BHARATHIDASAN UNIVERSITY, TIRUCHIRAPPALLI – 620 024.

M.Sc. Mathematics Course Structure under CBCS

(For the candidates admitted from the academic year 2016-2017 onwards)

Sem	Course	Course Title	Ins. Hrs / Week	Credit	Exam Hrs	Marks		Total
						Int.	Ext.	
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)	Ordinary Differential Equations	6	5	3	25	75	100
	Core Course – IV (CC)	Graph Theory	6	5	3	25	75	100
	Core Course - V (CC)	Integral Equations, Calculus of Variations and Transforms	6	5	3	25	75	100
	TOTAL		**30**	**25**				**500**
II	Core Course – VI (CC)	Complex Analysis	6	5	3	25	75	100
	Core Course – VII (CC)	Linear Algebra	6	5	3	25	75	100
	Core Course – VIII(CC)	Partial Differential Equations	6	5	3	25	75	100
	Elective Course – I (EC)		6	3	3	25	75	100
	Elective Course – II (EC)		6	3	3	25	75	100
	TOTAL		**30**	**21**				**500**
III	Core Course – IX (CC)	Classical Dynamics	6	5	3	25	75	100
	Core Course – X (CC)	Measure and Integration	6	5	3	25	75	100
	Core Course – XI(CC)	Topology	6	5	3	25	75	100
	Elective Course – III (EC)		6	3	3	25	75	100
	Elective Course – IV (EC)		6	3	3	25	75	100
	TOTAL		**30**	**21**				**500**
IV	Core Course – XII (CC)	Functional Analysis	6	5	3	25	75	100
	Core Course – XIII (CC)	Differential Geometry	6	5	3	25	75	100
	Core Course – XIV(CC)	Advanced Numerical Analysis	6	5	3	25	75	100
	Elective Course – V (EC)		6	3	3	25	75	100
	Project		6	5	-	-	-	100
	TOTAL		**30**	**23**				**500**
GRAND TOTAL			**120**	**90**				**2000**

List of Elective Courses (For 2016 – 2017) :

Elective I		**Elective II**	
1	Advanced Probability Theory	1	Stochastic Processes
2	Mathematical Modeling	2	Tensor Analysis and Special Theory of Relativity
3	Fuzzy sets and their Applications	3	Non linear Differential Equations
Elective III		**Elective IV**	
1	Design and Analysis of Algorithms	1	Financial Mathematics
2	Discrete Mathematics	2	Advanced Operations Research
3	Automata Theory	3	Combinatorics
Elective V			
1	Algebraic Topology		
2	Fluid Dynamics		
3	Algebraic Number Theory		

Note:

Project	:100 Marks
Dissertation	: 80 Marks
Viva Voice	: 20 Marks

Core Papers	-	10
Core Practical	-	4
Elective Papers	-	5
Project	-	1

Note:

1. Theory	Internal	25 marks	External	75 marks
2. Practical	”	40 marks	”	60 marks

Note:

1. Theory	Internal	25 marks	External	75 marks
2. Practical	”	40 marks	”	60 marks

3. Separate passing minimum is prescribed for Internal and External
   a) The passing minimum for CIA shall be 40% out of 25 marks (i.e. 10 marks)
   b) The passing minimum for University Examinations shall be 40% out of 75 marks (i.e. 30 marks)
   c) The passing minimum not less than 50% in the aggregate.

Reference/Text Books contain the following details:

I. Name of the Author
II. Title of the Book
III. Name of the Publisher
IV. Year

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CORE COURSE I

ALGEBRA

Objectives

1. To give foundation in Algebraic structures like Groups ,Rings
2. To train the students in problem solving in 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 : Homomorphisms -Ideals and quotient rings – More ideals and quotient rings –Euclidean Rings-A particular Euclidean Ring.

UNIT III

Polynomial rings – Polynomials over the rational field – polynomials over commutative Rings -Inner Product spaces.

UNIT IV

FIELDS: Extension fields – Roots of Polynomials – More about roots.

UNIT V

The elements of Galois theory– Finite fields.

TEXT BOOK

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

UNIT – I	-Chapter 2 : Sec 2.5, 2.6, 2.7,2.9, 2.10, 2.11, 2.12
UNIT – II	-Chapter 3 : Sec 3.3, 3.4, 3.5,3.7,3.8.
UNIT – III	- Chapter 3&4 : 3.9,3.10,3.11, 4.4
UNIT – IV	-Chapter 5 : Sec 5.1, 5.3,5.5
UNIT – V	-Chapter 5&7:Sec 5.6,7.1

REFERENCE BOOKS

1. David S.Dummit and Richard M.Foote ,Abstract Algebra,Third Edition,Wiley Student Edition,2015.
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.
4. Joseph A.Gallian,Contemporary Abstract Algebra,Fourth Edition,Narosa publishing House,1999.

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CORE COURSE II

REAL ANALYSIS

Objectives:

1. To give the students a thorough knowledge of the various aspects of Real line and Metric Spaces which is imperative for any advanced learning in Pure Mathematics.
2. To train the students in problem-solving as a preparatory for competitive exams.

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's 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 BOOKS

[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

REFERENCES

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.
4. N.L.Carothers, Real Analysis, Cambridge University press, Indian edition, 2013.

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CORE COURSE III

ORDINARY DIFFERENTIAL EQUATIONS

Objectives

1. To give an in-depth knowledge of differential equations and their applications.
2. To study the existence, uniqueness, stability behavior of the solutions of the ODE

UNIT I

The general solution of the homogeneous equation– he 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 BOOKS

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

REFERENCES

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.

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CORE COURSE IV

GRAPH THEORY

Objectives

1. To give a rigorous study of the basic concepts of Graph Theory.
2. To study the applications of Graph Theory in other disciplines.

***Note*: Theorems, Propositions and results which are starred are to be omitted.**

Unit I Basic Results

Basic Concepts - Subgraphs - Degrees of Vertices - Paths and Connectedness-Operations on Graphs - Directed Graphs: Basic Concepts - Tournaments.

Unit II Connectivity

Vertex Cuts and Edge Cuts - Connectivity and Edge - Connectivity, Trees:Definitions, Characterization and Simple Properties - Counting the Number of Spanning Trees - Cayley's Formula.

Unit III Independent Sets and Matchings

Vertex Independent Sets and Vertex Coverings - Edge Independent Sets -Matchings and Factors - Eulerian Graphs - Hamiltonian Graphs.

Unit IV Graph Colourings

Vertex Colouring - Critical Graphs - Triangle - Free Graphs - Edge Colourings of Graphs - Chromatic Polynomials.

Unit V Planarity

Planar and Nonplanar Graphs - Euler Formula and its Consequences - K5 and K3,3 are Nonplanar Graphs - Dual of a Plane Graph - The Four-Colour Theorem and the Heawood Five-Colour Theorem-Kuratowski's Theorem.

Textbook

1. R. Balakrishnan, K. Ranganathan, A Textbook of Graph Theory, Springer International Edition, New Delhi, 2008.

UNIT I	Chapter I & II: 1.1 to 1.4, 1.7, 2.1, 2.2
UNIT II	Chapter III & IV: 3.1, 3.2, 4.1, 4.3 to 4.4
UNIT III	Chapter V & VI: 5.1 to 5.4, 6.1, 6.2
UNIT IV	Chapter VII: 7.1 to 7.4, 7.7
UNIT V	Chapter VIII: 8.1 to 8.6

References

1. J.A. Bondy, U.S.R. Murty, Graph Theory with Applications, Mac MilanPress Ltd., 1976.
2. Gary Chartrand, Linda Lesniak, Ping Zhang, Graphs and Digraph,CRC press,2010.
3. F.Harary, Graph Theory, Addison - Wesley, Reading, Mass., 1969.

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CORE COURSE V

INTEGRAL EQUATIONS, CALCULUS OF VARIATIONS AND TRANSFORMS

Objectives.

1. To introduce the concept of calculus of variations and integral equations and their applications.
2. To study the different types of transforms and their properties.

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 – Parseval'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 BOOKS

[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]

REFERENCES

[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.

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CORE COURSE VI

COMPLEX ANALYSIS

Objectives

1. To learn the various intrinsic concepts and the theory of Complex Analysis.
2. To study the concept of Analyticity, Complex Integration and Infinite Products in depth.

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

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

REFERENCES

1. Serge Lang, Complex Analysis, Addison Wesley, 1977.
2. S. Ponnusamy, Foundations of Complex Analysis, Narosa Publishing House, New Delhi, 1997.
3. Karunakaran, Complex Analysis,Alpha Science international Ltd,Second edition,2005.

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CORE COURSE VII

LINEAR ALGEBRA

Objectives

1. To give the students a thorough knowledge of the various aspects of Linear Algebra
2. To train the students in problem-solving as a preparatory for competitive exam.

UNIT I: Matrices:

Systems of linear Equations - Matrices and Elementary Row operations -Row-reduced echelon Matrices - Matrix Multiplication - Invertible Matrices -Bases and Dimension. (Only revision of Vector spaces and subspaces).

Unit II: Linear transformations:

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: Algebra of polynomials:

The algebra of polynomials - Lagrange Interpolation - Polynomial Ideals -The prime factorization of a polynomial - Commutative rings – Determinant functions.

Unit IV: Determinants:

Permutations and the uniqueness of determinants - Classical Adjoint of a (square) matrix - Inverse of an invertible matrix using determinants -Characteristic values - Annihilating polynomials.

Unit V: Diagonalization:

Invariant subspaces - Simultaneous triangulation and simultaneous Diagonalization Direct-sum Decompositions - Invariant Direct sums – Primary Decomposition theorem.

TEXTBOOK

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

UNIT I Chapter 1 & 2 1.2-1.6 and 2.3
UNIT II Chapter 3
UNIT III Chapter 4 & 5 4.1 - 4.5 and 5.1 - 5.2
UNIT IV Chapter 5 & 6 5.3, 5.4 and 6.1 - 6.3
UNIT V Chapter 6 6.4 - 6.8

REFERENCES

1. S. Kumaresan, Linear Algebra: A Geometric Approach, Prentice-Hall of India Ltd, 2004.
2. V. Krishnamurthy, V.P. Mainra, J.L. Arora, Introduction to Linear Algebra, East West Press Ltd, 1985.
3. A.R. Rao, P. Bhimashankaram, Linear Algebra, Second Edition, Tata McGraw Hill, 2000.
4. Edgar G.Goodaire, Linear Algebra-Pure & Applied World Scientific, Cambridge University Press India Ltd, 2014

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CORE COURSE VIII

PARTIAL DIFFERENTIAL EQUATIONS

Objectives

1. To give an in-depth knowledge of solving partial differential equations and apply them in scientific and engineering problems.
2. To study the other aspects of PDE

UNIT I

Partial differential equations- origins of first order Partial differential equations- Cauchy's problem for first order equations- Linear equations of the first order- Integral surfaces Passing through a Given curve- surfaces Orthogonal to a given system of surfaces -Non linear Partial differential equations of the first order.

UNIT II

Cauchy's method of characteristics- compatible systems of first order equations- Charpits method- Special types of first order equations- Solutions satisfying given conditions- Jacobi's method.

UNIT III

Partial differential equations of the second order : The origin of second order equations –second order equations in Physics – Higher order equations in Physics - Linear partial differential equations with constant co-efficient- Equations with variable coefficients- Characteristic curves of second order equations

UNIT IV

Characteristics of equations in three variables- The solution of Linear Hyperbolic equations-Separation of variables. The method of Integral Transforms – Non Linear equations of the second order.

Unit V

Laplace equation : Elementary solutions of Laplace's equations-Families of equipotential Surfaces- Boundary value problems-Separation of variables –Problems with Axial Symmetry.

TEXT BOOK

Ian N. Sneddon,Elements of Partial differential equations**,** Dover Publication –INC, New York, 2006.
UNIT I Chapter II Sections 1 to 7
UNIT II Chapter II Sections 8 to 13
UNIT III Chapter III Sections 1 to 6
UNIT IV Chapter III Sections 7 to 11
UNIT V Chapter IV Sections 2 to 6

REFERENCES

1. **M.D.Raisinghania**, Advanced Differential Equations , S.Chand and company Ltd., New Delhi,2001.
2. **E.T.Copson,** Partial Differential Equations, Cambridge University Press

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ELECTIVE I (1)
(Any one)

ADVANCED PROBABILITY THEORY

Objectives:

1. To make the students to understand about fields, σ-fields and random variables.
2. To enable the students to learn about expectations, convergence in random variables and distribution functions.

Unit I Fields and σ Fields:

Class of events –Functions and Inverse functions – Random variables – Limits of random variables.

Unit II Probability Space:

Definition of probability – some simple properties – discrete probability space – General probability space – Induced probability space.

Unit III Distribution functions:

Distribution functions of a random variable –Decomposition of distributive functions- Distributive functions of vector random variables – Correspondence theorem.

Unit IV Expectation and Moments:

Definition of Expectation –Properties of expectation – Moments, Inequalities**.**

Unit V Convergence of Random Variables:

Convergence in Probability –Convergence almost surely – Convergence in distribution – Convergence in the r^{th} mean -Convergence theorems for Expectations .

TEXT BOOK

B.R. Bhat (2007), MODERN PROBABILITY THEORY,3^{rd} edition, New Age International private ltd, New Delhi.
Unit I : Chapter 1 and 2 Omit (1.1&1.2)
Unit II : Chapter 3 (Omit 3.6)
Unit III : Chapter 4
Unit IV : Chapter 5
Unit V : Chapter 6(6.1 to 6.5)

REFERENCES

1 Chandra T.K and Chatterjee D. (2003),A first course in probability , 2^{nd} Edition, Narosa Publishing House, New Delhi.
2 Kailai Chung and Farid Aitsahlia, Elementary Probability, Springer Verlag 2003, New York.
3 Marek Capinski and Thomasz Zastawniak(2003), Probability through problems, Springer Verlag, New York.
4 Sharma .T.K(2005), A text book of probability and theoretical distribution, Discovery publishing house, New Delhi.

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ELECTIVE I (2)

MATHEMATICAL MODELING

Objectives:

1. To study the different mathematical models in ODE and Difference equations.
2. To study graph theoretical models.

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

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

REFERENCES

J. N. Kapur, Mathematical Models in Biology and Medicine, Affiliated East – West Press Pvt Limited, New Delhi, 19

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ELECTIVE I (3)

FUZZY SETS AND THEIR APPLICATIONS

Objectives:

1. To introduce the concept of fuzzy theory and study its application in real problems
2. To study the uncertainty environment through the fuzzy sets that incorporates imprecision and subjectivity into the model formulation and solution process.

UNIT I From Classical Sets To Fuzzy Sets, Fuzzy Sets Verses Crisp Sets:

Fuzzy sets: Basic types – Fuzzy sets: Basic Concepts –Additional Properties of α – cuts-Extension Principle for fuzzy sets **.**

UNIT II Operations On Fuzzy Sets:

Types of operations– Fuzzy complements- Fuzzy Intersections:t-Norms – Fuzzy Unions:t-Conorms - Combinations of Operations**.**

UNIT III Fuzzy Arithmetic:

Fuzzy numbers - Linguistic variables -Arithmetic operations on intervals –Arithmetic operations on Fuzzy numbers **.**

UNIT IV Fuzzy Relations:

Binary Fuzzy Relations – Binary Relations on a Single Set – Fuzzy Equivalence Relations – Fuzzy Compatibility Relations –Fuzzy Ordering Relations – Fuzzy Morphisms.

UNIT V Fuzzy Decision Making:

Individual decision making – Multiperson Decision Making-Ranking methods – Fuzzy Linear programming.

TEXT BOOK

George J. Klir and Bo Yuan, Fuzzy sets and Fuzzy Logic Theory and Applications, Prentice Hall of India, (2005).
UNIT I Chapter 1 Sections 1.3, 1.4, Chapter :2 Sections 2.1 and 2.3
UNIT II Chapter 3 Sections 3.1, 3.2, 3.3, 3.4, 3.5.
UNIT III Chapter 4 Sections 4.1,4.2, 4.3, 4.4.
UNIT IV Chapter 5 Sections 5.3 ,5.4, 5.5, 5.6, 5.7, 5.8.
UNIT V Chapter 15 Sections 15.2,15.3, 15.6, 15.7

REFERENCES

1. H.J. Zimmermann, Fuzzy Set Theory and its Applications, Allied Publishers Limited (1991).
2. M. Ganesh, Introduction to Fuzzy sets and Fuzzy logic, Prentice Hall of India, New Delhi (2006).

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ELECTIVE II (1)
(Any one)

STOCHASTIC PROCESSES

Objectives

1. To understand the stochastic models for many real life probabilistic situations.
2. To learn the well known models like birth-death and queuing to reorient the knowledge of 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

1. J. Medhi,Stochastic Processes, New age international pblishers,New Delhi– Second edition.

UNIT I	Ch. II & Ch.III	Sec 2.1 to 2.3, 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)	

REFERENCES

1. Samuel Karlin, Howard M. Taylor, A first course in stochastic processes, Academic press, Second Edition,1975.
2. Narayan Bhat , Elements of Applied Stochastic Processes,John Wiley ,1972.
3. N.V. Prabhu, Stochastic Processes, Macmillan (NY).

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ELECTIVE II (2)

TENSOR ANALYSIS AND SPECIAL THEORY OF RELATIVITY

Objectives.

1. To introduce the notion of Tensor and study its properties.
2. To study the 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 symbols - 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

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]

REFERENCES

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

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ELECTIVE II (3)

NON LINEAR DIFFERENTIAL EQUATIONS

Objectives.

1. To study Non linear DE and its properties.
2. To study oscillation and stability properties of the solutions.

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 , 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.

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CORE COURSE IX

CLASSICAL DYNAMICS

Objectives

1. To give a detailed knowledge of the mechanical system of particles.
2. To study the applications of Lagrange's and Hamilton's equations .

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 BOOKS.

1. Donald T. Greenwood,Classical Dynamics, 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

REFERENCES.

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

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CORE COURSE X

MEASURE AND INTEGRATION

Objectives

1. To generalize the concept of integration using measures.
2. To develop the concept o f analysis in abstract situations.

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 Decomposition –The Jordan Decomposition

UNIT V

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

TEXT BOOKS

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

REFERENCES

1. M.E. Munroe,Measure and Integration, by 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.

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CORE COURSE XI

TOPOLOGY

Objectives

1. To study the concepts concerned with properties that are preserved under continuous deformations of objects.
2. To train the students to develop analytical thinking and the study of continuity and connectivity.

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

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.

REFERENCES

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.

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ELECTIVE III (1)
(Any one)

DESIGN AND ANALYSIS OF ALGORITHMS

Objectives

1. To impart the students the knowledge of design and analysis of algorithms in computer science.
2. To study the complexity of algorithms.

Unit I Algorithms:

Introduction- Algorithm - Algorithm specification: Pseudo code Conventions, Recursive algorithms - Performance analysis: Space Complexity, Time Complexity, Asymptotic Notation, and Practical Complexities.

Unit II Data structures and Queues:

Linear data structures: Concepts of non-primitive data structures – storage structure for arrays - stacks - operations on stacks - queues - priority queues.

Unit III Linked lists and trees:

Linked linear lists - operations on linked linear lists - circularly linked lists -doubly linked linear lists - Non-linear data structures: trees - binary trees -operations on binary trees - storage representation and manipulations of binary trees.

Unit IV Search and Sort:

Divide and conquer - General method - Binary search - Finding the maximum and minimum in a set of items - Merge sort - Quick sort - Selection sort. Basic Traversal and Search Techniques for graphs: Breadth First Search – Depth First Search.

Unit V Interpolations:

Backtracking - The 8-Queens problem - Algebraic problems - The general method - Evaluation and interpolation - Horner's rule - Lagrange interpolation- Newtonian interpolation.

TEXTBOOKS

1. Ellis Horowitz, Sartaj Sahni and Sanguthevar Rajasekaran, Fundamentals of Computer algorithms, Galgotia Publications Pvt. Ltd., 2004. (For Units I, IV, V)
2. Jean-Paul Tremblay and Paul G.Sorenson, An introduction to data structures with applications, Second Edition, Tata McGraw Hill Publishing Company Limited, New Delhi, 1995. (For Units II, III)

REFERENCES

1. A.V. Aho, J.E.Hopcroft, J.D. Ullman, The Design and Analysis of Computer Algorithms, Addison-Wesley Publ. Comp., 1974.
2. Seymour E.Goodman and S.T. Hedetniemi, Introduction to the design and analysis of algorithms, McGraw Hill International Edition, 2002.

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ELECTIVE III (2)

DISCRETE MATHEMATICS

Objectives

1. To study the concepts like Boolean algebra, coding theory.
2. To introduce the different notions grammar.

Unit I Relations and Functions:

Binary relations, equivalence relations and partitions, partial order relations, inclusion and exclusion principle, Hasse diagram, Pigeon hole principle. Functions, inverse functions, compositions of functions, recursive functions.

Unit II Mathematical Logic:

Logic operators, Truth tables, Theory of inference and deduction, mathematical calculus, predicate calculus, predicates and qualifiers.

Unit III Lattices:

Lattices as Partially Ordered Sets. Their Properties, Lattices as algebraic Systems, Sub lattices, Direct Product and homomorphism. Some Special Lattices - Complete, Complemented and Distributive Lattices, Isomorphic Lattices.

Unit IV Boolean algebra:

Various Boolean identities, the switching Algebra Example, Sub Algebras, Direct Production and Homomorphism. Boolean Forms and their Equivalence, Midterm Boolean forms, Sum of Products, Canonical Forms. Minimization of Boolean Functions. The Karnuagh Map Method.
Coding Theory: Coding of binary information and error detection, Group codes, decoding and error correction.

Unit V Grammar and Languages:

Phrase structure grammars, rewriting rules, derivation sentential forms, language generated by grammar, regular, context free and context sensitive grammar and languages.

TEXT BOOKS

1. Trembly. J.P & Manohar. P., “Discrete Mathematical Structures with Applications to Computer Science” McGraw- Hill.
2. Liu, C.L., “Elements of Discrete Mathematics”, McGraw-Hill Book co.
3. K.D Joshi, “Foundations of Discrete Mathematics”, Wiley Eastern Limited.

REFERENCES

1. Kolman, Busy & Ross, “Discrete Mathematical Structures”, PHI.
2. Alan Doer: “Applied Discrete Structure for Computer Science”, Galgotia Publications Pvt. Ltd.
3. Seymour Lipschutz, M. Lipson: “Discrete Mathematics”, McGraw-Hill Edition.
4. Kenneth G. Roden: “Discrete Mathematics and its Applications”, McGraw- Hill international editions, Mathematics Series.

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ELECTIVE III (3)

AUTOMATA THEORY

Objectives

1. To make the students to understand the nuances of Automata and Grammar.
2. To make them to understand the applications of these techniques in computer science.

Unit I: - Finite Automata and Regular expressions:

Definitions and examples - Deterministic and Nondeterministic finite Automata - Finite Automata with -moves. (Book 1, Chapter 2: Sections2.1-2.4)

Unit II: - Context free grammar:

Regular expressions and their relationship with automation - Grammar - Ambiguous and unambiguous grammars - Derivation trees – Chomsky Normal form. (Book 1, Chapter 2, Section 2.5, Chapter 4, Sections 4.1-4.3, 4.5,4.6)

Unit III: - Pushdown Automaton:

Pushdown Automaton - Definition and examples - Relation with Context free languages. (Book 1, Chapter 5: Section 5.2, 5.3)

Unit IV: - Finite Automata and lexical analysis:

Role of a lexical analyzer - Minimizing the number of states of a DFA - Implementation of a lexical analyzer. (Book 2, Chapter 3: Section 3.1-3.8)

Unit V: - Basic parsing techniques:

Parsers - Bottom up Parsers - Shift reduce - operator precedence - Top down Parsers - Recursive descent - Predictive parsers. (Book 2, Chapter 5: Section 5.1-5.5)

TEXTBOOKS

1. John E. Hopcroft and Jeffrey D. Ullman, Introduction to Automata theory, Languages and Computations, Narosa Publishing House, Chennai, 2000.
2. A.V. Aho and Jeffrey D. Ullman, Principles of Compiler Design, Narosa Publishing House, Chennai, 2002.

REFERENCES

1. Harry R. Lewis and Christos H. Papadimitriou, Elements of the Theory of Computation, Second Edition, Prentice Hall, 1997.
2. A.V. Aho, Monica S. Lam, R. Sethi, J.D. Ullman, Compilers: Principles, Techniques and Tools, Second Edition, Addison-Wesley, 2007.

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ELECTIVE IV (1)
(Any one)

FINANCIAL MATHEMATICS

Objectives

1. To study financial mathematics through various models.
2. To study the various aspects of 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

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

REFERENCES

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)

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ELECTIVE IV (2)

ADVANCED OPERATIONS RESEARCH

Objectives:

1. To enlighten the students in the field of operations research.
2. To help the students to apply OR techniques in business and management problems.

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

Hamdy A. Taha, Operations Research, Macmillan Publishing Company, 4th Edition.
Unit I Chapter 8 § 8.1 – 8.5
Unit II Chapter 9 § 9.1 – 9.5
Unit III Chapter 11 § 11.1 – 11.4
Unit IV Chapter 13 § 13.1 – 13.4
Unit V Chapter 19 § 19.1, 19.2

REFERENCES

1. Non Linear Programming, O.L. Mangasarian, McGraw Hill, New York .
2. Non Linear Programming, Theory and Algorithms, Mokther S. Bazaraa and C.M. Shetty,Willy, New York .
3. Operations Research-An Introduction, Prem Kumar Gupta and D.S. Hira, S. Chand

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ELECTIVE IV (3)

COMBINATORICS

Objectives:

1. To introduce the notion of different types of distributions of objects and generating functions.
2. To study the Polya's enumeration theorems.

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 Ferrer's 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

Introduction of Combinatorial Mathematics, C.L. Liu, McGraw Hill,1968. Chapters 1 to 5.

REFERENCES

1. Combinatorial Theory, Marshall Hall Jr.,John Wiley & Sons, second edition.
2. Combinatorial Mathematics, H.J. Rayser, Carus Mathematical Monograph, No.14.

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CORE COURSE XII

FUNCTIONAL ANALYSIS

Objectives

1. To study the three structure theorems of Functional Analysis viz., Hahn-Banach theorem, Open mapping theorem and Uniform boundedness principle.
2. To introduce Hilbert spaces and operator theory leading to the spectral theory of operators on a Hilbert space.

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

G.F.Simmons,Introduction to Topology and Modern Analysis, 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

REFERENCES

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.

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CORE COURSE XIII

DIFFERENTIAL GEOMETRY

Objectives

1. To introduce the notion of surfaces and their properties.
2. To study geodesics and differential geometry of surfaces.

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

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

REFERENCES

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.

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CORE COURSE XIV

ADVANCED NUMERICAL ANALYSIS

Objectives.

1. To know the theory behind various numerical methods.
2. To apply these methods to solve mathematical problems.

Unit I

Transcendental and polynomial equations:Rate of convergence – Secant Method, Regula Falsi Method, Newton Raphson Method, Muller Method and Chebyshev Method. Polynomial equations: Descartes' Rule of Signs - Iterative Methods: Birge-Vieta method, Bairstow's method Direct Method: Graeffe's root squaring method.

Unit II

System of Linear Algebraic equations and Eigen Value Problems: Error Analysis of Direct methods – Operational count of Gauss elimination, Vector norm, Matrix norm, Error Estimate. Iteration methods - Jacobi iteration method, Gauss Seidel Iteration method, Successive Over Relaxation method - Convergence analysis of iterative methods, Optimal Relaxation parameter for the SOR method. Finding eigen values and eigen vectors – Jacobi method for symmetric matrices and Power methods only.

Unit III

Interpolation and Approximation:- Hermite Interpolations, Piecewise and Spline Interpolation – piecewise linear interpolation, piecewise quadratic interpolation, piecewise cubic interpolation, spline interpolation-cubic Spline interpolation. Bivariate Interpolation- Lagrange Bivariate interpolation. Least square approximation.

Unit IV

Differentiation and Integration: Numerical Differentiation – Optimum choice of Step length – Extrapolation methods – Partial Differentiation. Numerical Integration: Methods based on undetermined coefficients - Gauss Legendre Integration method and Lobatto Integration Methods only.

Unit V

Ordinary differential equations – Singlestep Methods: Local truncation error or Discretization Error, Order of a method, Taylor Series method, Runge-Kutta methods: Explicit Runge–Kutta methods– Minimization of Local Truncation Error, System of Equations, Implicit Runge-Kutta methods. Stability analysis of single step methods (RK methods only).

TEXT BOOKS

M.K. Jain, S.R.K. Iyengar and R.K. Jain, Numerical Methods for Scientific and Engineering Computation, New Age International (p) Limited Publishers, New Delhi, Sixth Edition 2012.
Unit I Chapter 2 § 2.5 (Pages 41-52), 2.9 (Pages 83-99)
Unit II Chapter 3 § 3.3(Pages 134-140), 3.4(Pages 146-164), 3.5(Pages 170-173),
3.7 (Pages179-185) and 3.11 (Pages 196-198)
Unit III Chapter 4 § 4.5 - 4.7 & 4.9 (Pages 284-290)
Unit IV Chapter 5 § 5.2 - 5.5(Pages 320-345) and 5.8(pages 361 – 365 and 380-386)
Unit V Chapter 6 §6.4(Pages 434-459) and 6.5(Pages 468-475)

REFERENCES

1. Kendall E. Atkinson, An Introduction to Numerical Analysis, II Edn., John Wiley & Sons, 1988.
2. M.K. Jain, Numerical Solution of Differential Equations, II Edn., New Age International Pvt Ltd., 1983.
3. Samuel. D. Conte, Carl. De Boor, Elementary Numerical Analysis, Mc Graw-Hill International Edn., 1983.

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ELECTIVE V (1)
(Any one)

ALGEBRAIC TOPOLOGY

Objectives:

1. To introduce the notion of homotopy and covering spaces.
2. To study the Jordan curve theorem.

UNIT I

Homotopy of Paths-The Fundamental Group-Covering spaces.

UNIT II

The Fundamental group of the circle – The Fundamental group of the punctured plane- The Fundamental group of S^n.

UNIT III

Fundamental groups of surfaces- Essential and Inessential maps-The Fundamental theorem of algebra.

UNIT IV

Homotopy type – The Jordan separation theorem.

UNIT V

The Jordan Curve Theorem.

TEXTBOOK

Topology – A first course by James R.Munkres, Prentice-Hall of India Pvt Ltd, Third print.

REFERENCE BOOKS

1. A basic course in Algebraic Topology by William S Massey,Springer , First Edition.
2. Lecture notes on Elementary Topology and Geometry(Under graduate Texts in Mathematics) by I.M.Singer and John A Thorpe,Springer-Verlag,New York.
3. Elements of Algebraic Topology by James R. Munkres ,Addition-Wesley Publishing Company-1984
4. Allen Hatcher,Algebraic Topology,Cambridge University Press ,2002.

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ELECTIVE V (2)

FLUID DYNAMICS

Objectives

1. To give the students an introduction to the behaviour of fluids in motion.
2. To give the students a feel of the applications of Complex Analysis in the analysis of the flow of liquids.

UNIT I

Real Fluids and Ideal Fluids - Velocity of a Fluid at a point – Streamlines and Path lines: Steady and Unsteady Flows – The Velocity potential – The Vorticity vector – Local and Particle Rates of Change – The Equation of continuity – Worked examples – Acceleration of a Fluid – Conditions at a rigid boundary – General analysis of fluid motion – Pressure at a point in a Fluid at Rest – Pressure at a point in Moving Fluid – Conditions at a Boundary of Two Inviscid Immiscible Fluids – Euler's equation of motion – Bernoulli's equation – Worked examples.

UNIT II

Discussions of a case of steady motion under conservative body forces – Some potential theorems – Some Flows Involving Axial Symmetry – Some special two-Dimensional Flows-Impulsive Motion.Some three- dimensional Flows: Introduction – Sources, Sinks and Doublets – Images in a Rigid infinite Plane – Axi-Symmetric Flows; Stokes stream function.

UNIT III

Some Two- Dimensional Flows: Meaning of a Two- Dimensional Flow – Use of cylindrical polar co-ordinates – The stream function – The Complex Potential for Two- Dimensional, Irrotational , Incompressible Flow – complex velocity potentials for Standard Two Dimensional Flows – Some worked examples – The Milne- Thomson circle theorem and applications – The theorem of Blasius.

UNIT IV

The use of conformal Transformation and Hydrodynamical Aspects – Vortex rows. Viscous flow Stress components in a real fluid - relations between cartesian components of stress - Translational Motion of Fluid element – The Rate of Strain Quadraic and Principle Stresses – Some further properties of the rate of strain quardric - Stress analysis in fluid motion – Relations between stress and rate of strain - The coefficient of viscosity and laminar flow – The Navier- Stokes equations of motion of a viscous fluid.

UNIT V

Some solvable problems in viscous flow – Steady viscous flow in tubes of uniform cross section – Diffusion of vorticity – Energy Dissipation due to viscosity – Steady Flow past a Fixed Sphere – Dimensional Analysis; Reynolds Number – Prandtl's Boundary Layer.

TEXT BOOK

Text Book of Fluid Dynamics by F.Chorlton ,CBS Publishers & Distributors, New Delhi ,1985.

UNIT I	Chapter 2 and Chapter 3: Sections 3.1 to 3.6
UNIT II	Chapter 3 : Sections 3.7 to 3.11 and chapter 4 : Sections 4.1,4.2,4.3,4.5
UNIT II	Chapter 5 : Sections : 5.1 to 5.9 except 5.7
UNIT IV	Chapter 5 : Section 5.10, 5.12 and Chapter 8 : Sections 8.1 to 8.9
UNIT V	Chapter 8 : Sections 8.10 to 8.16.

REFERENCE

1. Computational Fluid Dynamics: An Introduction, J.F. Wendt J.D. Anderson, G. Degrez and E. Dick, Springer – Verlag, 1996.
2. Computational Fluid Dynamics,The Basics with Applicatios, J. D. Anderson, McGraw Hill, 1995.
3. An Introduction to Fluid Mechanics, Foundation Books, G. K. Batchelor, New Delhi, 1984.
4. A Mathematical Introduction to Fluid Dynamics, A. J. Chorin and A. Marsden, Springer- Verlag, New York, 1993.
5. Foundations of Fluid Mechanics, S. W. Yuan, Prentice Hall of India Pvt Limited, New Delhi, 1976.
6. An Introduction to Fluid Dynamics, R. K. Rathy Oxford and IBH Publishing Company, New Delhi, 1976.

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ELECTIVE V (3)

ALGEBRAIC NUMBER THEORY

Objectives

1. To expose the students to the charm, niceties and nuances in the world of numbers.
2. To highlight some of the Applications of the 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

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.

REFERENCES

1. Elementary Number Theory, David M. Burton W.M.C. Brown Publishers, Dubuque, Lawa, 1989.
2. Number Theory, George Andrews, Courier Dover Publications,1994.
3. Fundamentals of Number Theory, William J. Leveque Addison-Wesley Publishing Company, Phillipines, 1977.

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