduction – Constructors – Parameterized Constructors – Multiple Constructors in a class – Constructors with Default Arguments – Dynamic Initializations of Objects – Copy Constructor – Constructing Two dimensional arrays – Constant Objects – Destructors.

Unit V:

Operators Overloading and Type Conversions: Introduction – Defining Operator Overloading – Overloading Unary Operators – Overloading Binary Operators – Overloading Binary Operators Using Friends – manipulating of strings Using Operators – Rules of Overloading Operators.

Inheritance: Extending Classes: Introduction – Defining Derived Classes – Single inheritance – Making a Private Member Inheritable – Multilevel Inheritance – Multiple

Inheritance – Hierachial Inheritance – Hybrid Inheritance – Virtual Base Classes – Abstract Classes – Constructors in Derived Classes – Member Classes: Nesting of Classes.

Treatment as in:

1. Object – Oriented Programming with C++ by E. Balaguruswamy, Tata McGraw-Hill Publishing Company Limited, 1999.

Unit I	:	1.1 – 1.8
Unit II	:	3.1 – 3.24
Unit III	:	4.1 – 4.11 and 10.1 – 10.6
Unit IV	:	5.1 – 5.17, 6.1 – 6.7 and 6.9 – 6.11
Unit V	:	7.1 – 7.7 and 8.1 – 8.12

CC XIV. C++ PRACTICAL

1. DISTANCE CONVERSION PROBLEM:

Create two classes DM and DB which store the value of distances. DM store the value of distances. DM stores distances in meters and centimeters in DB in feet and inches. Write a Program that can create the values of the class objects and add one object DM with another object DB.

Use a friend function to carry out addition operation. The object that stores the result may be DM object or DB object depending on the units in which results are required.

The display should be in the order of meter and centimeter and feet or inches depending on the order of display.

2. OVERLOADING OBJECTS:

Create a class FLOAT that contains one float data member overload all the four arithmetic operators so that operate on the objects of FLOAT.

3. OVERLOADING CONVERSIONS:

Design a class polar which describes a pant in a plane using polar Co-ordinates radius and angle. A point in polar Co-ordinates is as shown below.

Use the overloader + operator to add two objects of polar. Note that we cannot add polar values of two points directly. This requires first the conversion.

Points into rectangular Co-ordinates and finally converting the result into polar Co-ordinates. You need to use following trigonometric formulas.

X= r * cos (a); **Y= r * sin (a);** **a=** $\tan^{-1}\left(Y/X\right)$, **r = sqrt (X * X +Y * Y);**

4. POLAR CONVERSION:

Define two classes polar and rectangular to represent points in the polar and rectangle systems. Use conversion routines to convert from one syatem to another.

5. OVRELOADING MATRIX:

Create a class MAT of size M*N. Define all possible matrix operations for MAT type objects. Verify the identity.

*(A-B)^2 = A^2+B^2 – 2*A*B*

6. AREA COMPUTATION USING DERIVED CLASS:

Area of rectangle = *X*Y*

Area of triangle = ½ * *X* * *Y*

7. VECTOR PROBLEM:

Define a class for vector containing scalar values. Apply overloading concepts for vector addition, Multiplication of a vector by a scalar quantity, replace the values in a position vector.

LIST OF ELECTIVES
1. 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

The algebra of polynomials – Lagrange Interpolation – Polynomial Ideals – The prime factorization of a polynomial, 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 – Simultaneous triangulation and simultaneous Diagonalization – Direct-sum Decompositions.

UNIT V

Invariant Direct sums – The Primary Decomposition Theorem – Cyclic subspaces – Cyclic Decompositions and the Rational Form.

TEXT BOOK(S)

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

UNIT – I	-	Chapters 1 and 2
UNIT – II	-	Chapter 3
UNIT – III	-	Chapter 4 and Chapter 5: Sections 5.1 to 5.4
UNIT – IV	-	Chapter 6: Sections 6.1 to 6.6
UNIT – V	-	Sections 6.7 and 6.8 and Chapter 7: Sections 7.1 to 7.4

REFERENCE(S)

[1] I.N. Herstein, Topics in Algebra, Wiley Eastern Limited, New Delhi, 1975.

[2] I.S. Luther and I.B.S. Passi, Algebra, Vol.I – Groups, Vol.II- Rings, Narosa Publishing House (Vol.I – 1996, Vol.II- 1999)

[3] N. Jacobson, Basic Algebra, Vols. I & II, Freeman, 1980 (also published by Hisdustan Publishing Company)

2. THEORY OF NUMBERS

UNIT I

Introduction – Divisibility – Primes – The Binomial Theorem – Congruences – Euler's totient - Fermat's, Euler's and Wilson's Theorems – Solutions of congruences – The Chinese Remainder theorem.

UNIT II

Techniques of numerical calculations – Public key cryptography – Prime power Moduli – Primitive roots and Power Residues –Congruences of degree two.

UNIT III

Number theory from an Algebraic Viewpoint – Groups, rings and fields – Quadratic Residues- The Legendre symbol (a/r) where r is an odd prime – Quadratic Reciprocity – The Jacobi Symbol (P/q) where q is an odd positive integer

UNIT IV

Binary Quadratic Forms – Equivalence and Reduction of Binary Quadratic Forms – Sums of three squares – Positive Definite Binary Quadratic forms – Greatest integer Function – Arithmetic Functions – The Mobius Inversion Formula – Recurrence Functions – Combinatorial number theory

UNIT V

Diophantine Equations – The equation ax+by=c – Simultaneous Linear Diophantine Equations – Pythagorean Triangles – Assorted examples

TEXT BOOK(S)

[1] Ivan Niven, Herbert S, Zuckerman and Hugh L, Montgomery, An Introduction to the Theory of Numbers, Fifth edn., John Wiley & Sons Inc, 2004

UNIT I Chapter 1 and Chapter 2 : Sections 2.1 to 2.3
UNIT II Chapter 2 : Sections 2.4 to 2.9
UNIT III Chapter 2 : Sections 2.10, 2.11 and Chapter 3: Sections 3.1 to 3.3
UNIT IV Chapter 3 : Sections 3.4 to 3.7 and Chapter 4
UNIT V Chapter 5: Sections 5.1 to 5.4

REFERENCE(S)

[1] David M. Burton, Elementary Number Theory, W.M.C. Brown Publishers, Dubuque, Lawa, 1989.
[2] George Andrews, Theory of Numbers.
[3] Fundamentals of Number Theory, William.J. Leveque, Addison-Wesley Publishing Company, Phillipines, 1977.

3. FUZZY MATHEMATICS

UNIT – I

Fuzzy sets – Basic types – Basic concepts – α-cuts – Additional properties of α-cuts – Extension principle for Fuzzy sets.

UNIT – II

Operations on Fuzzy sets – Types of operations – Fuzzy complements – t-Norms – Fuzzy Unions – Combinations of operations.

UNIT – III

Fuzzy Arithmetic – Fuzzy numbers – Arithmetic operations on intervals – Arithmetic operations on Fuzzy numbers.

UNIT – IV

Fuzzy relations – Binary fuzzy relations – Fuzzy equivalence relations – Fuzzy compatibility relations – Fuzzy ordering relations – fuzzy morphisms.

UNIT - V

Fuzzy Relation Equations – General discussion – Problem partitioning – Solution method – Fuzzy Relation Equations based on Sup-i Compositions - Fuzzy Relation Equations based on inf-ω_i Compositions.

TEXT BOOK

[1] George J.Klir and Bo Yuan, Fuzzy Sets and Fuzzy Logic, Prentice Hall of India, New Delhi, 2004.

REFERENCE(S)

[1] H.J. Zimmermann, Fuzzy Set Theory and its Applications, Allied Publishers Limited, New Delhi, 1991.
[2] G.J. Klir and B. Yuan, Fuzzy Sets and Fuzzy Logic, Prentice Hall of India, New Delhi, 1995.

4. STOCHASTIC PROCESSES

UNIT I

Stochastic Processes: Some notions – Specification of Stochastic processes – Stationary processes – Markov Chains – Definitions and examples – Higher Transition probabilities – Generalization of Independent Bernoulli trails – Sequence of chain – Dependent trains.

UNIT II

Markov chains : Classification of states and chains – determination of Higher transition probabilities – stability of a Markov system – Reducible chains – Markov chains with continuous state space.

UNIT III

Markov processes with Discrete state space : Poisson processes and their extensions – Poisson process and related distribution – Generalization of Poisson process- Birth and Death process – Markov processes with discrete state space (continuous time Markov Chains).

UNIT IV

Renewal processes and theory : Renewal process – Renewal processes in continuous time – Renewal equation – stopping time – Wald's equation – Renewal theorems.

UNIT V

Stochastic processes in Queuing – Queuing system – General concepts – the queuing model M/M/1 – Steady state Behaviour – transient behaviour of M/M/1 Model – Non-Markovian models - the model GI/M/1.

TEXT BOOK(S)

[1] J. Medhi, Stochastic Processes, Howard M. Taylor – Second edition.

UNIT I Ch. II : Sec 2.1 to 2.3, Ch III : Sec 3.1 to 3.3
UNIT II Ch III – Sec 3.4 tp 3.6, 3.8, 3.9 and 3.11
UNIT III Ch IV : Sec 4.1 to 4.5
UNIT IV Ch VI : Sec 6.1 to 6.5
UNIT V Ch X : Sec 10.1 to 10.3, 10.7 and 10.8 (omit sec 10.2.3 & 10.2.3.1)

REFERENCE(S)

1. Samuel Korlin, Howard M. Taylor, A first course in stochastic processes, II Edn.
2. Narayan Bhat , Elements of Applied Stochastic Processes,
3. Srinivasan and Metha, Stochastic Processes,
   N.V. Prabhu, Macmillan (NY), Stochastic Processes.

5. NON LINEAR DIFFERENTIAL EQUATIONS

Unit-I:

First order systems in two variables and linearization: The general phase plane-some population models – Linear approximation at equilibrium points – Linear systems in matrix form.

Unit-II:

Averaging Methods: An energy balance method for limit cycles – Amplitude and frequency estimates – slowly varying amplitudes – nearly periodic solutions - periodic solutions: harmony balance – Equivalent linear equation by harmonic balance – Accuracy of a period estimate.

Unit-III:

Perturbation Methods: Outline of the direct method – Forced Oscillations far from resonance - Forced Oscillations near resonance with Weak excitation – Amplitude equation for undamped pendulum – Amplitude Perturbation for the pendulum equation – Lindstedt's Method – Forced oscillation of a self – excited equation – The Perturbation Method and Fourier series.

Unit-IV:

Linear Systems: Time Varying Systems – Constant coefficient System – Periodic Coefficients – Floquet Theory – Wronskian.

Unit-V:

Stability: Poincare stability – solutions, paths and norms – Liapunov stability Stability of linear systems – Comparison theorem for the zero solutions of nearly – linear systems.

Text Book:

Nonlinear Ordinary Differential Equations By D.W.Jordan, & P.Smith, Clarendon Press, Oxford, 1977.

References:

1. Differential Equations by G.F.Simmons, Tata McGraw Hill, NewDelhi (1979)

2. Ordinary Differential Equations and Stability Theory By D.A.Sanchez, Freeman (1968).

3. Notes on Nonlinear Systems by J.K.Aggarwal, Van Nostrand, 1972.

6. TENSOR ANALYSIS AND SPECIAL THEORY OF RELATIVITY

UNIT I

Invariance - Transformations of coordinates and its properties - Transformation by invariance - Transformation by covariance and contra variance - Covariance and contra variance - Tensor and Tensor character of their laws - Algebras of tensors - Quotient tensors - Symmetric and skew symmetric tensors – Relative tensors.

UNIT II

Metric Tensor - The fundamental and associated tensors - Christoffel's symbals - Transformations of Chrisffel's symbols- Covariant Differentiation of Tensors - Formulas for covariant Differentiation- Ricci Theorem - Riemann -Christoffel Tensor and their properties.

UNIT III

Einstein Tensor - Riemannian and Euclidean Spaces (Existence Theorem) - The e-systems and the generalized Kronecker deltas - Application of the e-systems.

UNIT IV

Special Theory of Relativity: Galilean Transformation - Maxwell's equations - The ether Theory – The Principle of Relativity Relativistic Kinamatics : 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.

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 .

TEXT BOOK(S)

[1] I.S. Sokolnikoff, Tensor Analysis, John Wiley and Sons, New York, 1964
[2] D. Greenwood, Classical Dynamics, Prentice Hall of India, New Delhi, 1985

UNIT I Chapter 2 : Sections 18 to 28 of [1]
UNIT II Chapter 2 : Sections 29 to 37 of [1]
UNIT III Chapter 2 : Section 38 to 41 of [1]
UNIT IV Chapter 7 : Sections 7.1 and 7.2 of [2]
UNIT V Chapter 7 : Sections 7.3 and 7.4 of [2]

REFERENCE(S)

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 Tensor Calculus, Cambridge, 1938

7. METHODS OF MATHEMATICAL PHYSICS

UNIT I

Boundary value problems and series solution - Examples of boundary value problems - Eigen values, eigen functions and the Sturm-Liouville problem - Hermitian operator, their eigen values and eigen functions.

UNIT II

Bessel functions - Bessel functions of 'the second kind, Hankel functions Spherical Bessel functions - Legendre polynomials - Associated Legendre polynomials and spherical harmonics.

UNIT III

Hermite polynomials - Laguerre polynomials - The Gamma function - The Dirac Delta function

UNIT IV

Non homogeneous boundary value problems and Green's function - Green's function for one-dimensional problems - eigen function expansion of Green's function - Fourier transform method of constructing Green's function.

UNIT V

Green's function in higher dimensions - Green's function for Poisson's equation and a formal solution of electrostatic boundary value problems ~ Wave equation with source - the quantum mechanical scattering problem.

TEXT BOOK(S)

[1] P.K. Chattopadhyay -Mathematical Physics, Wiley Eastern Limited, 1990.

Unit I : Sections 4.2 to 4.5
Unit II : Sections 5.1 to 5.5
Unit III : Sections 5.6 to 5.9
Unit IV : Sections 6.1 to 6.4
Unit V : Sections 6.5. to 6.8.

REFERENCE(S)

[1] B.D. Gupta, Mathematical Physics, Vikas Publishing House Pvt Ltd, New Delhi, 1993.
[2] Goyal AK Ghatak, Mathematical Physics- Differential Equations and Transform Theory, McMillan India Ltd, 1995.
[3] Kryzeg, Higher Engineering Mathematics.

8. MATHEMATICAL MODELLING

UNIT I

Mathematical Modelling through Ordinary Differential Equations of First order : Linear Growth and Decay Models – Non-Linear Growth and Decay Models – Compartment Models – Dynamics problems – Geometrical problems.

UNIT II

Mathematical Modelling through Systems of Ordinary Differential Equations of First Order : Population Dynamics – Epidemics – Compartment Models – Economics – Medicine, Arms Race, Battles and International Trade – Dynamics.

UNIT III

Mathematical Modelling through Ordinary Differential Equations of Second Order: Planetary Motions – Circular Motion and Motion of Satellites – Mathematical Modelling through Linear Differential Equations of Second Order – Miscellaneous Mathematical Models.

UNIT IV

Mathematical Modelling through Difference Equations : Simple Models – Basic Theory of Linear Difference Equations with Constant Coefficients – Economics and Finance – Population Dynamics and Genetics – Probability Theory.

UNIT V

Mathematical Modelling through Graphs : Solutions that can be Modelled through Graphs – Mathematical Modelling in Terms of Directed Graphs, Signed Graphs, Weighted Digraphs and Unoriented Graphs.

TEXT BOOK(S)

J.N. Kapur, Mathematical Modelling, Wiley Eastern Limited, New Delhi, 1988.

REFERENCE(S)

[1] J. N. Kapur, Mathematical Models in Biology and Medicine, Affiliated East –West Press Pvt Limited, New Delhi, 1981.

9. FINANCIAL MATHEMATICS

UNIT I

SINGLE PERIOD MODELS: Definitions from Finance - Pricing a forward - One-step Binary Model - a ternary Model - Characterization of no arbitrage - Risk-Neutral Probability Measure

UNIT II

BINOMIAL TREES AND DISCRETE PARAMETER MARTINGALES: Multi-period Binary model - American Options - Discrete parameter martingales and Markov processes - Martingale Theorems - Binomial Representation Theorem - Overturn to Continuous models

UNIT III

BROWNIAN MOTION: Definition of the process - Levy's Construction of Brownian Motion - The Reflection Principle and Scaling - Martingales in Continuous time.

UNIT IV

STOCHASTIC CALCULUS: Non-differentiability of Stock prices - Stochastic Integration - Ito's formula - Integration by parts and Stochastic Fubini Theorem - Girsanov Theorem - Brownian Martingale Representation Theorem – Geometric Brownian Motion - The Feynman - Kac Representation

UNIT V

BLOCK-SCHOLES MODEL: Basic Block-Scholes Model - Block-Scholes price and hedge for European Options - Foreign Exchange - Dividends - Bonds - Market price of risk.

TEXT BOOK(S)

[1] Alison Etheridge, A Course in Financial Calculus, Cambridge University Press, Cambridge, 2002.

REFERENCE(S)

1. Martin Boxter and Andrew Rennie, Financial Calculus: An Introduction to Derivatives Pricing, Cambridge University Press, Cambridge, 1996.
2. Damien Lamberton and Bernard Lapeyre, (Translated by Nicolas Rabeau and Farancois Mantion),
3. Introduction to Stochastic Calculus Applied to Finance, Chapman and Hall, 1996.
4. Marek Musiela and Marek Rutkowski, Martingale Methods in Financial Modeling, Springer Verlag, New York, 1988.
5. Robert J.Elliott and P.Ekkehard Kopp, Mathematics of Financial Markets, Springer Verlag, New York, 2001 (3rd Printing)

10. MATHEMATICAL STATISTICS

UNIT I

Collection, classification and tabulation of data, graphical and diagramatic representation – Bar diagrams, Pie diagram, Histogram, Frequency polygon, frequency curve and Ogives. Measure of central tendency – Mean, Median and Mode in series of individual observations, Discrete series, Continuous series (inclusive), More than frequency, Less than frequency, Mid-value and open-end class.

UNIT II

Measures of dispersion – Range, Quartile deviation, Mean deviation about an average, Standard deviation and co-efficient of variation for individual, discrete and continuous type data.

UNIT III

Correlation – Different types of correlation – Positive, Negative, Simple, Partial Multiple, Linear and non-Linear correlation. Methods of correlation – Karlpearson's Spearman's correlations, Concurrent deviation and Scatter diagram.

UNIT IV

Regression types and method of analysis, Regression line, Regression equations, Deviation taken from arithmetic mean of X and Y, Deviation taken from assumed mean, Partial and multiple regression coefficients – Applications

UNIT V

Sampling theory – Testing of hypothesis using normal distribution – Single mean, Two mean, Single proportion, Two proportions and Two Standard Deviations and Student – t distribution – Single mean, Two mean, Paired t-test, Simple correlation coefficient – Chi-square test-Independents of attributes and goodness of fit-applications. Analysis of variance – One-way and two-way classification with simple problems.

TEXT BOOK(S)

[1] S.C.Gupta, V.K.Kapoor, Fundamentals of Mathematical Statistics, Sultan Chand and Sons, New Delhi, 1994.

REFERENCE(S)

[1] Freund J.E.(2001); Mathematical Statistics, Prentice Hall of India.
[2] Goon, A.M., Gupta M.K., Dos Gupta, B, (1991), Fundamentals of Statistics, Vol.I, World Press, Calcutta.

11. COMBINATORICS

UNIT I

Permutations and combinations - distributions of distinct objects ~ distributions of non distinct objects - Stirlings formula.

UNIT II

Generating functions. - generating function for combinations - enumerators for permutations - distributions of distinct objects into non-distinct cells - partitions of integers – the Ferrers graphs - elementary relations. .

UNIT III

Recurrence relation - linear recurrence relations with constant coefficients solutions by the technique of generating functions - a special class of nonlinear difference equations - recurrence relations with two indices.

UNIT IV

The principle of inclusion and exclusion - general formula - permutations with restriction on relative positions - derangements - the rook polynomials - permutations with forbidden positions.

UNIT V

Polya's theory of counting - equivalence classes under a permutation group Burnside theorem - equivalence classes of functions - weights and inventories of functions - Polya' s fundamental theorem – generation of Polya’s theorem

TEXT BOOK(S)

[1] C.L. Liu - Introduction of Combinatorial Mathematics, McGraw Hill, Chapters 1 to 5.

REFERENCE(S)

[1] Marshall Hall. Jr., Combinatorial Theory.
[2] H.J. Rayser, Combinatorial Mathematics, Carus, Mathematical Monograph, No.14

12. OPTIMIZATION TECHNIQUES

UNIT I

Integer programming

UNIT II

Dynamic (Multistage) programming,

UNIT III

Decision Theory and Games.

UNIT IV

Inventory Models.

UNIT V

Non-Linear Programming algorithms.

TEXT BOOK(S)

[1] Hamdy A. Taha, Operations Research (7^{th} Edn.), McGraw Hill Publications, New Delhi.

UNIT I Sections 8.1 to 8.5
UNIT II Sections 9.1 to 9.5
UNIT III Sections 11.1 to 11.4
UNIT IV Sections 13.1 to 13.4
UNIT V Sections 19.1 and 19.2.

REFERENCE(S)

[1] O.L. Mangasarian, Non Linear Programming, McGraw Hill, New York.
[2] Mokther S. Bazaraa and C.M. Shetty, Non Linear Programming, Theory and Algorithms, Willy, New York.
[3] Prem Kumar Gupta and D.S. Hira, Operations Research : An Introduction, S. Chand and Co., Ltd. New Delhi,
[4] S.S. Rao, Optimization Theory and Applications, Wiley Eastern Limited, New Delhi.

13.STOCHASTIC DIFFERENTIAL EQUATIONS

Unit I

Introduction: Stochastic Analogs of Classical Differential Equations, Filtering Problems, Stochastic Approach to Deterministic Boundary Value Problems, Optimal Stopping, Stochastic Control and Mathematical Finance. Some mathematical preliminaries: Probalitity Spaces, Random Variables and Stochastic Processes and an Important Example: Brownian Motion.

Unit II

Ito Integrals: Construction of the Ito integral, Some Properties of the Ito Integral and Extensions of the Ito Integral.

Unit III

The Ito formula and the Martingale Representation Theorem: The 1- dimentional Ito Formula, the Multi dimensional Ito Formula and the Martingale Reprsentation Theorem. Stochastic Differential Equations: Examples and Some Solution Methods, An Existence and Uniqueness Result and Weak and Strong Solutions.

Unit IV

The Filtering problem: Introduction, The 1- dimentional Linear Filtering Problem and the Multi- dimentional Linear Filtering Problem.

Unit V

Diffusions: Basic Properties: The Markov Property, the Strong Markov Property, the Generator of an Ito Diffusion, the Dynkin Formula, the Characteristic Operator.

Text Book:

"Stochastic Differential Equations - An Introduction with Applications", by **Bernt Oksendal**, Sixth Edition, Springer-Verlag, Heidelberg, 2003.

Unit I : Chapter 1 and 2
Unit II : Chapter
Unit III: Chapter 4 and 5
Unit IV: Chapter 6
Unit V : Chapter 7.

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