L. N. GOVT. COLLEGE (AUTONOMOUS)

PONNERI-601204

Post Graduate Department of Mathematics

M. Sc. Mathematics Syllabus

(For candidates admitted from 2020 -21 onwards)

M.Sc. MATHEMATICS

COURSE OF STUDY, CREDITS AND SCHEME OF EXAMINATION

The Course Components and Credit Distribution

S. No.	Semester	Subject		Nature	Inst. Hours	Credit	Exam Hours	Max. Marks		Total	Passing Minimum
		Code	Name					CIA	Ext		
1	I		Algebra I	Core I	6	5	3	25	75	100	50
2			Real Analysis I	Core II	6	5	3	25	75	100	50
3			Ordinary Differential Equations	Core III	6	4	3	25	75	100	50
4			Graph Theory	Core IV	6	4	3	25	75	100	50
5			Advanced Operations Research	Elective I	4	3	3	25	75	100	50
6			Soft Skill I-Essentials of Language and Communication	Soft Skill I	2	2	3	25	75	100	50
7	II		Algebra II	Core V	6	5	3	25	75	100	50
8			Real Analysis II	Core VI	6	5	3	25	75	100	50
9			Partial Differential Equations	Core VII	6	4	3	25	75	100	50
10			Classical Dynamics	Core VIII	6	4	3	25	75	100	50
11			Discrete Mathematics	Elective II	4	3	3	25	75	100	50
12			EDC I: (From Other Department)	EDC I	5	3	3	25	75	100	50
13			Soft Skill II - Essentials of Spoken and Presentation Skills	Soft Skill II	2	2	3	25	75	100	50
14			Internship	Int		2					
15	III		Complex Analysis	Core IX	6	4	3	25	75	100	50
16			Topology	Core X	6	4	3	25	75	100	50
17			Differential Geometry	Core XI	6	4	3	25	75	100	50
18			Probability theory	Elective III	6	3	3	25	75	100	50
19			EDC II: (From other Department)	EDC II	4	3	3	25	75	100	50
20			Soft Skill III - Personality Enrichment	Soft Skill III	2	2	3	25	75	100	50
21	IV		Functional Analysis	Core XII	6	4	3	25	75	100	50
22			Calculus of variations and Integral Equations	Core XIII	6	4	3	25	75	100	50
23			Fluid Dynamics	Core XIV	6	4	3	25	75	100	50
24			Stochastic Processes	Elective IV	5	3	3	25	75	100	50
25			Fuzzy Sets and its applications	Elective V	5	3	3	25	75	100	50
26			Soft Skill IV - Computing Skills	Soft Skill IV	2	2	3	25	75	100	50
Total						**91**					

Elective - I (Semester I)

Any one of the following courses from Group A shall be chosen as an Elective-I for Semester I.

Group-A:

1. Advanced Operations Research (**Chosen as Elective I**)
2. Formal languages and Automata theory
3. Mathematical Economics

Elective-II (Semester II)

Any one of the following courses from Group B shall be chosen as an Elective-II for Semester II.

Group-B:

1. Discrete Mathematics (**Chosen as Elective II)**
2. Combinatorics.
3. Wavelets.

Elective-III (Semester III)

Any one of the following courses from Group-C shall be chosen as Elective-III for Semester III.

Group-C:

1. Probability theory (**Chosen as Elective III**)
2. Algebraic Theory of Numbers
3. Number theory and Cryptography.

Elective-IV (Semester IV)

Any two of the following papers from Group-D shall be chosen as Elective-IV and Elective-V for Semester IV.

Group-D:

1. Stochastic Processes. (**Chosen as Elective IV**)
2. Fuzzy sets and its applications. (**Chosen as Elective V**)
3. Mathematical Statistics.

4. Algebraic Topology.
5. Tensor Analysis and Relativity.

EXTRA DISCIPLINARY COURSES

1. Mathematics for Competitive Examinations I (Offering for other Departments)
2. Mathematics for Competitive Examinations II (Offering for other Departments)

QUESTION PAPER PATTERN

SECTION – A (30 words)

Answer 10 out of 12 Questions 10 x 2 = 20 marks

SECTION – B (200 words)

Answer 5 out of 7 Questions 5 x 5 = 25 marks

SECTION – C (500 words)

Answer 3 out of 5 Questions 3 x 10 = 30 marks

TOTAL = 75 marks

MARKS DISTRIBUTION

Internal mark	External mark	Total
25	**75**	**100**

CORE COURSE I

Semester	Subject Code	Subject Title	Total Hours	Credit
I		ALGEBRA I	90	5
Objectives	• To understand the concept of Sylow's theorem and Abelian groups • To know about direct products • To learn polynomial rings • To understand the concept of canonical forms			
Learning Outcomes	**After completion of this course, students will be able:** • To understand and develop the concepts of Sylow's theorem, Abelian groups and direct products • To solve the problems of Sylow's theorem • To describe fundamental properties of linear transformation that lead to the development of linear algebra in various fields like Traffic flow, Electrical circuits, Genetics, etc.			
Unit 1	Another Counting Principle – Sylow's Theorem.			
Unit 2	Direct Products– Finite Abelian Groups, Modules			
Unit 3	Ring Theory – Polynomial rings – Polynomials over the rational field and commutative rings.			
Unit 4	Linear Transformations – Canonical Forms – Nilpotent Transformations – Jordan Forms.			

Unit 5	Linear Transformations – Trace and Transpose – Hermitian, Unitary and Normal Transformations.
Contents & Treatment as in	**Topics in Algebra, I.N. Herstein, Second Edition, Wiley Eastern Limited New Delhi.** Unit 1: Chapter 2: Section 2.11, 2.12 (Omit Lemma 2.12.5) (For theorem 2.12.1 first proof only) Unit 2: Chapter 2: Section 2.13, 2.14 (Theorem 2.14.1 only),4.5 Unit 3: Chapter 3: Section 3.9, 3.10,3.11 Unit 4: Chapter 6: Section 6.5, 6.6 Unit 5: Chapter 6: Section 6.8, 6.10
Books for Reference	1. Algebra, M. Artin, Prentice Hall of India, NewDelhi. 2. Basic Abstract Algebra, P.B. Bhattacharya, S. K. Jain and S. R. Nagpaul, Cambridge UniversityPress. 3. Algebra, L. S. Luther and I. B. S. Passi, Vol. I - Groups, Vol. II - Rings, Narosa Publishing House, NewDelhi. 4. Fundamentals of Abstract Algebra, D. S. Malik, J. N. Mordeson and M. K. Sen, McGraw Hill, International Edition, NewYork. 5. Basic Algebra, Vol. I and II, N. Jacobson, Hindustan Publishing Company, New Delhi.

CORE COURSE II

Semester	Subject Code	Subject Title	Total Hours	Credit
I		REAL ANALYSIS II	90	5
Objectives	• To introduce the basic concepts of real numbers and Euclidean spaces. • To know about the Riemann -Stieltjes Integral • To learn infinite and power series. • To understand sequence of functions.			
Learning Outcomes	**After completion of this course, students will be able:** • To understand the treatment of Integration in the sense of both Riemann and Lebesgue integrals. • To get introduce to the approach of integration via measure, rather than measure via integration. • To understand the methods of Decomposing signed measures which has applications in probability theory and Functional Analysis.			
Unit 1	**Functions of bounded variation and Infinite Series:** Introduction - Properties of monotonic functions - Functions of bounded variation - Total variation - Additive property of total variation - Total variation on [a, x] as a function of x - Functions of bounded variation expressed as the difference of two increasing functions - Continuous functions of bounded variation.			
Unit 2	**The Riemann - Stieltjes Integral:** Introduction - Notation - The definition of the Riemann - Stieltjes integral - Linear Properties - Integration by parts- Change of variable in a Riemann - Stieltjes integral - Reduction to a Riemann Integral – Euler’s summation formula - Monotonically increasing integrators, Upper and lower integrals - Additive and linearity properties of upper and lower integrals - Riemann's condition - Comparison theorems.			
Unit 3	**The Riemann-Stieltjes Integral:** Integrators of bounded variation-Sufficient conditions for the existence of Riemann-Stieltjes integrals - Necessary conditions for the existence of Riemann-Stieltjes integrals - Mean value theorems for Riemann - Stieltjes integrals - The integrals as a function of the interval - Second fundamental theorem of integral calculus - Change of variable in a Riemann integral-Second Mean Value Theorem for Riemann integral - Riemann-Stieltjes integrals depending on a			

	parameter - Differentiation under the integral sign - Lebesgue criterion for the existence of Riemann integrals.
Unit 4	**Infinite Series, Infinite Products and Power Series** Double sequences - Double series - Rearrangement theorem for double series - A sufficient condition for equality of iterated series - Multiplication of series - Cesaro summability - Infinite products, Multiplication of power series - The Taylor's series generated by a function - Bernstein's theorem - Abel's limit theorem - Tauber's theorem.
Unit 5	**Sequences of Functions:** Pointwise convergence of sequences of functions - Examples of sequences of real - valued functions - Definition of uniform convergence - Uniform convergence and continuity - The Cauchy condition for uniform convergence - Uniform convergence of infinite series of functions - Uniform convergence and Riemann - Stieltjes integration - Non-uniform Convergence and Term-by-term Integration - Uniform convergence and differentiation - Sufficient condition for uniform convergence of a series - Mean convergence.
Contents & Treatment as in	***Mathematical Analysis*, Tom M.Apostol, 2nd Edition, Narosa,1989.** Unit 1: Chapter 6: Sections 6.1 to 6.8 Unit 2: Chapter 7: Sections 7.1 to 7.7 and 7.10 to 7.14 (Omit 7.8 and 7.9) Unit 3: Chapter 7: Sections 7.15 to 7.26 Unit 4: Chapter 8: Sections 8.20 to 8.26 Chapter 9: Sections 9.15, 9.19, 9.20, 9.22, 9.23(Omit 9.14, 9.16, 9.17, 9.18, 9.21) Unit 5: Chapter 9: Sections 9.1 to 9.6, 9.8 to 9.11 & 9.13 (Omit 9.7 and 9.12)
Books for Reference	1. Bartle, R.G. *Real Analysis*, John Wiley and Sons Inc., 1976. 2. Rudin,W. *Principles of Mathematical Analysis*, 3rd Edition. McGraw Hill Company, NewYork, 1976. 3. Malik,S.C. and Savita Arora. *Mathematical Anslysis*, Wiley Eastern Limited.New Delhi,1991. 4. Sanjay Arora and Bansi Lal, *Introduction to Real Analysis*, Satya Prakashan, New Delhi,1991. 5. Gelbaum, B.R. and J. Olmsted, *Counter Examples in Analysis*, Holden day, San Francisco,1964. 6. A.L.Gupta and N.R.Gupta, *Principles of Real Analysis*, Pearson Education,

	(Indian print), 2003.

CORE COURSE III

Semester	Subject Code	Subject Title	Total Hours	Credit
I		**ORDINARY DIFFERENTIAL EQUATIONS**	90	4

Objectives	• To understand the different types of ODE • To know about the various methods to solve the ODE problems • To introduce Euler equation and Bessel function • To know about the existence and uniqueness of solution of ODE
Learning Outcomes	**After completion of this course** • The student will be able to formulate and solve some practical problems as ordinary differential equations. • The students will understand the concept and apply it in the field of Thermo dynamics, Nanotechnology, Medicine, Engineering and various other fields.
Unit 1	Second Order Homogeneous Equations – Initial Value Problems – Linear Dependence and Independence – Wronskian and a Formula for Wronskian-Non-Homogeneous Equation of order two.
Unit 2	Homogeneous and Non-Homogeneous Equation of Order n – Initial Value Problems – Annihilator Method to Solve Non-Homogeneous Equation – Algebra of Constant Coefficient Operators.
Unit 3	Initial Value Problems – Existence and Uniqueness Theorems – Solutions to Solve a Non–Homogeneous Equation – Wronskian and Linear Dependence – Reduction of the Order of a Homogeneous Equation – Homogeneous Equation with Analytic Coefficients –The Legendre Equation.
Unit 4	Euler Equation – Second Order Equations with Regular Singular Points – Exceptional Cases –

	Bessel Function.
Unit 5	Equation with Variable Separated – Exact Equation – Method of Successive Approximations – The Lipschitz Condition – Convergence of the Successive Approximations and The Existence Theorem.
Contents & Treatment as in	**An Introduction to Ordinary Differential Equations, E.A. Coddington, Third Printing, Prentice Hall of India Ltd., New Delhi,1987.** Unit 1: Chapter 2: Sections 1 to 6 Unit 2: Chapter 2: Sections 7 to 12 Unit 3: Chapter 3: Sections 1 to 8 Unit 4: Chapter 4: Sections 1 to 4, 6 to 8 Unit 5: Chapter 5: Sections 1 to 6
Books for Reference	1. Differential Equations with Applications and Historical Notes, George F Simmons, Tata McGraw Hill, New Delhi,1974. 2. Ordinary Differential Equations, W. T. Reid, John Wiley and Sons, New York,1971. 3. Advanced Differential Equations, M. D. Raisinghania, S.Chand & Company Ltd., New Delhi2001. 4. A course in Ordinary Deferential Equations, B. Rai, D. P. Choudhry and H. I. Freedman, Narosa Publishing House, New Delhi,2002.

CORE COURSE IV

Semester	Subject Code	Subject Title	Total Hours	Credit
II		**GRAPH THEORY**	**90**	**4**
Objectives	• To understand graphs and trees. • To know about the connectivity and Hamilton cycles • To learn the basic concept of colourings. • To introduce the concept of planar graphs.			
Learning Outcomes	**At the end of the course, the students would be able:** • To understand and deal with research problems related to graph theory. • To understand the concepts related to Eigen values of graphs, extremal graphs, Ramsey theory and digraphs. • To apply in the field of Networking, Google map, Tele communications, etc.			
Unit 1	**Graphs and Sub-graphs, Trees** Graphs and Simple Graphs – Graph Isomorphism – The Incidence and Adjacency Matrices – Subgraphs – Vertex Degrees – Paths and Connection – Cycles – Trees – Cut Edges and Bonds – Cut Vertices.			
Unit 2	**Connectivity, Euler Tours and Hamilton Cycles** Connectivity – Blocks – Euler Tours – Hamilton Cycles.			
Unit 3	**Matchings and Edge Colorings** Matchings – Matchings and Coverings in Bipartite Graphs – Edge Chromatic Number – Vizing's Theorem.			

Unit 4	**Independent Sets and Cliques, Vertex Colorings** Independent Sets – Ramsey’s Theorem – Chromatic Number – Brook’s Theorem.
Unit 5	**Planar Graphs** Plane and Planar Graphs – Dual Graphs – Euler’s Formula –The Five - Color Theorem and the Four - Color Conjecture.
Contents & Treatment as in	**Graph Theory with Applications, J. A. Bondy and U. S. R. Murty, The Macmillan Press Ltd, London, 1976.** Unit 1: Chapter 1: Sections 1.1 to 1.7 Chapter 2: Sections 2.1 to 2.3 Unit 2: Chapter 3: Sections 3.1 and 3.2 Chapter 4: Sections 4.1 and 4.2 Unit 3: Chapter 5: Sections 5.1 and 5.2 Chapter 6: Sections 6.1 and 6.2 Unit 4: Chapter 7: Sections 7.1 and 7.2 Chapter 8: Sections 8.1 and 8.2 Unit 5: Chapter 9: Sections 9.1 to 9.3, 9.6 (Omit 9.4 and 9.5)
Books for Reference	1. A First look at Graph Theory, J. Clark and D. A. Holton, Allied Publishers, New Delhi, 1995. 2. Graph Theory, R. Gould, Benjamin Cummings, Menlo Park, 1989. 3. Graphs, An Introductory Approach, R. J. Wilson and J. J. Watkins, John Wiley and Sons, New York, 1989.

GROUP A: ELECTIVE COURSE 1

Semester	Subject Code	Subject Title	Total Hours	Credit
I		**ADVANCED OPERATIONS RESEARCH**	**60**	**3**
Objectives		● To introduce to the quantitative methods and techniques for effective decision making ● To develop mathematical skills and to analyze and solve IPP ● To understand the basic concepts of queuing theory		
Learning Outcomes		**After completion of this course:** ● The student able prepare the model for various real life situations as Optimization problems and effect their solution through Programming techniques ● Students will understand the concepts of solving Non-Linear programming problems, IPP, DPP and Queueing models and apply in the fields like Business Management, Economics, Science, Engineering and Technology.		
Unit 1		**Integer Linear Programming** Introduction – Types of Integer Programming Problems – Enumeration and Cutting Plane Solution Concept – Gomory's All Integer Cutting Plane Method– Gomory's Mixed Integer Cutting Plane Method.		
Unit 2		**Dynamic Programming** Introduction – Characteristics of Dynamic Programming Problem – Developing Optimal Decision Policy – Dynamic Programming under Certainty – DP Approach for Solving LPP.		
Unit 3		**Non–linear Programming** Introduction–General NLPP–Quadratic Programming– Kuhn–Tucker Condition – Wolfe's Modified Simplex Methods.		
Unit 4		**Queuing Theory** Essential Features of Queuing System – Performance Measures of QueuingSystem – Probabilistic Distribution in Queuing Systems – Classification of Queuing Models and their Solutions – Single Server Queuing Models – Multi Server Queuing Models.		
Unit 5		**Decision Theory and Decision Trees** Introduction – Steps of Decision Making Process - Types of Decision Making Environments – Decision Making under Uncertainty –		

	Decision Making Under Risk.
Contents & Treatment as in	**Operations Research Theory and Applications, J. K. Sharma, V Edition, Macmillan India, Ltd., 2013.** Unit 1: Chapters 7: Sections 7.1 to 7.5 Unit 2: Chapter 22: Sections 22.1 to 22.5 Unit 3: Chapter 24: Sections 24.1, 24.2 Unit 4: Chapter 16: Sections 16.1 to 16.6 Unit 5: Chapter 11: Sections 11.1 to 11.5.
Books for Reference	1. Operations Research, Hamdy A. Taha, VII Edition, Prentice Hall of India Private Ltd., New Delhi,1997. 2. Introduction to Operation Research, F. S. Hillier and J. Lieberman, VII Edition, Tata McGraw Hill company, New Delhi,2001. 3. Foundations of Optimization, Beightler C., D. Phillips, B. Wilde, II Edition, Prentice Hall Pvt. Ltd., New York,1979. 4. Optimization Theory and Applications, S. S. Rao, Wiley Eastern Ltd., New Delhi, 1990.

GROUP A: ELECTIVE COURSE 2

<table>
<tr><th>Semester</th><th>Subject Code</th><th>Subject Title</th><th>Total Hours</th><th>Credit</th></tr>
<tr><td>I</td><td></td><td>FORMAL LANGUAGES AND AUTOMATA THEORY</td><td>60</td><td>3</td></tr>
<tr><td>Objectives</td><td colspan="4">• To introduce Finite Automata, Regular expressions and Regular grammars
• To study about Regular sets using Pumping Lemma.
• To learn about Pushdown automata and context-free Languages.</td></tr>
<tr><td>Learning Outcomes</td><td colspan="4">After completion of this course:
• Students are able to apply the concepts in the field like text processing, compiler and hardware design.
• Context-free grammars are used in programming languages and artificial intelligence.
• Formal languages are used and defined for any kind of automation like Turing Machine.</td></tr>
<tr><td>Unit 1</td><td colspan="4">Finite automata, regular expressions and regular grammars
Finite state systems – Basic definitions – Non-deterministic finite automata – Finite automata with ϵ moves – Regular expressions – Regular grammars.</td></tr>
<tr><td>Unit 2</td><td colspan="4">Properties of regular sets.
The Pumping lemma for regular sets – Closure properties of regular sets – Decision algorithms for regular sets – The Myhill-Nerode Theorem and minimization of finite automata.</td></tr>
<tr><td>Unit 3</td><td colspan="4">Context-free grammars
Motivation and introduction – Context-free grammars – Derivation trees- Simplification of context-free grammars – Chomsky normal form – Greibach normal form.</td></tr>
<tr><td>Unit 4</td><td colspan="4">Pushdown automata
Informal description- Definitions-Pushdown automata and context-free languages – Normal forms</td></tr>
</table>

	for deterministic pushdown automat.
Unit 5	**Properties of context-free languages** The pumping lemma for CFL's – Closure properties for CFL's – Decision algorithms for CFL's.
Contents & Treatment as in	**John E.Hopcraft and Jeffrey D.Ullman, *Introduction to Automata Theory, Languages and Computation*, Narosa Publishing House, New Delhi, 1987.** Unit 1: Chapter 2: Sections 2.1 to2.5 Chapter 9:Section 9.1 Unit 2: Chapter 3: Sections 3.1 to 3.4 Unit 3: Chapter 4: Section 4.1 to 4.6 Unit 4: Chapter 5: Sections 5.1 to 5.3 Unit 5: Chapter 6: Sections 6.1 to 6.3
Books for Reference	1. A. Salomaa, *Formal Languages*, Academic Press, New York, 1973. 2. John C. Martin, *Introduction to Languages and theory of Computations* (2nd Edition) Tata-McGraw Hill Company Ltd., New Delhi, 1997.

GROUP A: ELECTIVE COURSE 3

Semester	Subject Code	Subject Title	Total Hours	Credit
I		**MATHEMATICAL ECONOMICS**	**60**	**3**
Objectives	• To initiate the study on consumer behaviour, Theory of firms, Market equilibrium. Welfare Economics. • To learn about Market Equilibrium • To study about Imperfect Competition.			
Learning Outcomes	**After the completion of this course:** • Students are used to calculate to total cost and total revenue. • Calculus is used to find the derivatives of utility curve, profit maximization curves and growth model.			
Unit 1	**The Theory of Consumer Behaviour:** Utility function – Indifference Curves – Rate of Commodity Substitution – Existence of Utility Function – Maximizatin of Utility – Choice of a utility Index – Demand function – Income and Leisure – Substitution and Income Effects – Generalization to *n* variables – Theory of Revealed Preference – Problem of Choice in Risk.			
Unit 2	**The Theory of Firm:** Production Function – Productivity Curves – Isoquents – Optimization behaviour – Input Demand Functions – Cost Functions (short-run and long-run) – Homogeneous Production functions and their properties – CES Production Function and their Properties – Joint Products – Generalisation to *m* variables.			
Unit 3	**Market Equilibrium:** Assumptions of Perfect Competition – Demand Functions – Supply Functions – Commodity Equilibrium – Applications of the Analysis – Factor Market Eqilibrium – Existence of Uniqueness of Equilibrium – Stability of Equilibrium – Dynamic Equilibrium with lagged adjustment.			

Unit 4	**Imperfect Competition:** Monopoly and its Applications – Duopoly and Oligopoly – Monopolistic Composition – Monopsony, Duopsony and Oligopsony – Bilateral Monopoly
Unit 5	**Welfare Economics:** Parato Optimality and the efficiency of Perfect competition – The efficiency of Imperfect competition – External Effects in comsumption and Production – Taxes, Subsidies and Compensation – Social Welfare functions – The theory of Second Best.
Contents & Treatment as in	**J.M.Henderson and R.E.Quandt, *Micro Economic Theory- A Mathematical Approach,* (2nd Edn) McGraw Hill, New York, 1971.** Unit 1: Chapter 2: 2.1 to 2.10 Unit 2: Chapter 3: 3.1 to 3.7 Unit 3: Chapter 5: 5.1 to 5.6 Unit 4: Chapter 6: 6.1 to 6.7 Unit 5: Chapter 7: 7.1 to 7.7
Books for Reference	1. William J. Baumol. *Economic Theory and Operations Analysis*, Prentice Hall of India, New Delhi,1978 2. A.C.Chiang, *Fundamental Methods of Mathematical Economics*, McGraw Hill, New York, 1984 3. Michael D. Intriligator, *Mathematical Optimization and Economic Theory*, Prentice Hall, New York, 1971. 4. A. Kautsoyiannis, *Modern Microeconomics* (2nd edn) MacMillan, New York, 1979.

CORE COURSE-V

Semester	Subject Code	Subject Title	Total Hours	Credit
II		ALGEBRA II	90	5
Objective	• To introduce the basic concepts of Fields and its extension • To understand the elements of Galois theory • To know about the various properties of division rings • To learn how to solvability by radicals			
Learning Outcomes	**After completion of this course, students will be able to:** • To understand and develop the concepts of finite fields, extension fields and galois group. • To describe the finite fields and their extension fields that lead to the development of cryptography. • To get knowledge on higher level of Algebra and apply it in the field of Genetics, Traffic flow, Electrical circuits, etc.			
Unit 1	Extension Fields			
Unit 2	Roots of Polynomials – More about roots			
Unit 3	The elements of Galois theory			
Unit 4	Finite Fields –Wedderburn's theorem on Finite Division Rings			
Unit 5	Solvability by Radicals – Galois Groups over the Rationals - A theorem on Frobenius			

Contents & Treatments in	**Topics in Algebra, I.N. Herstein, Wiley Eastern Limited New Delhi.** Unit 1: Chapter 5: Section 5.1. Unit 2: Chapter 5: Section 5.3 and 5.5 Unit 3: Chapter 5: Section 5.6 Unit 4: Chapter 7: Section 7.1 and 7.2 (Theorem 7.2.1 only) Unit 5: Chapter 5: Section 5.7 (Omit Lemma 5.7.1, 5.7.2 and theorem 5.7.1) ,5.8 Chapter 7: Sec. 7.3
Books for Reference	1. Algebra, M. Artin, Prentice Hall of India. 2. Basic Abstract Algebra, P.B. Bhattacharya, S. K. Jain and S. R. Nagpaul, Cambridge University Press. 3. Algebra, L.S. Luther and I. B. S. Passi, Vol. I - Groups, Vol II. - Rings, Narosa Publishing House, New Delhi. 4. Fundamentals of Abstract Algebra, D. S. Malik, J. N. Mordeson and M. K. Sen, McGraw Hill, International Edition, New York. 5. Basic Algebra, Vol. I and Vol. II, N. Jacobson, Hindustan Publishing Company, NewDelhi.

CORE COURSE- VI

Semester	Subject Code	Subject Title	Total Hours	Credit
II		**REAL ANALYSIS II**	**90**	**5**

Objectives	• To understand measure on real line. • To know integration of functions. • To learn Fourier series and Fourier integral. • To cater knowledge of multivariable differential calculus.
Learning Outcomes	**At the end of this course, students will able** • To understand the concepts of outer measure and integration of functions • To apply the concepts of fourier series and fourier integrals • To understand the concepts of applying multivariables in Natural and Social science and Engineering to model and study high dimensional systems that exhibit deterministic behavior.
Unit 1	**Measure on the Real line** Lebesgue Outer Measure - Measurable sets - Regularity - Measurable Functions - Borel and Lebesgue Measurability
Unit 2	**Integration of Functions of a Real Variable** Integration of Non-negative functions - The General Integral - Riemann and Lebesgue Integrals
Unit 3	**Fourier Series and Fourier Integrals** Introduction - Orthogonal system of functions - The theorem on best approximation - The Fourier series of a function relative to an orthonormal system - Properties of Fourier Coefficients - The Riesz-Fischer Theorem - The convergence and representation problems for trigonometric series - The Riemann - Lebesgue Lemma - The Dirichlet Integrals - An integral representation for the partial sums of Fourier series - Riemann's localization theorem - Sufficient conditions for convergence of a Fourier series at a particular point - Cesaro summability of Fourier series- Consequences of Fejer's theorem - The Weierstrass approximation theorem
Unit 4	**Multivariable Differential Calculus** Introduction - The Directional derivative - Directional derivative and continuity - The total derivative - The total derivative expressed in terms of partial derivatives - The matrix of linear function - The Jacobian matrix - The chain rule - Matrix form of chain rule - The mean - value theorem for differentiable functions - A sufficient condition for differentiability - A sufficient condition for equality of mixed partial derivatives - Taylor's formula for functions of R^n to R^1
Unit 5	**Implicit Functions and Extremum Problems** Functions with non-zero Jacobian determinants - The inverse function theorem - The Implicit

	function theorem - Extrema of real valued functions of one variable - Extrema of real valued functions of severable variables - Extremum problems with side conditions.
Contents & Treatment as in	**Measure Theory and Integration, G. de Barra, New Age International, 2003 (Units I & II)** Unit 1: Chapter - 2 Sec 2.1 to 2.5 Unit 2: Chapter3: Sections 3.1, 3.2 and 3.4 **Mathematical Analysis, Tom M.Apostol 2nd Edition, Narosa 1989 (Units III, IV and V)** Unit 3: Chapter 11: Sections 11.1 to 11.15 Unit 4: Chapter 12: Sections 12.1 to 12.5 and 12.7 to 12.14. Unit 5: Chapter 13 : Sections 13.1 to 13.7
Books for Reference	1. Burkill,J.C. *The Lebesgue Integral*, Cambridge University Press, 1951. 2. Munroe,M.E. *Measure and Integration*. Addison-Wesley, Mass.1971. 3. Royden,H.L.*Real Analysis*, Macmillan Pub. Company, New York, 1988. 4. Rudin, W. *Principles of Mathematical Analysis*, McGraw Hill Company, New York,1979. 5. Malik,S.C. and Savita Arora. *Mathematical Analysis*, Wiley Eastern Limited. New Delhi, 1991.

CORE COURSE VII

Semester	Subject Code	Subject Title	Total Hours	Credit
II		PARTIAL DIFFERENTIAL EQUATIONS	90	4

Objectives	• To introduce the basic concepts of PDE • To understand the classifications of PDE • To solve various PDE • To introduce the concept of Green's function
Learning Outcomes	**After completion of this course:** • The students will be able to solve partial differential equations arising in various branches of Science and Engineering like Thermo Dynamics, Heat Transfer, Wavelets, etc. • The students will be able to understand the concepts of IVP, BVP and Green's functions.
Unit 1	**Partial Differential Equations of First Order:** Formation and Solution of PDE of first order– Integral Surfaces passing through a given curve– The Cauchy Problem Order Equations – Surfaces– First Order Non- Linear – Compatible Systems of first order equations – Charpit Method.
Unit 2	**Fundamental Concepts:** Introduction – Classification of Second Order PDE – Canonical Forms– Linear PDEs with Constants Coefficients – Homogeneous Linear PDE with Constants Coefficients
Unit 3	**Parabolic Differential Equations:** Occurrence of Diffusion Equation – Boundary Conditions – Elementary Solutions of Diffusion Equation – Dirac-Delta Function – Separation of Variables Method – Examples.
Unit 4	**Hyperbolic Differential equations:** Formation and Solution of One-Dimensional Wave Equation – Canonical Reduction – IVP – D'Alembert's Solution – Vibration of Circular Membrane – Uniqueness of the Solution for the Wave Equation – Examples.

Unit 5	**Green’s Function:** Green’s Function for Laplace Equation – Methods of Images – Eigen Function Method – Green’s Function for the Wave and Diffusion equations.
Contents & Treatment as in	**Introduction to Partial Differential Equations, S. SankarRao, III Edition, Prentice Hall of India, New Delhi, 2013.** Unit 1: Chapter 0: Sections 0.4 to 0.8, 0.10 and 0.11 Unit 2: Chapter 1: Sections 1.1 to 1.3, 1.6 and 1.7 Unit 3: Chapter 3: Sections 3.1 to 3.5 Unit 4: Chapter 4: Sections 4.1 to 4.4 Unit 5: Chapter 5: Sections 5.2 to 5.4
Books for Reference	1. Partial Differential Equations, R.C. Mc Owen, II Edition. Pearson Education, New Delhi,2005. 2. Elements of Partial Differential Equations, I. N. Sneddon, McGraw Hill, New Delhi,1983. 3. Linear Partial Differential Equations and Boundary Value Problems, Tyint and Myiunt-Loknath and Debnath, McGraw Hill, New York,1968. 4. Advanced Differential Equations, M. D. Raisinghania, S. Chand & Co., New Delhi, 2001.

CORE COURSE VIII

Semester	Subject Code	Subject Title	Total Hours	Credit
II		**CLASSICAL DYNAMICS**	**90**	**4**
Objectives	• To create a foundation for understanding basic principles of mechanics and some classical problems. • To learn Lagrangian and Hamiltonian formulations. • To learn importance and consequences of Canonical transformations, Lagranges and Poisson Brackets.			
Learning Outcomes	**After completion of this course:** • The students will able to do derivation of Lagrange's equation using elementary calculus, Hamilton-Jacobi theory. • The students can use the concept of analytical treatments in checking the numerical models. • Students can apply the results in seat belts in cars, air bubble packing, banking of roads, railway tracks, etc.			
Unit 1	**Introductory Concepts**: The Mechanical Systems – Generalized Coordinates - Constraints – Virtual Work – Energy and Momentum.			
Unit 2	**Lagrange's Equation:** Derivation of Lagrange's Equation – Examples– Integrals of the motion			
Unit 3	**Hamilton's Equations:** Hamilton's Principle Functions – Hamilton's Equation – Other variational principles.			
Unit 4	**Hamilton - Jacobi Theory:** Hamilton's Principle Function – The Hamilton - Jacobi Equation – Separability.			
Unit 5	**Canonical Transformations:** Differential Forms and Generating Functions- Special transformation – Lagrange and Poisson Brackets.			

Contents & Treatment as in	**Classical Dynamics, Donald T. Greenwood, Prentice Hall of India Pvt. Ltd., New Delhi, 1985.** Unit 1: Chapter 1: Sections 1.1 to 1.5 Unit 2: Chapter 2: Sections 2.1 to 2.3 Unit 3: Chapter 4: Sections 4.1 to 4.3 Unit 4: Chapter 5: Sections 5.1 to 5.3. Unit 5: Chapter 6: Sections 6.1 to 6.3
Books for Reference	1. Classical Mechanics, Herbert Goldstein Charles P. Poole and John L. Safko, Addison, Wesley Press Inc.,2002. **2.** Principles of Mechanics, John L. Syngeand Byron A. Griffith, III Edition, McGraw, Hill Book, New York,1959.

GROUP B: ELECTIVE COURSE 1

Semester	Subject Code	Subject Title	Total Hours	Credit
II		DISCRETE MATHEMATICS	75	3
Objectives	● To understand the concept of mathematic logic. ● To learn about Lattices and Boolean algebra. ● To know about the algorithmic graph theory. ● To know about the Binary trees.			
Learning Outcomes	**Students will acquire knowledge** ● To validate the logical arguments ● To understand the generalization and abstract of Mathematical concepts. ● To understand the concept of Boolean optimization methods. ● To solve mathematical as well as algorithmic theory based on computer science problems. ● To apply in circuit theory.			
Unit 1	**Mathematical logic:** Statements and notation – Connectives – Normal forms.			
Unit 2	**Mathematical logic:** The theory of inference for the statement calculus–The predicate calculus –Inference theory of the predicate calculus.			
Unit 3	**Lattices and Boolean Algebra:** Lattices as partially ordered sets –Boolean algebra – Boolean functions.			
Unit 4	**Algorithmic Graph Theory:** Connectedness in Directed Graphs – Shortest Path Algorithm – Dijkstra’s Algorithm – Warshall’s Algorithm – Spanning Trees – Minimum Spanning Trees – Prim’s Algorithm.			
Unit 5	**Algorithmic Graph Theory:** Kruskal’s Algorithm – Rooted and Binary Trees – Binary Trees – Properties of Binary Trees – Tree Traversal – Expression Trees – Infix Notation – Prefix Notation – Postfix Notation.			

Contents & Treatment as in	**Discrete mathematical structures with applications to computer science, J.P. Tremblay R. Manohar. (For units 1, 2 and 3)** Unit 1: Chapter 1: Sections 1.1, 1.2(1.2.1 to 1.2.15), 1.3(1.3.1 to 1.3.6). Unit 2: Chapter 1: Sections 1.4(1.4.1 to 1.4.4), 1.5(1.5.1 to 1.5.5), 1.6(1.6.1 to 1.6.5). Unit 3: Chapter 4:Sections 4.1(4.1.1 to 4.1.5), 4.2(4.2.1 to 4.2.2), 4.3 (4.3.1 to 4.3.2). **Discrete Mathematics with Graph Theory and Combinatorics, T. Veerarajan, Tata McGraw Hill Publishing Company Ltd., New Delhi, VIII Reprint,2009 (For Units 4 and 5).** Unit 4: Chapter 7 Unit 5: Chapter 7
Books for Reference	1. Algorithmic Graph Theory, A. Gibbons, Cambridge University Press, Cambridge, 1989. 2. Graphs: An Introductory Approach, R. J. Wilson and J. J. Watkins, John Wiley and Sons, New York,1989.

GROUP B: ELECTIVE COURSE 2

Semester	Subject Code	Subject Title	Total Hours	Credit
II		**COMBINOTORICS**	**75**	**3**
Objectives	● To introduce Classical Techniques using Generator functions and Recurrence relations ● To study about Polya theory, Necklace problem and Burnside's lemma. ● To learn about Schur functions, Character theory and Inversion techniques.			
Learning Outcomes	**After completion of this course, the students will able to:** ● Use in Molecular Biology for patterns of atoms and DNA. ● Apply in the field like Networks, Cryptography, Data bases, etc. ● Use in Statistics needed for Machine learning.			
Unit 1	**Classical Techniques:** Basic combinatorial numbers - Generator functions and Recurrence Relations – Symmetric functions – Multinomials – Inclusion and Exclusion Principle.			
Unit 2	**Polya Theory:** Necklace problem and Burnside's lemma – cycle Index of Permutation group – Polya's Theorems and their applications – Binary operations on permutation Groups.			
Unit 3	**Schur Functions:** Robinson–Schensted–Knuth correspondence – Combinatorics of the Schur Functions. More on Schur functions: Little wood – Richardson Rule – Plethysm and Polya process – The Hook formula.			
Unit 4	**Character Theory of S_n:** Character Theory of finite groups . **Matching Theory:** Partially ordered set – Basic Existence Theory.			
Unit 5	**Inversion Techniques:** Classical Inversion Formulae Inversion via Mobius Function. Designs: Existence and construction . Ramsey Theory: Ramsey Theorem.			

Contents & Treatment as in	**V.Krishnamurthy, Combinatorics – Theory and Applications, Affiliated East – West Press Pvt Ltd, New Delhi . 1985.** Unit 1: Chapter 1: Sections 1 to 5 (Omit 6) Unit 2: Chapter 2: Sections 1 to 4 Unit 3: Chapter 3: Sections 1 & 2 Chapter 5: Sections 1 to 3 only Unit 4: Chapter 6: Sections 1 Chapter 6: Sections 1 & 2 Unit 5: Chapter 7: Sections 1 & 2 Chapter 8: Section 1 Chapter 9: Section 1
Books for Reference	1. Aigner, M. Combinatorial Theory, Springer Verlag, Berlin 1979. 2. Liu, C.L. Introduction to combinatorial Mathematics . MC Grimaldi,R.P. Discrete and Combinatorial Mathematics : An applied Introduction (4^{th} Edition).Pearson, (8^{th} Indian Print).

GROUP B: ELECTIVE COURSE 3

Semester	Subject Code	Subject Title	Total Hours	Credit
II		WAVELETS	75	3
Objectives	• To use Discrete Fourier Transforms • To introduce Wavelets on Z_n , Z and R. • To learn more about Wavelets and Differential Equations.			
Learning Outcomes	**After completion of this course:** • Students are able to apply the concept in Pattern recognition in Biotechnology. • Students are used in Metallurgy in order to study the characterisation of rough surfaces. • Students are able to apply their knowledge in exploring variation of stock prices in Finance.			
Unit 1	The Discrete Fourier Transforms.			
Unit 2	Wavelets on $\mathbf{Z}_n$.			
Unit 3	Wavelets on **Z.**			
Unit 4	Wavelets on **R.**			
Unit 5	Wavelets and Differential Equations.			
Contents & Treatment as in	**Michael W.Frazier, *An Introduction to Wavelets through Linear Algebra*, Springer Verlag, Berlin, 1999** Unit 1: Chapter 2: 2.1 to 2.3 Unit 2: Chapter 3: 3.1 to 3.3 Unit 3: Chapter 4: 4.1 to 4.7 Unit 4: Chapter 5: 5.1 to 5.5 Unit 5: Chapter 6: 6.1 to 6.3			
Books for Reference	1. C.K.Chui, *An Introduction to Wavelets*, Academic Press, 1992 2. E.Hernandez and G.Weiss, *A First Course in Wavelets*, CRC Press, New York,1996 3. D.F.Walnut, *Introduction to Wavelet Analysis*, Birhauser, 2004.			

CORE COURSE IX

Semester	Subject Code	Subject Title	Total Hours	Credit
III		**COMPLEX ANALYSIS**	**90**	**4**

Objectives	• To introduce the concept of Analytic function the basic analogous of complex line Integral, Cauchy theorem, the fundamental of entire and meromorphic function. • To introduce Harmonic functions. • To Study the power series of representation.
Learning Outcomes	**After completion of this course:** • The student will get strong foundation of complex analysis as well as motivation at advanced level. • To apply the concepts in wavelets theory and Harmonic Analysis.
Unit 1	**Fundamental Theorems:** Line Integral-Rectifiable arc-Cauchy's Theorem for a rectangle-Cauchy's Theorem in a disk – Cauchy's Integral formula – Higher derivatives.
Unit 2	Local properties of Analytic function – Zeros and poles – The Local mapping – The maximum Principle.
Unit 3	Chains and Cycles – Simple Connectivity – Homology – The General Statement of Cauchy's Theorem – The residue theorem – The Argument Principle.
Unit 4	**Harmonic Function:** Definition and properties – The Mean Value Property – Poisson's formula-Schwartz's Theorem – Reflection Principle.
Unit 5	**Power Series representation:** Weierstrass Theorem -The Taylor Series – The Laurent Series – Partial fractions and Factorizaiton.

Contents & Treatment as in	**Complex Analysis, Lars.V. Ahlfors, Third Edition – 1979, Mcgraw Hill Educations.** Unit 1:Chapter 4: Section 1.1-1.5 and 2.1 - 2.3. Unit 2:Chapter 4: Section 1.1-1.5 and 2.1 - 2.3 Unit 3:Chapter 4 : Section 4.1-4.5 and 5.1-5.2 Unit 4: Chapter 5: Sections 5.1 to 5.3. Unit 5: Chapter 5: Section 1.1-1.3 and 2.1
Books for Reference	1. Conway J.B. Functions of one Complex Variables, Second Edition 2000, Springer international Student Edition. 2. S. Ponnusamy, "Foundations of Complex Analysis. Second Edition: Narosa Publish House.

CORE COURSE X

Semester	Subject Code	Subject Title	Total Hours	Credit
III		**TOPOLOGY**	**90**	**4**

Objectives	• To study about the topological spaces • To develop the concepts based on continuity, connectedness, completeness& compactness in topological spaces • To learn few theorems based on countability and separation axioms
Learning Outcomes	**At the end this course, the students will be able** : • To get good foundation for future study in analysis and in geometry. • To understand the concepts of basic notion of a Topological Space, Continuous between topological spaces, Compactness and Connectedness of a Topological space. • To develop the knowledge about the Countability, Separation axiom, Urysohn Metrization theorem and Tietze Extension theorem. • To apply the concepts in dynamical Systems, Knott theory, Riemannian surfaces in complex analysis. • To use in string theory in Physics.
Unit 1	**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 2	**Continuous Functions:** Continuous Functions – The Product Topology – The Metric Topology.
Unit 3	**Connectedness:** Connected Spaces – Connected Subspaces of the Real Line – Components and Local Connectedness.
Unit 4	**Compactness:** Compact Spaces – Compact Subspaces of the Real Line – Limit Point Compactness.
Unit 5	**Countability and Separation Axioms:** The Countability Axioms – The Separation Axioms – Normal Spaces – The Urysohn Lemma – The UrysohnMetrization Theorem – Tietz Extension Theorem.
Contents & Treatment as in	**Topology, James R. Munkres, II Edition, Pearson Education Pvt. Ltd., Delhi.** Unit 1: Chapter 2: Section 12 to 17 Unit 2: Chapter 2: Section 18 to 21

	Unit 3: Chapter 3: Section 23 to 25 Unit 4: Chapter3: Section 26 to 28 Unit 5: Chapter 5: Section 30 to 35
Books for Reference	1. Topology, J. Dugunji, Prentice Hall of India, New Delhi,1975. 2. Introduction to Topology and Modern Analysis, George F. Simmons, McGraw Hill Book Co.,1963. 3. General Topology, J. L. Kelly, Van Nostrand, Reinhold Co., NewYork. 4. Counter Examples in Topology, L. Steen and J. Subhash, Holt, Rinehart and Winston, New York,1970. 5. General Topology, S. Willard, Addison Wesley, Mass.,1970.

CORE COURSE XI

<table>
<tr><th>Semester</th><th>Subject Code</th><th>Subject Title</th><th>Total Hours</th><th>Credit</th></tr>
<tr><td>III</td><td></td><td>DIFFERENTIAL GEOMETRY</td><td>90</td><td>4</td></tr>
<tr><td>Objectives</td><td colspan="4">● This course introduces the key concepts of Differential Geometry.
● To introduce Curves, Surfaces and Curves on the surfaces.
● To learn about Geodesics, Gaussian curvature, Line curvature, etc.
● To study about Developable associated with space curves.</td></tr>
<tr><td>Learning Outcomes</td><td colspan="4">At the end of this course
● Students gain some mathematical maturity and involves connections to other areas.
● To effectively communicate mathematics in both professional and informal style.
● To understand the concepts of space curves and intrinsic equations and properties of a surface and geodesics.
● To apply the concept in Artificial intelligence, Robotics, Biology, etc</td></tr>
<tr><td>Unit 1</td><td colspan="4">Space Curves:
Definition of a Space Curve – Arc Length – Tangent, Normal and Binormal Vectors – Curvature and Torsion – Contact Between Curves and Surfaces.</td></tr>
<tr><td>Unit 2</td><td colspan="4">Space Curves and Surface:
Intrinsic Equations – Fundamental Existence Theorem for Space Curves – Helices.
Intrinsic Properties of a Surface: Definition of a Surface – Curves on a Surface – Surface of Revolution – Helicoids – Metric.</td></tr>
<tr><td>Unit 3</td><td colspan="4">Direction Coefficients - Families of curves-Isometric Correspondence-Intrinsic Properties.
Geodesics: Geodesics – Canonical Geodesic Equations – Normal Property of Geodesics.</td></tr>
<tr><td>Unit 4</td><td colspan="4">Existence Theorems – Geodesic Parallels – Geodesics Curvature – Gauss-Bonnet Theorem – Gaussian Curvature – Surface of Constant Curvature.</td></tr>
<tr><td>Unit 5</td><td colspan="4">Curves on a Surface:
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 .</td></tr>
</table>

Contents & Treatment as in	**An Introduction to Differential Geometry, T. J. Willmore, Oxford University Press, New Delhi, Indian Print, 2002.** Unit 1: Chapter 1: Sections 1 to 6 Unit 2: Chapter 1: Sections 8 & 9 Chapter 2: Sections 1 to 5 Unit 3: Chapter 2: Sections 6 to 12 Unit 4: Chapter 2: Sections 13 to 18 Unit 5: Chapter 3: Sections 1 to 6
Books for Reference	1. Lectures on Classical Differential Geometry, D.T. Struik, Addison Wesley, Mass. 1950. 2. Foundations of Differential Geometry, Kobayashi S. and Nomizh K., Interscience Publishers,1963. 3. A course in Differential Geometry, Wilhelm Klingenberg, Graduate Texts in Mathematics, Springer Verlag,1978.

GROUP C: ELECTIVE COURSE 1

Semester	Subject Code	Subject Title	Total Hours	Credit
III		**PROBABILITY THEORY**	**60**	**3**
Objective	• This subject aims to explain the distributions of random variable • To study about the expectations and Stochastic independence • To learn some special distributions like Binomial, Poisson & Normal • To know about limiting distributions			
Learning Outcomes	**At the end of this course, Students are able:** • To have a clear perception of the power of probability theory ideas and tools and would be able to demonstrate the application of mathematics to problems drawn from industry and financial services. • To describe the main equilibrium asset pricing models and perform calculations using such models; understand the relationship between investment risk and return and calculate the option prices using the studied models.			
Unit 1	Random Events and Random Variables: Random events – Probability axioms – Combinatorial formulae – conditional probability – Bayes theorem – Independent events – Random Variables – Distribution function - Joint Distribution – Marginal Distribution – Conditional distribution - Independent random variables – Functions of random variables.			
Unit 2	Parameters of the Distribution - Expectation- Moments – The Chebyshev Inequality – Absolute moments – Order parameters - Moments of random vectors - Regression of the first and second types.			
Unit 3	Characteristic functions: Properties of characteristic functions –Characteristic functions and moments – semi-invariants – characteristic function of the sum of the independent random variables – Determination of distribution function by the Characteristic function - Characteristic function of multidimensional random vectors - Probability generating functions.			
Unit 4	Some Probability distributions:One point , two point , Binomial, Polya, Hyper Geometric, Poisson (discrete) distributions, Uniform, Normal, Gamma, Beta, Cauchy and Laplace distributions.			

Unit 5	Limit Theorems: Stochastic convergence – Bernaulli law of large numbers - Convergence of sequence of distribution functions – Levy- Cramer Theorems – de Moivre-Laplace Theorem – Poisson, Chebyshev, Khintchine Weak law of large numbers – Lindberg Theorem – Lapunov Theroem - Borel-Cantelli Lemma - Kolmogorov Inequality and Kolmogorov Strong Law of large numbers.
Contents & Treatment as in	**Probability Theory and Mathematical Statistics, M. Fisz, John Wiley and Sons, New York, 1963.** Unit 1: Chapter 1: Section 1.1 to 1.7 Chapter 2: Section 2.1 to 2.9 Unit 2: Chapter 3: Section 3.1 to 3.8 Unit 3: Chapter 4: Section 4.1 to 4.7 Unit 4: Chapter 5: Section 5.1 to 5.10 (Omit 5.11) Unit 5: Chapter 6 Section 6.1 to 6.4, 6.6 to 6.9, 6.11 and 6.12 (Omit 6.5, 6.10 and 6.13).
Books for Reference	**1.** R.B. Ash, Real Analysis and Probability, Academic Press, New York, 1972. **2.** K.L.Chung, A course in Probability, Academic Press, New York, 1974. **3.** R.Durrett, Probability : Theory and Examples, (2nd Edition) Duxbury Press, New York,1966. **4.** V.K.Rohatgi An Introduction to Probability Theory and Mathematical Statistics, WileyEastern Ltd., New Delhi, 1988(3rd Print). **5.** S.I.Resnick, A Probability Path, Birhauser, Berlin,1999. **6.** B.R.Bhat , Modern Probability Theory (3rd Edition), New Age International (P)Ltd, NewDelhi, 1999.

GROUP C: ELECTIVE COURSE 2

Semester	Subject Code	Subject Title	Total Hours	Credit
III		**ALGEBRAIC THEORY OF NUMBERS**	**60**	**3**
Objective	● To introduce Symmetric polynomials, Modules and Free abelian groups. ● To study about Algebraic numbers, Quadratic and Cyclotomic fields. ● To learn more about Ideals and prime factorization of Euclidean domain.			
Learning Outcomes	**After completion of this course:** ● Students are used the concept in String theory inspired approaches in Financial Markets. ● They are used string prediction models as an invariant of time series in Forex market. ● Students are able to use the concepts in Cryptography, Digital information, Physics, Computing, etc.			
Unit 1	**Algebraic background:** Rings and Fields- Factorization of Polynomials – Field Extensions – Symmetric Polynomials – Modules – Free Abelian Groups.			
Unit 2	**Algebraic Numbers:** Algebraic numbers –Conjugates and Discriminants – Algebraic Integers – Integral Bases – Norms and Traces – Rings of Integers.			
Unit 3	**Quadratic and Cyclotomic Fields :** Quadratic fields and cyclotomic fields **Factorization into Irreducibles:** Trivial factorization – Factorization into irreducibles – Examples of non-unique factorization into irreducibles.			
Unit 4	Prime Factorization – Euclidean Domains – Euclidean Quadratic fields - Consequences of unique factorization – The Ramanujan –Nagell Theorem.			
Unit 5	**Ideals:** Prime Factorization of Ideals – The norms of an Ideal – Non-unique Factorization in Cyclotomic Fields.			
Contents & Treatment as in	I. Stewart and D.Tall. *Algebraic Number Theory and Fermat's Last Theorem* (3rd Edition) A.K.Peters Ltd., Natrick, Mass. 2002. Unit 1: Chapter 1: Sec. 1.1 to 1.6. Unit 2: Chapter 2: Sec. 2.1 to 2.6. Unit 3: Chapter 3: Sec. 3.1 and 3.2; Chapter 4: Sec. 4.1 to 4.4. Unit 4: Chapter 4: Sec. 4.5 to 4.9. Unit 5: Chapter 5: Sec. 5.1 to 5.4.			
Books for Reference	1. Z.I.Borevic and I.R.Safarevic, *Number Theory*, Academic Press, New York, 1966. 2. J.W.S.Cassels and A.Frohlich, *Algebraic Number Theory*, Academic Press, New York, 1967. 3. P.Ribenboim, *Algebraic Numbers*, Wiley, New York, 1972. 4. P. Samuel, *Algebraic Theory of Numbers*, Houghton Mifflin Company,			

	Boston, 1970.

GROUP C: ELECTIVE COURSE 3

Semester	Subject Code	Subject Title	Total Hours	Credit
III		**NUMBER THEORY AND CRYPTOGRAPHY**	**60**	**3**

Objectives	• To make the Mathematics Students understand the theory behind certain cryptographic scheme in full depth**.** • To introduce cryptography and its applications.
Learning Outcomes	**At the end of this course, students will be able** • To understand the concept of number theory required for public key cryptography. • To understand the concept of Mathematics behind some of the Cryptographic primitives. • To apply in Military Operation as secret codes.
Unit 1	**Elementary Number Theory**: Time Estimates for doing arithmetic – divisibility and Euclidean algorithm – Congruences – Application to factoring.
Unit 2	**Introduction to Classical Crypto systems:** Some simple crypto systems – Enciphering matrices DES.
Unit 3	**Finite Field:** Finite Fields, Quadratic Residues and Reciprocity.
Unit 4	Public Key Cryptography.
Unit 5	Primality, Factoring, Elliptic curves and Elliptic curve crypto systems.
Contents & Treatment as in	**A Course in Number Theory and Cryptography, Neal Koblitz, Springer-Verlag, New York,1987.**

	Unit 1: Chapter 1 Unit 2: Chapter 3 Unit 3: Chapter 2 Unit 4: Chapter 4 Unit 5: Chapter 5 (Omit Sec. 4) and Chapter 6 (Section 1 and 2 only).
Books for Reference	1. I. Niven and H.S.Zuckermann, *An Introduction to Theory of Numbers* (Edn. 3), Wiley Eastern Ltd., New Delhi,1976 2. David M.Burton, *Elementary Number Theory*, Brown Publishers, Iowa,1989 *3.* K.Ireland and M.Rosen, *A Classical Introduction to Modern Number Theory*, SpringerVerlag, 1972. 4. N.Koblitz, *Algebraic Aspects of Cryptography*, Springer 1998.

CORE COURSE XII

Semester	Subject Code	Subject Title	Total Hours	Credit
IV		FUNCTIONAL ANALYSIS	90	4
Objective	• To learn the fundamentals of Functional Analysis. • To study about Open mapping theorem, Closed graph theorem. • The Topic include Hahn-Banach theorem, Riesz representation theorem etc. • To know about Banach and Hilbert spaces.			
Learning Outcomes	**After completion of this course:** • The student will be in a position to take up advance courses in analysis. • The student will be able to apply the concepts and theorem for studying Numerical analysis, design maturity and complexity of mission etc. • To apply the concept in approximation theory, Spectral theory, Calculus of variations, etc.			
Unit 1	**Banach Space:** Definition and Examples – Continuous Linear Transformation - The Hahn – Banach Theorem.			
Unit 2	**Fundamental Theorems in Normed Linear Space:** The natural imbedding of N in N**-The open mapping theorem-Closed Graph theorem – The Conjugate of an operator – Uniform boundedness theorem.			
Unit 3	**Hilbert Spaces:** Definitions and properties – Schwarz inequality – Orthogonal complements – Orthonormal sets – Bessel's Inequality – Gram – Schmidt Orthogonalization Process – The Conjugate space H* - Riesz Representation theorem.			
Unit 4	**Operator in a Hilbert space:** The adjoint of an operator – Self adjoint Operators – Normal and Unitary operators – Projections.			
Unit 5	**Spectral and fixed point theorems:** Matrices – Determinants and the spectrum of an operator – Spectral theorem -Fixed point theorems and some applications to analysis.			
Contents & Treatment as in	**Introduction to topology and Modern Analysis, Simmons G.F. Tata Mc-Graw Hill Pvt Ltd., New Delhi 2011.**			

	Unit 1: Sections: 46,47&48. Unit 2: Sections: 49,50&51 Unit 3: Sections: 52,53,54 & 55. Unit 4: Sections: 56,57,58 & 59 Unit 5: Sections: 60,61,62 & Appendix 1
Books for Reference	1. Limaye B.V. " Functional Analysis" New Age International Ltd., Publishers, Second Edition, New Delhi 1996 **2.** Rudin W., "Functional Analysis" Tata Mc-Graw Hill Pvt Ltd., New Delhi 2011.

CORE COURSE XIII

Semester	Subject Code	Subject Title	Total Hours	Credit
IV		**CALCULUS OF VARIATIONS AND INTEGRAL EQUATIONS**	**90**	4

Objective	• To introduce variational problems. • To develop methods to solve the variational problems. • To introduce different types of integral equations. • To develop methods to solve Integral equations.
Learning Outcomes	**At the end of this course, the students will be:** • To familiarize in the field of differential and elliptic equations to solve boundary value problems associated with engineering applications. • To understand the concepts of variational formulation and numerical integration techniques. • To develop the mathematical models of applied mathematics and mathematical physics with an emphasis on calculus of variations problems. • To apply the concept of integral equations at scattering in Quantum mechanics, Water waves, Conformal mapping, etc.
Unit 1	The Method of Variations in Problems with Fixed Boundaries.
Unit 2	Variational Problems with Moving Boundaries and Certain other Problems and Sufficient Conditions for an Extremum.
Unit 3	Variational Problems involving a Conditional Extremum.
Unit 4	Integral Equations with Separable Kernels and Method of Successive Approximation.
Unit 5	Classical Fredholm Theory – Symmetric Kernels and Singular Integral Equations.
Contents & Treatment as in	**Differential Equations and Calculus of Variations, L. Elsgolts, Mir Publications, Mosow, 1973.** (For Unit 1, Unit 2 and Unit 3) Unit 1: Chapter 6: Sections 1 to 5 and 7 Unit 2: Chapter 7: Sections 1 to 4 Unit 3: Chapter 9: Sections 1 to 3 **Linear Integral Equations, Theory and Techniques, Ram P. Kanwal, Academic Press, NewYork,1971**

	(For Unit 4 and Unit 5) Unit 4: Chapter 1: Sections 1.1 to 1.7 Chapter 2: Sections 2.1 to 2.5 Chapter 3: Sections 3.1 to 3.5 Unit 5: Chapter 4: Sections 4.1 to 4.5 (Fredholm's theorems without proof) Chapter 7: Sections 7.1 to 7.6 Chapter 8: Sections 8.1 to 8.5
Books for Reference	1. Calculus of Variations with Applications, A. S. Gupta, PHI India, New Delhi,2005. 2. Calculus of Variations, I. M. Gelfand and S. V. Fomin, PrenticeHall Inc., New Jersy, 1963. 3. Linear Integral Equations, S. G. Mikhlin, Hindustan Publishing Corp., Delhi,1960. 4. Integral Equations and Boundary Value Problems, M. D. Raisinghania, S. Chand & Co., New Delhi2007.

CORE COURSE XIV

Semester	Subject Code	Subject Title	Total Hours	Credit
IV		**FLUID DYNAMICS**	**60**	**3**

Objective	• To introduce the equation of motion of the fluid particle. • To study about velocity and acceleration of the fluid particle. • To learn about Kinematics of fluid in motion. • To study about some three dimensional motion of a fluid. • To learn about a treatment of topics in Fluid dynamics to a standard where the students will be able to apply the techniques used in deriving s range of important results.
Learning Outcomes	**At the end of this course, students will be able** • To understand the basic principles in Fluid dynamics. • To provide a treatment of topics in Fluid dynamics to a standard where the students will be able to apply the techniques used in deriving s range of important results. • To provide the knowledge of fundamentals of Fluid Dyanmics. Moreover through this course they can attain the knowledge in Vector analysis, Geometry and Mechanics.
Unit 1	**KINEMATICS OF FLUIDS IN MOTION:** Real fluids and Ideal fluids - Velocity of a fluid at a point, Stream lines, path lines, steady and unsteady flows- Velocity potential - The vorticity vector- Local and particle rates of changes - Equations of continuity - Worked examples - Acceleration of a fluid - Conditions at a rigid boundary.
Unit 2	**EQUATIONS OF MOTION OF A FLUID:** Pressure at a point in a fluid at rest. - Pressure at a point in a moving fluid - Conditions at a boundary of two inviscid immiscible fluids- Euler's equation of motion - Discussion of the case of steady motion under conservative body forces.
Unit 3	**SOME THREE DIMENSIONAL FLOWS:** Introduction- Sources, sinks and doublets - Images in a rigid infinite plane - Axis symmetric flows - stokes stream function.

Unit 4	**SOME TWO DIMENSIONAL FLOWS :** Meaning of two dimensional flow - Use of Cylindrical polar coordinate - The stream function - The complex potential for two dimensional, irrotational incompressible flow - Complex velocity potentials for standard two dimensional flows - Some worked examples - Two dimensional Image systems - The Milne Thompson circle Theorem.
Unit 5	**VISCOUS FLOWS:** Stress components in a real fluid. - Relations between Cartesian components of stress- Translational motion of fluid elements - The rate of strain quadric and principal stresses - Some further properties of the rate of strain quadric - Stress analysis in fluid motion - Relation between stress and rate of strain - The coefficient of viscosity and Laminar flow.
Contents & Treatment as in	**Text Book of Fluid Dynamics,F. Chorlton,,CBS Publications. Delhi ,1985.** Unit 1:Chapter 2. Sections 2.1 to 2.10 Unit 2: Chapter 3 Sections 3.1 to 3.7 Unit 3:Chapter 4 Sections 4.1, 4.2, 4.3, 4.5. Unit 4: Chapter 5. Sections 5.1 to 5.8 Unit 5:Chapter 8. Sections 8.1 to 8.8
Books for Reference	1. Introduction to Fluid Mechanics, R.W.Fox and A.T.McDonald Wiley, 1985. 2. Fluid Mechanics with Problems and Solutions E.Krause, Springer, 2005. 3. Mechanics of Fluids, B.S.Massey, J.W.Smith and A.J.W.Smith, Taylor and Francis,New York, 2005 4. Basics of Fluid Mechanics and Introduction to Computational Fluid Dynamics.

GROUP D: ELECTIVE COURSE 1

Semester	Subject Code	Subject Title	Total Hours	Credit
IV		**STOCHASTIC PROCESSES**	**60**	**3**
Objectives	● This course aims at providing the necessary basic concept in stochastic processes. ● To introduce Markov processes and Markov chain ● To learn about Poisson process, Birth and Death Process, etc.			
Learning Outcomes	**At the end of the course, Students will be able** ● To understand and characterize phenomena which involve with respective time in a probabilistic manner ● To understand the concept of advanced topics for future research involving stochastic modeling. ● To study the knowledge of fundamentals and applications of random phenomena will greatly helping the understanding of topics such as signals and systems, pattern recognition, voice and image processing and filtering theory.			
Unit 1	Introduction of Stochastic Processes – Specification of Stochastic Processes – Stationary Processes – Martingales.			
Unit 2	Definition of Markov Chain – Higher Transition Probabilities – Classification of States and Chains – Determination of Higher Transition Probabilities – Stability of Markov Chain.			
Unit 3	Poisson Process and Related Distributions - Generalizations of Poisson Process.			

Unit 4	Birth and Death Process - Markov Processes with Discrete State Space – Erlang Process.
Unit 5	Renewal Process - Renewal Processes in Continuous Time – Renewal Equation and Renewal theorems.
Contents & Treatment as in	**Stochastic Processes, J. Medhi, Wiley Eastern Limited, New Delhi.** Unit 1: Chapter 2: Sections – 2.1 to 2.4 Unit 2: Chapter 3: Sections – 3.1 and 3.2, 3.4 to 3.6 (Omit 3.3) Unit 3: Chapter 4: Sections – 4.1 to 4.3 Unit 4: Chapter 4: Sections - 4.4, 4.5 and 4.7 (Omit 4.6) Unit 5: Chapter 6: Sections – 6.1 to 6.5
Books for Reference	1. Stochastic Processes, J. L. Doob, John Wiley and Sons Inc., NewYork. 2. Probability, Random Variables and Stochastic Processes, Athanasios Papoulis, S. Unnikrishna Pillai, McGraw Hill, Europe, IV Edition, 2002. 3. Applied Probability and Stochastic Processes: In Engineering and Physical Sciences, Michel K. Ochi, Wiley Interscience,1990. 4. The Theory of Stochastic Processes, D. R. Cox, H. D. Miller, Chapman and Hall/CRC,1977. 5. Stochastic Processes, Sheldon M. Ross Author, Wiley, II Edition,1995.

GROUP D: ELECTIVE COURSE 2

Semester	Subject Code	Subject Title	Total Hours	Credit
IV		**FUZZY SETS AND ITS APPLICATIONS**	**60**	**3**
Objective	• To define the basic ideas and entities in fuzzy set theory. • To introduce the operations and relations on fuzzy sets. • To learn about Fuzzy graph and Fuzzy matrix • To learn how to compute with fuzzy sets and numbers.			
Learning Outcomes	**After completion of the course, the students will be able** • To understand the use of fuzzy logic based on methodology for retrieval of temporal cases in a case-based reasoning. • To understand the application of fuzzy concepts on civil, mechanical and industrial engineering. • To apply in the field of facial pattern recognition, air conditioner, washing machines, vacuum cleaner, etc.			
Unit 1	Fundamental Notions.			

Unit 2	Fuzzy Graphs.
Unit 3	Fuzzy Relations.
Unit 4	Fuzzy Logic
Unit 5	The Laws of Fuzzy Composition
Contents & Treatment as in	**Introduction to the Theory of Fuzzy Subsets - Vol. I, A.Kaufman, Academic Press, New York,1975.** Unit 1: Chapter 1: Sections 1 to 8 Unit 2: Chapter 2: Sections 10 to 18 Unit 3: Chapter 2: Sections 19 to 29 Unit 4: Chapter 3: Sections 31 to 36, 39, 40 (Omit section 30, 37 and38) Unit 5: Chapter 4: Sections 43 to 49 (Omit Section 41, 42).
Books for Reference	1. Fuzzy Set Theory and its Applications, H. J. Zimmermann, Allied Publishers, Chennai, India,1996. **2.** Fuzzy Sets and Fuzzy Logic, George J.Klir and Bo Yuan,Prentice Hall of India, New Delhi, 2004.

GROUP D: ELECTIVE COURSE 3

Semester	Subject Code	Subject Title	Total Hours	Credit
IV		**MATHEMATICAL STATISTICS**	**60**	**3**

Objective	• To introduce Sample Moments and their functions. • To learn about Significance of Test, Estimation. • To study about Analysis of Variance and Hypothesis Testing.
Learning Outcomes	**After the completion of this course:** • Students are able to apply the concept in Chemometrics is the science of relating measurements made on a chemical system or process to the state of system via statistical methods. • Students can apply their knowledge in Actuarial Science, Biostatistics, Business analytics, etc.

Unit 1	**Sample Moments and their Function:** Sample and a statistic – Distribution functions of X, S^2 and (X,S^2) - χ^2 distribution – Student t-distribution – Fisher's Z-distribution – Snedecor's F- distribution – Distribution of sample mean from non-normal populations.
Unit 2	**Significance Test:** Concept of a statistical test – Parametric tests for small samples and large samples - χ^2 test – Kolmogorov Theorem – Smirnov Theorem – Tests of Kolmogorov and Smirnov type – The Wald-Wolfovitz and Wilcoxon-Mann-Whitney tests – Independence Tests by contingency tables.
Unit 3	**Estimation:** Preliminary notion – Consistency estimation – Unbiased estimates – Sufficiency – Efficiency – Asymptotically most efficient estimates – methods of finding estimates – confidence Interval.
Unit 4	**Analysis of Variance:** One way classification and two-way classification. **Hypotheses Testing:** Poser functions – OC function- Most Powerful test – Uniformly most powerful test – unbiased test.
Unit 5	**Sequential Analysis:** SPRT – Auxiliary Theorem – Wald's fundamental identity – OC function and SPRT – E(n) and Determination of A and B – Testing a hypothesis concerning p on 0-1 distribution and m in Normal distribution.
Contents & Treatment as in	**M. Fisz** , ***Probability Theory and Mathematical Statistics,* John Wiley and sons, New Your, 1963**. Unit 1: Chapter 9: Sections 9.1 to 9.8 Unit 2: Chapter 10: Sections 10.11 Chapter 11: 12.1 to 12.7. Unit 3: Chapter 13: Sections 13.1 to 13.8 (Omit Section 13.9) Unit 4: Chapter 15: Sections 15.1 and 15.2 (Omit Section 15.3) Chapter 16: Sections 16.1 to 16.5 (Omit Section 16.6 and 16.7) Unit 5: Chapter 17: Sections 17.1 to 17.9 (Omit Section 17.10)
Books for Reference	1. **E.Dudewicz and S.N.Mishra**, *Modern Mathematical Statistics*, John Wiley and Sons, New York, 1988. 2. **V.K.Rohatgi** *An Introduction to Probability Theory and Mathematical Statistics*, Wiley Eastern New Delhi, 1988(3rd Edn) 3. **G.G.Roussas**, *A First Course in Mathematical Statistics,*

	Addison Wesley Publishing Company, 1973 4. **B.L.Van der Waerden,** *Mathematical Statistics*, G.Allen & Unwin Ltd., London, 1968.

GROUP D: ELECTIVE COURSE 4

Semester	Subject Code	Subject Title	Total Hours	Credit
IV		**ALGEBRAIC TOPOLOGY**	**60**	**3**
Objective	● To introduce the Homotopy of paths, Fundamental Group and Covering space. ● To study about Fundamental Groups of some surfaces. ● To learn more about Homology of surfaces and Equivalence of covering spaces. ●			
Learning Outcomes	**After completion of this course:** ● Students are able to apply the concept in Knott theory			

	• They can apply in the field of Topological combitorinics. • They can use the concepts in differential structure of smooth manifolds.
Unit 1	Homotopy of paths **-** Fundamental Group – Covering space -The Fundamental Group of the circle – Retractions and Fixed points
Unit 2	The Fundamental Theorem of Algebra – Borsuk–Ulam Theorem – Deformation Retracts and Homotopy Type – The Fundamental Group of S^n - Fundamental Groups of some surfaces.
Unit 3	Direct sums of Abelian Groups – Free products of Groups – Free Groups – The Seifert–van Kampen Theorem – The Fundamental Group of a wedge of circles.
Unit 4	Fundamental groups of surfaces – Homology of surfaces – cutting and pasting – The classification theorem – constructing compact surfaces.
Unit 5	Equivalence of covering spaces – The Universal covering space – covering transformations – Existence of covering spaces.
Contents & Treatment as in	**J.R.Munkres, Toplogy, Pearson Education Asia, Second Edition 2002.** Unit 1: Chapter 9: Sections 51 – 55. Unit 2: Chapter 9: Sections 56 – 60. Unit 3: Chapter 11: Sections 67 -71. Unit 4: Chapter 12: Sections 74 – 78 Unit 5: Chapter 13: Sections 79 – 82
Books for Reference	1. **M.K.Agoston**, Algebraic topology – A First Course, Marcel Dekker, 1962. **2. Satya Deo,** Algebraic Topology , Hindustan Book Agency, New Delhi, 2003. **3. M.Greenberg and Harper**, Algebraic Topology – A First course, Benjamin/Cummings, 1981. **4. C.F. Maunder**, Algebraic topology, Van Nostrand, New York, 1970. **5. A.Hatcher**, Algebraic Topology, CambridgeUniversity Press, South Asian Edition 2002. **6. W.S.Massey**, Algebrai Topology : An Introduction, Springer 1990

GROUP D: ELECTIVE COURSE 5

Semester	Subject Code	Subject Title	Total Hours	Credit
IV		**TENSOR ANALYSIS AND THEORY OF RELATIVITY**	**60**	**3**
Objective	• To introduce the concepts of Tensor Algebra • To learn about Tensor calculus. • To know about Special theory of Relativity			
Learning Outcomes	**After the completion of this course:** • Students are able to understand the Tensor algebra and Tensor Calculus and can apply in various fields like Elasticity, Continuum Mechanics, Electro magnetism, etc. • They are used the concepts of Relativity theory in Quantum			

	Mechanics ● It can also be used in Higher Dimensional Geometry.
Unit 1	**Tensor Algebra:** Systems of Different orders – Summation Convention – Kronecker Symbols - Transformation of coordinates in S_n - Invariants – Covariant and Contravariant vectors - Tensors of Second Order – Mixed Tensors – ZeroTensor – Tensor Field – Algebra of Tensors – Equality of Tensors – Symmetric and Skew-symmetric tensors - Outer multiplication, Contraction and Inner Multiplication – Quotient Law of Tensors – Reciprocal Tensor – Relative Tensor – Cross Product of Vectors.
Unit 2	**Tensor Calculus:** Riemannian Space – Christoffel Symbols and their properties.
Unit 3	**Tensor Calculus(Contd.):** Covariant Differentiation of Tensors – Riemann–Christoffel Curvature Tensor – Intrinsic Differentiation.
Unit 4	**Special Theory of Relativity:** Galilean Transformations – Maxwell's equations – The ether Theory – The Principle of Relativity. **Relativistic Kinematics:** Lorentz Transformation equations – Events and simultaneity – Example – Einstein Train – Time dilation – Longitudinal Contraction - Invariant Interval - Proper time and Proper distance - World line - Example – twin paradox – addition of velocities – Relativistic Doppler effect.
Unit 5	**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.
Contents & Treatment as in	**U.C. De, Absos Ali Shaikh and Joydeep Sengupta, Tensor Calculus, Narosa Publishing House, New Delhi, 2004.** Unit 1: Chapter I: I.1 – I.3, I.7 and I.8 and Chapter II: II.1 – II.19 Unit 2: Chapter III: III.1 and III.2 Unit 3: Chapter III: III.3 – III.5 **D.Greenwood, Classical Dynamics, Prentice Hall of India, New Delhi, 1985.** Unit 4: Chapter 7: Sections 7.1 and 7.2 Unit 5: Chapter 7: Sections 7.3 and 7.4
Books for Reference	1. J.L.Synge and A.Schild, Tensor Calculus, Toronto, 1949. **2.** A.S.Eddington. The Mathematical Theory of Relativitity, Cambridge University Press, 1930.

	3. P.G.Bergman, An Introduction to Theory of Relativity, Newyor, 1942. C.E.Weatherburn, Riemannian Geometry and the Tensor Calculus, Cambridge, 1938.

EXTRA DISCIPLINARY COURSE I

Semester	Subject Code	Subject Title	Total Hours	Credit
IV		**MATHEMATICS FOR COMPETITIVE EXAMINATIONS I**	**60**	**3**
Objective	• To learn about the quantitative aptitude problems like Average, Time and Work, Time and distance, etc. • To know more about the Area, Volume and Surface Area of some Geometrical shapes. • To study about the logical reasoning of sequences and series.			

Learning Outcomes	**After completion of this course:** ● Students gain knowledge in the aptitude and make use of it in competitive examinations. ● They obtain more thinking power in solving the simple mathematical problems.
Unit 1	Average - Problems on Ages.
Unit 2	Percentage – Profit and Loss.
Unit 3	Time and Work – Time and Distance.
Unit 4	Area – Volume and Surface Area.
Unit 5	Odd man out and Series.
Contents & Treatment as in	**Quantitative Aptitude, R.S. Agarwal. S. Chand and Sons, New Delhi.** Unit 1: Chapter: 6 and 8 Unit 2: Chapter: 10 and 11 Unit 3: Chapter: 15 and 17 Unit 4: Chapter: 24 and 25 Unit 5: Chapter: 35
Books for Reference	1. Wiley's Quantitative Aptitude, P.A. Anand, Wiley, First edition, 2015. 2. Objective Arithmetic, Rajesh Verma, Arihant Publications, Eighth Edition, 2018.

EXTRA DISCIPLINARY COURSE II

Semester	Subject Code	Subject Title	Total Hours	Credit
IV		**MATHEMATICS FOR COMPETITIVE EXAMINATIONS II**		**3**
Objectives	● To learn about the quantitative aptitude problems like Percentage, Ratio and Proportion etc. ● To know more about the banking problems like True Discount			

	and Banker's Discount ● To study about the linear equations, quadratic equations, A.P, G.P and Heights and Distances which are useful for attempting problems in Competitive examinations.
Learning Outcomes	**After completion of this course:** ● Students gain knowledge in the aptitude and make use of it in competitive examinations. ● They obtain more thinking power in solving the simple mathematical problems.
Unit 1	Percentage – Ratio and Proportion
Unit 2	Simple Interest and Compound Interest
Unit 3	True Discount and Banker's Discount
Unit 4	Linear Equations in two variables and Quadratic Equations
Unit 5	Arithmetic and Geometric Progression – Heights and Distances
Contents & Treatment as in	**Objective Arithmetic, R.S. Aggarwal, S.Chand & Co. Pvt. Ltd., New Delhi.** **Unit 1:** Chapter 10 and Chapter 12 **Unit 2:** Chapter 21 and Chapter 22 **Unit 3:** Chapter 25 and Chapter 26 **Unit 4:** Chapter 31 and Chapter 32 **Unit 5:** Chapter 33 and Chapter 37
Books for Reference	1. Wiley's Quantitative Aptitude, P.A. Anand, Wiley, First edition, 2015. 2. Objective Arithmetic, Rajesh Verma, Arihant Publications, Eighth Edition, 2018.