



BHARATHIDASAN UNIVERSITY, TIRUCHIRAPPALLI -620 024.

M.Sc. MATHEMATICS

CHOICE BASED CREDIT SYSTEM -

LEARNING OUTCOMES BASED CURRICULUM FRAMEWORK (CBCS - LOCF)

(Applicable to the candidates admitted from the academic year 2026- 2027 onwards)

Sem	Course	Course Title	Ins. Hrs.	Credit	Exam Hrs.	Marks		Total
						Int.	Ext.	
I	Core Course - 1 (CC - 1)	Algebra - I	6	4	3	30	70	100
	Core Course - 2 (CC - 2)	Real Analysis - I	6	4	3	30	70	100
	Core Course - 3 (CC - 3)	Ordinary Differential Equations	6	4	3	30	70	100
	Discipline Centric Elective Course - 1 (DCEC-1)	Any one from the list	5	4	3	30	70	100
	Generic Elective Course - 1 (GEC - 1)	Any one from the list	5	3	3	30	70	100
	Skill Enhancement Course (Practical) - 1 (SEC - 1)	Mathematical Documentation Using Latex	2	2	3	40	60	100
	Value Added Course - 1 (VAC - 1)*	Mathematics for Competitive Examinations-I	-	2*		30	70	100*
	Total		30	21	-	-	-	600
II	Core Course - 4 (CC - 4)	Algebra-II	6	4	3	30	70	100
	Core Course - 5 (CC - 5)	Real Analysis-II	6	4	3	30	70	100
	Core Course - 6 (CC - 6)	Partial Differential Equations	6	4	3	30	70	100
	Discipline Centric Elective Course - 2 (DCEC - 2)	Any one from the list	4	4	3	30	70	100
	Generic Elective Course - 2 (GEC - 2)	Any one from the list	4	3	3	30	70	100
	Skill Enhancement Course (Practical) - 2 (SEC - 2)	Mathematical Computations Using Python	2	2	3	40	60	100
	Non-Major Elective Course - 1 (NMEC - 1)	One Course from Outside Department	2	2	3	30	70	100
	Total		30	23	-	-	-	700
Summer Internship / Industrial Activity during the Summer Vacation after 1st Year								

III	Core Course - 7 (CC - 7)	Topology	6	4	3	30	70	100
	Core Course - 8 (CC - 8)	Complex Analysis	6	4	3	30	70	100
	Core Course - 9 (CC - 9)	Measure Theory and Integration	6	4	2	30	70	100
	Discipline Centric Elective Course - 3 (DCEC - 3)	Any one from the list	5	4	2	30	70	100
	Generic Elective Course - 3 (GEC - 3)	Any one from the list	5	3	3	30	70	100
	Non-Major Elective Course - 2 (NMEC - 2)	One Course from Outside Department	2	2	3	30	70	100
	Internship / Industrial Activity @			2		20	80	100
	Total		30	23	-	-	-	700
IV	Core Course - 10 (CC - 10)	Functional Analysis	6	4	3	30	70	100
	Core Course - 11 (CC - 11)	Differential Geometry	6	4	3	30	70	100
	Core Course - 12 (CC - 12)	Numerical Analysis	6	4	3	30	70	100
	Discipline Centric Elective Course - 4 (DCEC - 4)	Any one from the list	4	4	2	30	70	100
	Entrepreneurship / Industry Based Course @	Industrial Mathematics	3	3	3	30	70	100
	Project Work @	--	5	5	-	20	80	100
	Value Added Course - 2 (VAC - 2)*	Mathematics for Competitive Examinations -II	-	2*		30	70	100*
	Total		30	24	-	-	-	600
Grand Total				91				2600

LIST OF DISCIPLINE CENTRIC ELECTIVE COURSE

Discipline Centric Elective Course - 1 (DCEC - 1)	
1.	Graph Theory
2.	Number Theory
Discipline Centric Elective Course - 2 (DCEC - 2)	
1.	Fuzzy Mathematics
2.	Discrete Mathematics
Discipline Centric Elective Course - 3 (DCEC - 3)	
1.	Methods of Applied Mathematics
2.	Nonlinear Differential Equations
3.	Probability Theory
Discipline Centric Elective Course - 4 (DCEC - 4)	
1.	Stochastic Process
2.	Mathematical Modeling
3.	Mathematical Statistics

LIST OF NON-MAJOR ELECTIVE COURSE

(for other Department Students only)

NON-MAJOR ELECTIVE COURSE - 1 (NME-1)	
1	Mathematical Statistics
NON-MAJOR ELECTIVE COURSE - 2 (NME-2)	
2	Optimization Techniques

LIST OF GENERIC ELECTIVE COURSE (GEC)

GENERIC ELECTIVE COURSE - 1 (GEC - 1)	
1. A	Foundations of Mathematics
2. B	Automata Theory
3. C	Integral Transforms
GENERIC ELECTIVE COURSE - 2 (GEC - 2)	
1. A	Mechanics
2. B	Neural Networks
3. C	Difference Equations
GENERIC ELECTIVE COURSE - 3 (GEC - 3)	
1. A	Optimization Techniques
2. B	Financial Mathematics
3. C	Fluid Dynamics

SUMMARY OF CURRICULUM STRUCTURE OF PG PROGRAMMES: SCIENCE

Sl. No.	Types of the Course	No. of Courses	Credits for each Course	Total Credits	Marks
1.	Core Course	12	4	48	1200
2.	Discipline Centric Elective Course	4	4	16	400
3.	Generic Elective Course	3	3	9	300
4.	Skill Enhancement Course	2	2	4	200
5.	Non-Major Elective Courses	2	2	4	200
6.	Internship / Industrial Activity @	1	2	2	100
7.	Entrepreneurship/ Industry Based Course @	1	3	3	100
8.	Project @	1	5	5	100
Total		26	-	91	2600
Value Added Courses *		2*	2	4*	200*

*	The value added courses credit will not be included in the total CGPA. These courses are extra-credit courses. Instruction hours for these courses is 30 hours								
@	Summer Internship will be carried out during the summer vacation after the First year. Viva Voce will be conducted by the college and Marks shall be sent to the University and the same will be included in the 3rd semester Mark Statement. Summer Internship / Industrial Activity& Project Scheme of Evaluation: <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <th style="text-align: left;">Description</th><th style="text-align: left;">Marks</th></tr> <tr> <td>Report</td><td>80</td></tr> <tr> <td>Viva</td><td>20</td></tr> <tr> <td>Total</td><td>100</td></tr> </table>	Description	Marks	Report	80	Viva	20	Total	100
Description	Marks								
Report	80								
Viva	20								
Total	100								

1. REGULATIONS AND LEARNING OUTCOMES

Programme	M.Sc. Mathematics
Programme Code	MAT
Duration	2 Years
Program outcomes (POs)	
PO1	Disciplinary Knowledge: Broad and in-depth knowledge of advanced scientific concepts, principles, and methodologies within the chosen domain. Ability to critically explain, integrate, and apply scientific knowledge to theoretical and practical problems. Opportunities to earn additional credits through specialized and interdisciplinary courses further enhance expertise and broaden disciplinary understanding.
PO2	Critical Thinking: Field visits, academic interactions, and experiential learning activities will help students develop critical observation, interpretation, and analytical skills. Ability to evaluate and interpret scientific data, formulate hypotheses, and draw logical conclusions. Encourages independent thinking and the ability to assess scientific problems from multiple perspectives.
PO3	Analytical Reasoning: Through classroom discussions, scientific literature reviews, and interactive learning environments, students will strengthen their analytical reasoning abilities. Ability to critically evaluate scientific texts, identify gaps in existing knowledge, formulate research questions, and synthesize new ideas and concepts. Promotes evidence-based reasoning and logical interpretation of scientific information.
PO4	Scientific Reasoning: Strong foundation in scientific methods, experimental design, and data interpretation through laboratory-based courses. Enhances practical knowledge of scientific instrumentation, calibration procedures, laboratory safety, and appropriate research techniques. Ability to conduct scientifically sound experiments and interpret results accurately.
PO5	Self-Directed Learning: Encourages independent and self-directed learning through assignments, field reports, project work, and literature-based studies. Ability to organize, analyze, and present scientific findings in professional formats relevant to academic and industrial settings. Fosters responsibility, time management, and continuous self-improvement in learning.
PO6	Reflective Thinking: Laboratory-intensive core courses will expose students to a broad range of research methodologies and experimental techniques. Ability to reflect on learning experiences, evaluate the effectiveness of scientific approaches, and understand the broader applications of scientific techniques within the discipline.

P07	Problem-Solving Skills: Ability to develop and apply scientific principles, quantitative reasoning, and mathematical concepts to solve discipline-specific problems. Ability to analyze experimental data, interpret scientific observations, and derive meaningful conclusions. Prepares students to address real-world scientific and societal challenges effectively.
P08	Research-Related Skills: Internships, dissertation work, and research-oriented projects provide opportunities to design, develop, and execute independent research studies. Students gain hands-on experience in research methodology, experimental techniques, data analysis, scientific writing, and ethical research practices. These experiences strengthen laboratory competence and prepare students for advanced research and professional careers.
P09	Lifelong Learning: Cultivates a mindset of continuous learning and professional adaptability. Ability to identify gaps in knowledge and skills, adapt to emerging technologies and scientific advancements, and pursue self-directed learning throughout their careers. Encourages lifelong learning that supports academic growth, employability, and professional excellence.
P010	Leadership Readiness: Ability to take initiative, work collaboratively, and manage academic and research responsibilities effectively. Through seminars, group projects, internships, and research activities, students develop decision-making, problem-solving, organizational, and interpersonal skills. Ability to lead scientific teams, communicate effectively in professional environments, and contribute responsibly to academic, industrial, and societal development.
Programme Specific Outcomes (PSOs)	
PSO1	Help to strengthen Mathematical background of the subjects like algebra, analysis, and geometry.
PSO2	Providing problem solving skills which involves identification, analysis of unsolved and non-routine or real world problems by using Mathematical strategies of pure and applied Mathematics.
PSO3	Provide an interdisciplinary course bridging Mathematics, Computer/Data Science and financial studies.
PSO4	Prepare and motivate students to attend the National level examinations, such as, CSIR-UGC NET, GATE, TIFR – GS, for pursuing research.
PSO5	Focus on applied Mathematics and computational tools for sciences, engineering and Humanities.
PSO6	Involve investigating and writing in a particular area of mathematical sciences, without the requirement (while not excluding the possibility) of obtaining original results.

Year: I

CORE COURSE 1

Semester: I

Code:

**ALGEBRA-I
(Theory)**

Credits: 4

OBJECTIVES:

To introduce the fundamental concepts and structures of groups, rings, polynomial rings, vector spaces, and modules, and to develop abstract algebraic reasoning skills.

UNIT - I:

Group Theory: Groups - Subgroups – A Counting Principle - Normal Subgroups and Quotient Groups.

UNIT - II:

Homomorphisms of Groups: Homomorphisms - Cayley's Theorem- Permutation Groups - Another Counting Principle- Sylow's Theorem

UNIT - III:

Homomorphism of Rings: Homomorphisms- Ideals and Quotient Rings- More ideas and Quotient rings- Euclidean rings.

UNIT - IV:

Polynomial Rings: Polynomial rings - Polynomial rings over the Rational fields- Polynomial rings over Commutative rings.

UNIT - V:

Vector spaces and Modules: Elementary basic concepts of Vector Spaces - Dual spaces - Inner Product Spaces-Modules.

TEXT BOOK:

1. N.Herstein. Topics in Algebra (II Edition) Wiley Eastern Limited, New Delhi, 1975.
Unit I: Section 2.4, 2.5, 2.6
Unit II: Section 2.7, 2.9, 2.10, 2.11, 2.12
Unit III: Section 3.3, 3.5, 3.7
Unit IV: Section 3.9, 3.10, 3.11
Unit V: Section 4.3, 4.4, 4.5

REFERENCES:

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

COURSE LEARNING OUTCOME (for Mapping with POs and PSOs):

Students will be able to

CLO 1: Understand the fundamental concepts of groups, subgroups, normal subgroups, and quotient groups.

CLO 2: Analyze group homomorphisms, permutation groups, and apply Sylow theorems in finite group theory.

CLO 3: Understand ring homomorphisms, ideals, quotient rings, and Euclidean rings.

CLO 4: Analyze polynomial rings over fields and commutative rings and study their algebraic properties.

CLO 5: Understand the basic concepts of vector spaces, dual spaces, inner product spaces, and modules.

	POs									
	1	2	3	4	5	6	7	8	9	10
CLO1	3	2	2	2	1	1	2	1	1	1
CLO2	3	3	3	2	1	1	3	2	1	1
CLO3	3	2	3	2	1	1	3	1	1	1
CLO4	3	3	3	2	1	1	3	2	1	1
CLO5	3	2	2	2	1	1	2	1	1	1

	PSOs					
	1	2	3	4	5	6
CLO1	3	2	1	1	1	1
CLO2	3	3	1	2	1	1
CLO3	3	3	2	1	2	1
CLO4	3	3	2	1	2	1
CLO5	3	2	2	1	2	1

Year: I

CORE COURSE 2

Semester: I

Code:

**REAL ANALYSIS - I
(Theory)**

Credits: 4

COURSE OBJECTIVES:

To provide a rigorous mathematical theory of basic mathematical analysis of sequences and functions of real functions and study the basic properties of basic topology

UNIT - I

The Real and Complex Number System - Introduction – Ordered sets – least upper bound property – Fields – The Real field – Archimedean property - The Complex field – Euclidean spaces.

UNIT - II

Basic Topology - Finite – Countable and Uncountable sets - Metric spaces - Compact sets - Heine-Borel theorem – Weierstass Theorem - Cantor set – Connected sets.

UNIT - III

Numerical Sequence and Series - Convergent sequences - subsequences – Cauchy sequences – the upper and lower limits – some special sequences - series – series of nonnegative terms – The number e – Power series – summation by parts – Absolute convergence – Addition and Multiplication of series – rearrangements.

UNIT - IV

Continuity – limit of functions – continuous functions – continuity and compactness – continuity and connectedness – discontinuities – monotone functions.

UNIT - V

Differentiation – The derivative of a real function – mean value theorem – the continuity of derivatives – L Hospital's rule – Derivatives of higher order – Taylor's theorem – Differentiation of vector valued function.

TEXTBOOK(S):

1. Walter Rudin, Principles of Mathematical Analysis, McGraw Hill, Inc, 1976.
Unit I: Chapter 1
Unit II: Chapter 2
Unit III: Chapter 3
Unit IV: Chapter 4
Unit V: Chapter 5

REFERENCES:

1. Tom. M. Apostol, Mathematical Analysis, Narosa Publishing House, New Delhi, 1997.
2. R. G. Bartle, D. R. Sherbert, Introduction to Real Analysis, John Wiley and Sons, New York, 1982.

3. Kenneth A. Ross, Elementary Analysis: The Theory of Calculus, Springer NewYork, 2004.
4. H. L. Royden, Real Analysis, Third Edition, Macmillan Publishing Company, New Delhi, 1988.

COURSE LEARNING OUTCOME (for Mapping with POs and PSOs):

Students will be able to

CLO1: Understand the algebraic and order properties of real and complex number systems, Euclidean spaces, and the least upper bound property.

CLO2: Analyze metric spaces, compactness, connectedness, and countability concepts in topology and apply important theorems such as Heine–Borel and Weierstrass theorems.

CLO3: Understand convergence of sequences and series, Cauchy sequences, power series, and properties of infinite series.

CLO4: Examine continuity of real-valued functions and analyze the relationship between continuity, compactness, and connectedness.

CLO5: Apply differentiation techniques, Mean Value Theorem, Taylor’s theorem, and higher-order derivatives to real and vector-valued functions.

	POs									
	1	2	3	4	5	6	7	8	9	10
CLO1	3	2	2	2	1	1	2	1	1	1
CLO2	3	3	3	2	1	2	3	2	1	1
CLO3	3	3	3	2	1	1	3	1	1	1
CLO4	3	3	3	2	1	2	3	1	1	1
CLO5	3	3	3	3	1	1	3	2	1	1

	PSOs					
	1	2	3	4	5	6
CLO1	3	2	1	1	1	1
CLO2	3	3	1	2	2	2
CLO3	3	3	1	2	2	2
CLO4	3	3	1	1	2	2
CLO5	3	3	2	2	3	2

Year: I

CORE COURSE 3

Semester: I

Code:

**ORDINARY DIFFERENTIAL
EQUATIONS
(Theory)**

Credits: 4

COURSE OBJECTIVES:

To introduce advanced techniques for solving ordinary differential equations, power series solutions, special functions, linear systems, oscillation theory, and stability analysis. The course aims to develop analytical and computational skills for studying mathematical models arising in physical sciences and engineering applications.

UNIT - I

The General Solution of the Homogeneous Equation– The Use of a Known Solution to Find Another – The Method of Variation of Parameters – Introduction: A Review of Power Series – Series Solutions of First Order Equations – Second Order Linear Equations; Ordinary Points.

UNIT - II

Regular Singular Points – Regular Singular Points (Continued) – Gauss's Hypergeometric Equation – The Point at Infinity - Legendre Polynomials – Properties of Legendre Polynomials – Bessel Functions - The Gamma Function – Properties of Bessel Functions.

UNIT - III

Linear Systems – Homogeneous Linear Systems with Constant Coefficients – The Method of Solutions of Successive Approximations – Picard's Theorem.

UNIT - IV

Oscillations and the Sturm Separation Theorem – The Sturm Comparison Theorems –Eigen Values, Eigen Functions and The Vibrating String.

UNIT - V

Types of Critical Points; Stability – Critical Points and Stability for Linear Systems – Stability by Liapunov's Direct Method – Simple Critical Points of Nonlinear Systems.

TEXT BOOK(S):

1. G.F. Simmons, Differential Equations with Applications and Historical Notes, CRC Press, 2017.
UNIT I - Chapter III: Sec 15, 16, 19 and
Chapter V: Sec 26 to 28
UNIT II - Chapter V: Sec 29 to 32 and
Chapter VIII: Sec 44 to 47
UNIT III - Chapter X: Sec 55,56 and
Chapter XIII: Sec 69, 70
UNIT IV - Chapter IV: Sec 24, 25 and
Chapter VII: Sec 40
UNIT V - Chapter XI: Sec 59 to 62

REFERENCE BOOK(S):

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

COURSE LEARNING OUTCOME (for Mapping with POs and PSOs):

Students will be able to

CLO 1: Solve homogeneous and non-homogeneous differential equations using methods such as variation of parameters and power series techniques.

CLO 2: Analyze differential equations with regular singular points and study special functions including Legendre polynomials and Bessel functions.

CLO 3: Understand linear systems of differential equations, successive approximation methods, and Picard's existence theorem.

CLO 4: Apply Sturm comparison and separation theorems to study oscillatory behavior, eigenvalues, eigen functions, and vibrating string problems.

CLO 5: Analyze stability of linear and nonlinear systems using Liapunov's direct method and critical point theory.

	POs									
	1	2	3	4	5	6	7	8	9	10
CLO1	3	3	3	2	1	1	3	2	1	1
CLO2	3	3	3	3	1	2	3	2	1	1
CLO3	3	3	3	2	1	2	3	2	1	1
CLO4	3	3	3	3	1	2	3	2	1	1
CLO5	3	3	3	3	1	2	3	3	2	1

	PSOs					
	1	2	3	4	5	6
CLO1	3	2	1	3	1	3
CLO2	3	1	2	2	2	3
CLO3	3	2	2	2	2	3
CLO4	3	2	2	3	2	3
CLO5	3	2	2	3	2	3

Year: I	SKILL ENHANCEMENT COURSE 1	Semester: I
Code:	MATHEMATICAL DOCUMENTATION USING LATEX (Practical)	Credits: 2

OBJECTIVES:

To introduce the fundamentals of LaTeX type setting for preparing mathematical and scientific documents. The course aims to develop skills in document formatting, equation typing, figure and table inclusion, bibliography management, and presentation preparation using LaTeX tools and packages.

1. Create a basic LaTeX document that includes a title, author name, date, and three paragraphs of text. Compile the document and generate the PDF output.
2. Write a LaTeX input file that contains a title page, table of contents, two sections, and two subsections. Compile the document and display the output.
3. Create a LaTeX document with A4 page layout, page numbering, and header and footer formatting. Compile the document and convert it to PDF format.
4. Write a LaTeX program that demonstrates the use of itemize and enumerate environments, including nested lists up to three levels.
5. Prepare a formal letter using LaTeX that includes sender address, receiver address, subject, body of the letter, and closing signature.
6. Write a LaTeX document that includes aligned equations, matrix representation, and cases environment using the amsmath package.
7. Create a mathematical document that demonstrates summation, limits, fractions, and integrals, with proper equation numbering and referencing.
8. Insert a figure into a LaTeX document with an appropriate caption and label, and refer to the figure within the text.
9. Create a table with five rows and four columns in LaTeX, including caption and label, and reference the table in the text.
10. Create a LaTeX document demonstrating the use of the bibliography environment with at least five references cited within the text.

TEXT BOOK(S):

1. Leslie Lamport. LATEX: A Document Preparation System, Addison-Wesley, Reading, Massachusetts, second edition, 1994.

REFERENCE BOOK(S):

1. Tobias Oetiker, Hubert Partl, Irene Hyna and Elisabeth Schlegl., The (Not So) Short Introduction to LATEX2e, Samurai Media Limited (or available online at <http://mirrors.ctan.org/info/lshort/english/lshort.pdf>)

2. LATEX Tutorials - A Primer, Indian TeX Users Group, available online at <https://www.tug.org/twg/mactex/tutorials/ltxprimer-1.0.pdf>
3. H. J. Greenberg. A Simplified introduction to LATEX, available online at <https://www.ctan.org/tex-archive/info/simplified-latex/>
4. Using Kile - KDE Documentation, https://docs.kde.org/trunk4/en/extragear_office/kile/quick-using.html
5. Amsmath and geometry package available in Ctan.org.

COURSE LEARNING OUTCOME (for Mapping with POs and PSOs):

Students will be able to

CLO 1: Understand the basic structure of LaTeX documents, editors, compilation methods, and file conversions.

CLO 2: Create and format professional documents using sectioning, page layouts, lists, quotations, and letter formats.

CLO 3: Apply mathematical typesetting techniques using the amsmath package for equations, labeling, and cross-referencing.

CLO 4: Insert and format figures and tables effectively in scientific and mathematical documents.

CLO 5: Prepare bibliographies, indexes, and Beamer presentations using appropriate LaTeX styles and packages.

	POs									
	1	2	3	4	5	6	7	8	9	10
CLO1	2	1	1	2	2	1	1	1	2	1
CLO2	2	2	2	2	3	1	2	1	2	2
CLO3	3	2	2	2	2	1	2	2	2	1
CLO4	2	2	2	2	3	1	2	2	2	1
CLO5	2	2	2	2	3	1	2	2	3	2

	PSOs					
	1	2	3	4	5	6
CLO1	2	1	3	1	2	2
CLO2	2	2	3	1	2	2
CLO3	3	2	3	1	3	2
CLO4	2	2	3	1	3	2
CLO5	2	2	3	2	3	3

Year: I

VALUE ADDED COURSE 1

Semester: I

Code:

**MATHEMATICS FOR
COMPETITIVE EXAMINATIONS-
I (Theory)**

Credits: 2*

OBJECTIVES:

To develop fundamental mathematical aptitude and numerical problem-solving skills required for competitive examinations. The course aims to strengthen basic arithmetic concepts, logical reasoning ability, and analytical techniques for solving quantitative problems efficiently and accurately.

UNIT - I

Numbers - H.C.F and L.C.M. of Numbers.

UNIT - II

Decimal Fractions – Simplification.

UNIT - III

Square Roots and Cube Roots – Average.

UNIT - IV

Problems on Numbers - Problems on Ages.

UNIT - V

Surds & Indices – Percentage.

TEXT BOOK(S):

1. R.S. Aggarwal, Quantitative Aptitude for Competitive Examinations, S.Chand co Ltd., 152. Anna Salai, Chennai, 2010.
Unit I: Chapter – 1 & 2
Unit II: Chapter 3 & 4
Unit III: Chapter 5 & 6
Unit IV: Chapter 7 & 8
Unit V: Chapter 9 & 10

REFERENCE:

1. Quantitative Aptitude _by Abhijit Guha, Tata McGraw Hill Publishing Company Limited, New Delhi (2005)
2. <https://nptel.ac.in>

COURSE LEARNING OUTCOME (for Mapping with POs and PSOs):

Students will be able to

CLO 1: Understand properties of numbers and apply techniques to find H.C.F. and L.C.M. in problem-solving situations.

CLO 2: Perform operations involving decimal fractions and apply simplification techniques accurately.

CLO 3: Solve problems involving square roots, cube roots, and averages using appropriate computational methods.

CLO 4: Analyze and solve aptitude problems related to numbers and ages using logical mathematical reasoning.

CLO 5: Apply concepts of surds, indices, and percentages to solve quantitative aptitude problems encountered in competitive examinations.

	POs									
	1	2	3	4	5	6	7	8	9	10
CLO1	3	2	2	2	1	1	3	1	1	1
CLO2	3	2	2	2	1	1	3	1	1	1
CLO3	3	3	3	2	1	1	3	1	1	1
CLO4	3	3	3	2	1	1	3	1	1	1
CLO5	3	3	3	2	1	1	3	1	2	1

	PSOs					
	1	2	3	4	5	6
CLO1	3	3	1	2	2	1
CLO2	2	3	1	2	2	1
CLO3	2	3	1	2	2	1
CLO4	2	3	1	2	2	1
CLO5	3	3	1	2	2	1

Year: I

CORE COURSE 4

Semester: II

Code:

**ALGEBRA-II
(Theory)**

Credits: 4

OBJECTIVES:

To provide an advanced understanding of field theory, Galois theory, linear transformations, canonical forms, and determinant theory in abstract algebra. The course aims to develop algebraic reasoning, analytical skills, and the ability to study algebraic structures and transformations used in higher mathematics and related applications.

UNIT - I

Fields: Extension fields - Roots of Polynomials.

UNIT - II

Fields Continued: More about Roots - The Elements of Galois Theory.

UNIT - III

Linear Transformations: Algebra of Linear transformations -Characteristic roots- Matrices of linear transformations.

UNIT - IV

Canonical forms: Triangular forms- Nilpotent transformations -Trace and transpose.

UNIT - V

Determinants and Transformations: Determinants – Hermitian, Unitary and Normal transformations.

TEXTBOOK(S):

1. N. Herstein. Topics in Algebra (II Edition) Wiley Eastern Limited, New Delhi, 1975.
Unit I: Chapter 5: Section 5.1 and 5.3
Unit II: Chapter 5: Sections 5.5 and 5.6
Unit III: Chapter 6 : Section 6.1, 6.2 and 6.3
Unit IV: Chapter 6 : Section 6.4, 6.5 and 6.8
Unit V: Chapter 6 : Sections 6.9 and 6.10

REFERENCE:

1. M.Artin, Algebra, Prentice Hall of India, 1991.
2. P.B.Bhattacharya, S.K.Jain, and S.R.Nagpaul, Basic Abstract Algebra (II Edition) Cambridge University Press, 1997. (Indian Edition)
3. I.S.Luther and I.B.S.Passi, Algebra, Vol. I –Groups(1996); Vol. II Rings,Narosa Publishing House , New Delhi, 1999
4. D.S.Malik, J.N. Mordeson and M.K.Sen, Fundamental of Abstract Algebra, McGraw Hill (International Edition), New York. 1997.
5. N.Jacobson, Basic Algebra, Vol. I & II Hindustan Publishing Company, New Delhi.
6. <http://mathforum.org>, <http://ocw.mit.edu/ocwweb/Mathematics>,
7. <http://www.opensource.org>, www.algebra.com

COURSE LEARNING OUTCOME (for Mapping with POs and PSOs):

Students will be able to

CLO1: Understand extension fields, roots of polynomials, and algebraic properties of fields.

CLO2: Analyze polynomial roots and apply the fundamental concepts of Galois theory in algebraic structures.

CLO3: Study linear transformations, characteristic roots, and matrix representations of linear operators.

CLO4: Examine canonical forms, nilpotent transformations, trace, and transpose of linear transformations.

CLO5: Apply determinant theory and analyze Hermitian, unitary and normal transformations in vector spaces.

	POs									
	1	2	3	4	5	6	7	8	9	10
CLO1	3	2	2	2	1	1	2	1	1	1
CLO2	3	3	3	2	1	2	3	2	1	1
CLO3	3	3	3	3	1	1	3	2	1	1
CLO4	3	3	3	3	1	2	3	2	1	1
CLO5	3	3	3	3	1	2	3	2	2	1

	PSOs					
	1	2	3	4	5	6
CLO1	3	2	1	2	1	1
CLO2	3	3	1	3	1	2
CLO3	3	3	2	2	2	2
CLO4	3	3	2	2	2	2
CLO5	3	3	2	2	3	2

Year: I

CORE COURSE 5

Semester: II

Code:

**REAL ANALYSIS - II
(Theory)**

Credits: 4

COURSE OBJECTIVES:

To provide a rigorous understanding of advanced topics in real analysis including Riemann–Stieltjes integration, sequences and series of functions, special functions, and multivariable calculus. The course aims to develop analytical thinking, mathematical rigor, and problem-solving skills required for higher studies and research in pure and applied mathematics.

UNIT - I

The Riemann Stieltjes Integral – Definition and Existence of integral – Properties of Integral – Integration and Differentiation – Integration of Vector-valued functions – Rectifiable curves.

UNIT - II

Sequences and Series of Functions – Definition and Examples – Uniform convergence – Uniform convergence and continuity – Uniform convergence and Integration – Uniform convergence and Differentiation – Equicontinuous of functions – The Stone-Weierstrass theorem

UNIT - III

Some Special Functions – Power Series – The exponential and logarithmic functions – The trigonometric functions – Algebraic completeness of complex field – Fourier series – The Gamma function

UNIT - IV

Functions of Several Variables – Linear Transformation – Differentiation – The contraction principle – The inverse function theorem

UNIT - V

Functions of Several Variables Continued – The implicit function theorem – The Rank theorem – Determinants – Derivatives of higher order

TEXTBOOK(S):

1. Walter Rudin, Principles of Mathematical Analysis, McGraw Hill, Inc, 1976.
Unit I: Chapter 6
Unit II: Chapter 7
Unit III: Chapter 8
Unit IV: Chapter 9 Sections 1-4
Unit V: Chapter 9 Sections 5-8

REFERENCES:

1. Tom. M. Apostol, Mathematical Analysis, Narosa Publishing House, New Delhi, 1997.
2. R. G. Bartle, D. R. Sherbert, Introduction to Real Analysis, John Wiley and Sons, New York, 1982.

3. Kenneth A. Ross, Elementary Analysis: The Theory of Calculus, Springer New York, 2004.

COURSE LEARNING OUTCOME (for Mapping with POs and PSOs):

Students will be able to

CLO 1: Understand the definition, existence, and properties of the Riemann–Stieltjes integral and apply integration techniques to vector-valued functions and rectifiable curves.

CLO 2: Analyze sequences and series of functions with emphasis on uniform convergence and its relationship with continuity, integration, and differentiation.

CLO 3: Study special functions including exponential, logarithmic, trigonometric, Fourier series, and Gamma functions along with algebraic completeness of the complex field.

CLO 4: Apply concepts of linear transformations, differentiation of multivariable functions, contraction principle, and inverse function theorem.

CLO 5: Analyze implicit and rank theorems, determinants, and higher-order derivatives for functions of several variables.

	POs									
	1	2	3	4	5	6	7	8	9	10
CLO1	3	3	3	3	1	2	3	2	1	1
CLO2	3	3	3	2	1	2	3	2	1	1
CLO3	3	3	3	2	1	2	3	2	1	1
CLO4	3	3	3	3	1	2	3	2	1	1
CLO5	3	3	3	3	1	2	3	2	2	1

	PSOs					
	1	2	3	4	5	6
CLO1	3	3	1	2	2	2
CLO2	3	3	1	2	2	2
CLO3	3	2	1	2	2	2
CLO4	3	3	2	2	3	2
CLO5	3	3	2	2	3	2

Year: I

CORE COURSE 6

Semester: II

Code:

**PARTIAL DIFFERENTIAL
EQUATIONS
(Theory)**

Credits: 4

COURSE OBJECTIVES:

To introduce the theory and solution techniques of partial differential equation (PDE) arising in mathematical physics and engineering. The course aims to develop analytical skills in solving first and second order PDEs, boundary value problems, and classical equations such as wave and heat equations.

First Order PDE:

UNIT - I

Curves and Surfaces- Genesis of First Order PDE- Classification of Integrals- Linear Equations of the First Order- Pfaffian Differential Equations Compatible Systems- Charpit's Method- Jacobi's Method.

UNIT - II

Integral Surfaces Through a Given Curve- Quasi-Linear Equations- Non-linear First Order PDE.

UNIT - III

Second Order PDE: Genesis of Second Order PDE- Classification of Second Order PDE One-Dimensional Wave Equation- Vibrations of an Infinite String- Vibrations of a Semi-infinite String- Vibrations of a String of Finite Length (Method of separation of variables).

UNIT - IV

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

UNIT - V

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

TEXT BOOK(S):

1. T.Amarnath, An Elementary Course in Partial Differential Equations, 2nd edn, Narosa Publishing Company, 2010.
Unit I: Chapter 1: Sections 1.1 to 1.8
Unit II: Chapter 1: Sections 1.9 to 1.11
Unit III: Chapter 2: Sections 2.1 to 2.3.5, except 2.3.4
Unit IV: Chapter 2: Sections 2.4.1 to 2.4.10
Unit-V: Chapter 2: Sections 2.4.11 to 2.6.2

REFERENCE BOOK(S):

1. M.D. Raisighania, Advanced Differential Equations, S.Chand & Company Pvt. Ltd., 2015.
2. Tyn Myint-U, Lokenath Debnath, Linear Partial Differential equations for scientists and engineers, 3rd edn, Birkhauser, 2007.
3. I.N. Snedden, Elements of Partial Differential Equations, Dover, 2006.

COURSE LEARNING OUTCOME (for Mapping with POs and PSOs):

Students will be able to

CLO 1: Understand the formation and classification of first order partial differential equations and apply methods such as Charpit's and Jacobi's methods for solving them.

CLO 2: Analyze integral surfaces, quasi-linear equations, and nonlinear first order partial differential equations.

CLO 3: Classify and solve second order partial differential equations, including wave equations and vibration problems using separation of variables.

CLO 4: Apply boundary value techniques to solve Laplace equations, Dirichlet and Neumann problems, and analyze harmonic functions using maximum and minimum principles.

CLO 5: Solve heat conduction and wave propagation problems using classical methods and apply Duhamel's principle in heat equations.

	POs									
	1	2	3	4	5	6	7	8	9	10
CLO1	3	3	3	3	1	2	3	2	1	1
CLO2	3	3	3	2	1	2	3	2	1	1
CLO3	3	3	3	3	1	2	3	2	1	1
CLO4	3	3	3	3	1	2	3	2	1	1
CLO5	3	3	3	3	1	2	3	2	2	1

	PSOs					
	1	2	3	4	5	6
CLO1	3	3	1	1	3	1
CLO2	3	3	1	1	3	1
CLO3	3	3	2	2	3	2
CLO4	3	3	2	2	3	2
CLO5	3	3	2	2	3	2

Year: I	SKILL ENHANCEMENT COURSE 2	Semester: II
Code:	MATHEMATICAL COMPUTATIONS USING PYTHON (Practical)	Credits: 2

OBJECTIVES:

To introduce Python programming and computational techniques for solving mathematical problems. The course aims to develop programming skills, computational thinking, and the ability to use Python libraries for mathematical analysis, data handling, and scientific computations.

1. Write a Python program to implement Euclid's algorithm to compute the Greatest Common Divisor (GCD) of two or more integers. Extend the program to verify the Bézout identity for the given integers.
2. Write a Python program to test whether a given integer is prime. Extend the program to generate all prime numbers less than or equal to a given integer n using an efficient method.
3. Write a Python program that accepts a list of integers and performs the following operations:

 sorting using built-in functions

 finding the maximum and minimum values

 generating a new list consisting of squares of the elements.
4. Write a Python program to convert a decimal number into a number of base n where $2 \leq n \leq 16$. Demonstrate the program for at least three different bases.
5. Write a Python program to compute the area of a triangle using the coordinates of its vertices in the Cartesian plane.
6. Write a Python program to find the angle between two vectors using the scalar product formula.
7. Write a Python program to create a list of numbers and demonstrate slicing operations including extracting sublists, reversing lists, and generating new lists from existing ones.
8. Write a Python program to compute the mean, median, mode, and standard deviation of a given dataset using appropriate Python libraries.
9. Write a Python program to plot mathematical curves such as $y = x^2$, $y = \sin x$ and $y = e^{-x}$ using appropriate Python plotting libraries.
10. Write a Python program to implement functions and loops to evaluate the sum $\sum_{k=1}^n 1/k^2$ for a given integer n .

TEXT BOOK(S):

1. Real Python, A Practical introduction to Python,
<https://static.realpython.com/python-basics-sample-chapters.pdf>

REFERENCE BOOK(S)

1. Qingkai Kon et al, Python Programming and Numerical Methods - A Guide for Engineers and Scientists,
<https://pythonnumericalmethods.berkeley.edu/notebooks/Index.htm> Brian Heinold,
2. A Practical Introduction to Python Programming
https://www.brianheinold.net/python/A_Practical_Introduction_to_Python_Programming_Heinold.pdf

COURSE LEARNING OUTCOME (for Mapping with POs and PSOs):

Students will be able to

CLO 1: Understand Linux commands, file management, VI editor operations, and the basic syntax and structure of Python programming.

CLO 2: Apply Python programming concepts including functions, loops, conditionals, complex numbers, and standard mathematical operations.

CLO 3: Use lists, loops, sorting techniques, slicing, stacks, queues, and list manipulations effectively in Python programs.

CLO 4: Analyze and implement Python data structures such as tuples, sets, dictionaries, and perform formatted input-output and file operations using NumPy and SciPy libraries.

CLO 5: Develop Python programs to solve mathematical and statistical problems including matrix operations, primality testing, plotting graphs, vector operations, and statistical computations.

	POs									
	1	2	3	4	5	6	7	8	9	10
CLO1	3	2	2	1	2	1	1	1	2	1
CLO2	3	3	3	2	2	2	3	2	2	1
CLO3	3	3	3	2	2	2	3	2	2	1
CLO4	3	3	3	3	2	2	3	3	2	1
CLO5	3	3	3	3	3	2	3	3	3	2

	PSOs					
	1	2	3	4	5	6
CLO1	2	2	3	1	3	1
CLO2	2	3	3	1	3	1
CLO3	2	3	3	1	3	1
CLO4	2	3	3	2	3	2
CLO5	3	3	3	2	3	2

Year: I	NON-MAJOR ELECTIVE COURSE 1	Semester: II
Code:	MATHEMATICAL STATISTICS (Theory)	Credits: 2

OBJECTIVES:

To introduce the fundamental principles of statistical inference, estimation theory, hypothesis testing, sequential analysis, and analysis of variance. The course aims to develop analytical and statistical reasoning skills for interpreting data and solving real-world problems using mathematical statistics.

Unit - I: Theory of Estimation

Preliminary notions – consistent estimates – unbiased estimate – sufficient estimate – efficient estimate – asymptotically most efficient estimate – method of finding estimate.

Unit - II: Theory of Hypothesis Testing

Definition of Hypothesis – power function and OC function – Most powerful tests – uniformly most powerful test – unbiased tests – power and consistency of non-parametric tests.

UNIT - III: Sequential Analysis

Introduction – sequential probability ratio test – theorems – fundamental identity – the OC and ASN function of SPRT – expected value $E(n)$ -determination of A and B – testing a hypothesis concerning the parameter p of a zero – one distribution and expected value m of a normal distribution.

UNIT - IV: Significance Test

The concept of statistical test - parametric test for small samples - parametric test for large samples – the chi-square test.

UNIT - V: Analysis of Variance

Introduction of ANOVA – definition - assumptions – ANOVA for one-way classification – ANOVA for two – way classification – examples – multiple classification – modified regression problems.

TEXT BOOK(S):

1. M. Fisz, Probability Theory and Mathematical Statistics, John Wiley and sons, New Your, 3rd Edition, 1963.
Unit I: Chapter 13: Sections 13.1 – 13.8
Unit II: Chapter 16: Sections 16.1 – 16.6
Unit III: Chapter 17: 17.1 – 17.9
Unit IV: Chapter 12: Sections 12.1 – 12.5
Unit V: Chapter 14: Sections 14.1 – 14.5

REFERENCES:

1. T. Veerarajan , Fundamentals of Mathematical Statistics, Yesdee Publishing, 2017
2. P.R. Vittal, “Mathematical Statistics”, Margham Publications , 2002.

3. T. Veerarajan, Probability, Statistics and Random Processes, Mc Graw Hill Education (India) Private Limited, Third Edition, 2015.
4. R.S.N. Pillai and V. Bagavathi, Statistics, S.Chand & CO, 2010.
5. Singaravelu.A, S. Sivasubramanian, Probability & Random Processes , Meenakshi Agency 2008,
6. DN Elhance, Veena Elhance and BM Aggarwal, Fundamentals of Statistics, Kitab Mahal.
7. S.C.Gupta and V. K. Kapoor, Fundamentals of Mathematical Statistics, Sultan Chand & Sons, Edition 2008.

COURSE LEARNING OUTCOME (for Mapping with POs and PSOs):

Students will be able to

CLO 1: Understand the concepts of estimation theory including unbiasedness, consistency, sufficiency, and efficiency of estimators.

CLO 2: Apply hypothesis testing procedures, power functions, uniformly most powerful tests, and non-parametric testing methods.

CLO 3: Analyze sequential probability ratio tests, OC and ASN functions, and apply sequential analysis techniques to statistical problems.

CLO 4: Perform statistical significance tests for small and large samples, including chi-square tests for practical data analysis.

CLO 5: Apply analysis of variance techniques for one-way and two-way classifications and analyze regression-related statistical problems.

	POs									
	1	2	3	4	5	6	7	8	9	10
CLO1	3	3	3	2	2	2	2	2	2	1
CLO2	3	3	3	3	2	2	3	2	2	1
CLO3	3	3	3	3	2	2	3	3	2	1
CLO4	3	3	3	3	2	2	3	3	2	1
CLO5	3	3	3	3	2	2	3	3	2	2

	PSOs					
	1	2	3	4	5	6
CLO1	3	3	2	2	3	2
CLO2	3	3	2	2	3	2
CLO3	3	3	2	2	3	2
CLO4	2	3	2	1	3	1
CLO5	3	3	3	2	3	2

Year: II

CORE COURSE 7

Semester: III

Code:

**TOPOLOGY
(Theory)**

Credits: 4

OBJECTIVES:

To introduce the fundamental concepts and structures of topology, including topological spaces, connectedness, compactness, countability, and separation axioms. The course aims to develop abstract reasoning and analytical skills necessary for advanced studies in pure mathematics and related disciplines.

UNIT - I

Topological Spaces – Basis for a Topology – The Order Topology - The Product Topology on $X \times Y$ – The Sub-space topology – Closed sets and limit points – Continuous functions.

UNIT - II

The Product topology – The Metric Topology - Connected spaces - Connected Subspaces of the Real line - Components and Local connectedness.

UNIT - III

Compact Spaces - Compact subspaces of the real line – Limit point compactness - Local Compactness.

UNIT - IV

The countability axioms - The separation axioms – Normal space – Tychonoff's Theorem.

UNIT - V

The Urysohn's Lemma – The Urysohn's Metrization theorem - Tietz Extension theorem.

TEXT BOOK(S):

1. James. R. Munkres, "Topology", second Edition, Prentice Hall of India Pvt., Ltd., New Delhi 2005.
UNIT I - Chapter 2 Sec. 12 to 18
UNIT II - Chapter 2, Sec 19 to 21
Chapter 3, Sec 23 to 25
UNIT III - Chapter 3, Sec 26 to 29
UNIT IV - Chapter 3, Sec 30 to 32
Chapter 5: Section 37
UNIT V - Chapter 4, Sec 33 to 35

REFERENCE BOOK(S):

1. George F. Simmons, "Introduction to Topology and Modern Analysis", McGraw Hill Book Company 1963.
2. J. Dugundji, "Topology", Prentice Hall of India, New Delhi 1975.

3. J. L. Kelly, "General topology", Van Nostrand Reinhold Co., New York.
4. M. G. Murdeswar "General Topology", Academic press, 1964
5. K. D. Joshi "Introduction to General Topology", Addison-Wesley, 1994.
6. S. Kumaresan, "Topology of Metric Spaces" Alpha Science International Ltd. Harrow, U.K.

COURSE LEARNING OUTCOME (for Mapping with POs and PSOs):

Students will be able to

CLO 1: Understand the concepts of topological spaces, bases, subspace topology, product topology, closed sets, limit points, and continuous functions.

CLO 2: Analyze connected spaces, metric topology, components, and local connectedness in topological structures.

CLO 3: Study compactness, limit point compactness, and local compactness with applications to subspaces of the real line.

CLO 4: Apply countability and separation axioms, including normal spaces and Tychonoff's theorem in topology.

CLO 5: Understand and apply fundamental topological results such as Urysohn's Lemma, Urysohn's Metrization theorem, and Tietze Extension theorem.

	POs									
	1	2	3	4	5	6	7	8	9	10
CLO1	3	2	3	1	2	2	1	1	2	1
CLO2	3	3	3	2	2	2	2	2	2	1
CLO3	3	3	3	2	2	2	2	2	2	1
CLO4	3	3	3	2	2	2	2	3	2	1
CLO5	3	3	3	3	2	2	2	3	2	1

	PSOs					
	1	2	3	4	5	6
CLO1	3	2	1	1	1	1
CLO2	3	3	1	2	1	2
CLO3	3	3	1	2	1	2
CLO4	3	3	1	3	1	2
CLO5	3	3	1	3	1	3

Year: II

CORE COURSE 8

Semester: III

Code:

**COMPLEX ANALYSIS
(Theory)**

Credits: 4

OBJECTIVES:

The objective of this course is to study Cauchy integral formula, local properties of analytic functions, general form of Cauchy's theorem and evaluation of definite integral and harmonic functions.

UNIT - I: Cauchy's Integral Formula

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

UNIT - II: 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 - Residue theorem - The argument principle.

UNIT - III: Evaluation of Definite Integrals and Harmonic Functions

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

UNIT - IV: Harmonic Functions and Power Series Expansions

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

UNIT - V: Partial Fractions and Entire Functions

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

TEXT BOOK(S):

1. Lars V. Ahlfors, Complex Analysis, Third Edition, McGraw Hill Co., New York, 1979.
Unit I - Chapter 4: Section 2: 2.1-2.3, Section 3: 3.1-3.4
Unit II - Chapter 4: Sections 4.1 to 4.7, Chapter 5: Sections 5.1 and 5.2
Unit III- Chapter 4: Sections 5.3, 6.1 to 6.3
Unit IV- Chapter 4: Sections 6.4 and 6.5, Chapter 5: Sections 1.1 to 1.3
Unit V- Chapter 5: Sections 2.1 to 2.4, 3.1 to 3.2

BOOKS FOR SUPPLEMENTARY READING AND REFERENCES:

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

COURSE LEARNING OUTCOME (for Mapping with POs and PSOs):

Students will be able to

CLO 1: Understand Cauchy's integral formula, higher derivatives, singularities, zeros, poles, and the local properties of analytic functions.

CLO 2: Apply the general form of Cauchy's theorem, homology concepts, residue theorem, and argument principle in complex integration problems.

CLO 3: Evaluate definite integrals using contour integration techniques and analyze harmonic functions and Poisson formula.

CLO 4: Study harmonic function properties, Schwarz theorem, reflection principle, and expansions using Taylor and Laurent series.

CLO 5: Analyze partial fractions, infinite and canonical products, Gamma function, Jensen's formula, and Hadamard's theorem for entire functions.

	POs									
	1	2	3	4	5	6	7	8	9	10
CLO1	3	2	3	1	2	2	1	1	2	1
CLO2	3	3	3	2	2	2	3	2	2	1
CLO3	3	3	3	2	2	2	3	2	2	1
CLO4	3	3	3	2	2	2	2	2	2	1
CLO5	3	3	3	3	2	2	2	3	2	1

	PSOs					
	1	2	3	4	5	6
CLO1	3	2	1	1	2	1
CLO2	3	3	1	2	2	2
CLO3	3	3	1	2	3	2
CLO4	3	3	1	2	2	2
CLO5	3	3	1	3	2	3

Year: II

CORE COURSE 9

Semester: III

Code:

**MEASURE THEORY AND
INTEGRATION
(Theory)**

Credits: 4

OBJECTIVES:

To introduce the fundamental concepts of measure theory, Lebesgue measure, integration, differentiation, and general measure spaces. The course aims to develop rigorous analytical skills and a deeper understanding of modern analysis essential for advanced mathematical studies and research.

UNIT - I: Lebesgue Measure

Introduction – Outer measure – Measurable sets and Lebesgue measure – Measurable functions – Littlewood's three principles

UNIT - II: Lebesgue integral

The Riemann integral – Lebesgue integral of bounded functions over a set of finite measure – The integral of a nonnegative function – The general Lebesgue integral

UNIT - III: Differentiation and Integration

Differentiation of monotone functions – Functions of bounded variation – Differentiation of an integral – Absolute continuity

UNIT - IV: General Measure and Integration

Measure spaces – Measurable functions – Integration – General convergence theorems – Signed Measure – The Radon – Nikodym theorem

UNIT - V: Measure and Outer Measure

Outer measure and measurability – The Extension theorem – Product measures.

TEXT BOOK(S):

1. H.L. Royden, "Real Analysis", Third Edition, Macmillan Publishing Company, New York, 1988.
Unit I – Chapter 3: Sections 1 – 3, 5 & 6
Unit II – Chapter 4: Sections 1 – 4
Unit III – Chapter 5: Sections 1 – 4
Unit IV – Chapter 11: Sections 1 – 6
Unit V – Chapter 12: Sections 1, 2, 4

REFERENCES:

1. Robert G. Bartle, The Elements of Integration and Lebesgue Measure, 2nd Edition, Wiley-Blackwell, 1995.
2. G. de Barra, Measure Theory and Integration, 2nd Edition, Horwood, Publishing, 2003.
3. W. Rudin, Real and Complex Analysis, 3rd Edition, Tata McGraw-Hill Education, New Delhi, 2013.

COURSE LEARNING OUTCOME (for Mapping with POs and PSOs):

Students will be able to

CLO 1: Understand Lebesgue measure, measurable sets, measurable functions, and the foundational principles of measure theory.

CLO 2: Analyze the construction and properties of the Lebesgue integral and distinguish it from the Riemann integral.

CLO 3: Apply concepts of differentiation, bounded variation, absolute continuity, and differentiation of integrals in real analysis.

CLO 4: Study general measure spaces, convergence theorems, signed measures, and the Radon–Nikodym theorem in abstract integration theory.

CLO 5: Understand outer measures, extension theorems, and product measures in advanced measure theory.

	POs									
	1	2	3	4	5	6	7	8	9	10
CLO1	3	2	3	1	2	2	1	1	2	1
CLO2	3	3	3	2	2	2	2	2	2	1
CLO3	3	3	3	2	2	2	3	2	2	1
CLO4	3	3	3	3	2	2	2	3	2	1
CLO5	3	3	3	3	2	2	2	3	2	1

	PSOs					
	1	2	3	4	5	6
CLO1	3	2	1	2	1	2
CLO2	3	3	1	2	2	2
CLO3	3	3	1	2	2	2
CLO4	3	3	1	3	2	3
CLO5	3	3	1	3	2	3

Year: II

NON-MAJOR ELECTIVE COURSE 2

Semester: III

Code:

**OPTIMIZATION TECHNIQUES
(Theory)**

Credits: 2

OBJECTIVES:

To introduce optimization techniques and operations research methods used in decision-making and resource management. The course aims to develop analytical and computational skills in solving linear programming problem (LPP). Also it provides skills on transportation, assignment, sequencing and project scheduling problems arising in industries and real-world applications.

UNIT - I:

Linear Programming Formulation and Graphical Method: Introduction - Requirements for employing LPP technique - Mathematical Formulation of LPP - Basic assumptions - Graphical method of the Solution of a LPP - Some more cases - Advantage of Linear Programming - Limitations of Linear Programming.

UNIT - II:

Transportation Model: Introduction - Mathematical formulation of a transportation problem - Methods for finding initial basic feasible solution - Transportation algorithm or MODI method - Degeneracy in Transportation problems - Unbalanced Transportation Problems - Maximization case in Transportation problems.

UNIT - III:

Assignment Problem: Introduction - Mathematical formulation of an Assignment Problem - Difference between the Transportation Problem and Assignment Problem - Assignment Algorithm or Hungarian Method - Unbalanced Assignment Models - Maximization case in Assignment Problems.

UNIT - IV:

Sequencing Problems: Introduction - Assumptions of solving a sequencing Problem - Definition - Procedure for finding Optimum Sequence (n jobs on 2 machines) - Processing n jobs on three machines - Processing n jobs on m machines.

Unit - V:

Scheduling by PERT and CPM: Introduction - Basic Terminologies - Rules for constructing a project network - Network computations - Floats - Programme Evaluation Review Technique (PERT) - Basic differences between PERT and CPM.

TEXT BOOK(S):

1. Sundaresan,V., Ganapathy Subramanian, K.S. and Ganesan, K. Resource Management Techniques. [Seventh Edition]. AR Publication, Chennai, 2013
Unit I - Chapter 2 (Sections 2.1 - 2.8)
Unit II - Chapter 7 (Sections 7.1 - 7.5)
Unit III - Chapter 8 (Sections 8.1 - 8.2, 8.4 - 8.7)
Unit IV - Chapter 14 (Sections 14.1 - 14.6).

Unit V - Chapter 15 (Sections 15.1 – 15.7)

REFERENCES:

1. Kantiswarup., Gupta, P.K. and Man Mohan. Operations Research.[Seventeenth Edition]. Sultan Chand and Sons, New Delhi.2020.
2. Gupta, P.K. and Hira, D.S. Operations Research. [Eighth Edition]. Sulthan Chand and Company, New Delhi .2020.
3. Kalavathy.S. Operations Research[Fourth Edition], Vikas Publishing House,Chennai.2012.

COURSE LEARNING OUTCOME (for Mapping with POs and PSOs):

Students will be able to

CLO 1: Formulate and solve linear programming problems using graphical methods and understand the assumptions, advantages, and limitations of linear programming.

CLO 2: Analyze and solve transportation problems using initial basic feasible solution methods and MODI technique, including unbalanced and maximization cases.

CLO 3: Apply assignment models and Hungarian methods to solve minimization and maximization assignment problems.

CLO 4: Solve sequencing problems involving jobs and machines and determine optimal processing sequences.

CLO 5: Apply PERT and CPM techniques for project scheduling, network analysis, and computation of project completion times and floats.

	POs									
	1	2	3	4	5	6	7	8	9	10
CLO1	3	3	3	2	2	2	3	2	2	1
CLO2	3	3	3	2	2	2	3	2	2	1
CLO3	3	3	3	2	2	2	3	2	2	1
CLO4	3	3	3	2	2	2	3	2	2	2
CLO5	3	3	3	3	2	2	3	3	2	3

	PSOs					
	1	2	3	4	5	6
CLO1	2	3	2	1	3	1
CLO2	2	3	2	1	3	1
CLO3	2	3	2	1	3	1
CLO4	2	3	2	1	3	1
CLO5	2	3	2	2	3	2

Year: II

CORE COURSE 10

Semester: IV

Code:

**FUNCTIONAL ANALYSIS
(Theory)**

Credits: 4

OBJECTIVES:

To introduce the fundamental concepts of functional analysis including Banach spaces, Hilbert spaces, linear operators, spectral theory, and Banach algebras. The course aims to develop rigorous analytical skills and abstract reasoning essential for advanced mathematical analysis, quantum theory, and applied mathematics.

UNIT - I: 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–Orthogonal normal sets–The conjugate space H^*

UNIT - III: Hilbert Spaces (Contd...)

The adjoint of an operator – Self-adjoint operators - Normal and unitary operators – Projections

UNIT - IV: Finite-Dimensional Spectral Theory

Matrices – Determinants and the spectrum of an operator –The spectral theorem.

UNIT - V: 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 – Radical and semi simplicity.

TEXT BOOK(S):

1. G.F. Simmons, Introduction to Topology and Modern Analysis, McGraw Hill Education (India) Private Limited, New Delhi, 1983.
Unit I - Chapter 9: Sections 46-51
Unit II - Chapter 10: Sections 52-55
Unit III - Chapter 10: Sections 56-59
Unit IV - Chapter 11: Sections 60-62
Unit V - Chapter 12: Sections 64-69

REFERENCES:

1. C. Goffman and G. Pedrick, First course in Functional Analysis, Prentice Hall of India, NewDelhi, 1987.
2. S. Kesavan, Functional Analysis, Springer, Singapore, 2023.
3. E. Kreyszig, Introductory Functional Analysis with Applications, John Wiley & Sons, New York, 1978.
4. S. Kumaresan and D. Sukumar, Functional Analysis: A First Course, Narosa Publishing House, 2020.

5. B.V. Limaye, Functional Analysis, New Age International, 1996.
6. W. Rudin, Functional Analysis, McGraw Hill Education (India) Private Limited, New Delhi, 1973.
7. M. Thamban Nair, Functional Analysis, A First course, Prentice Hall of India, New Delhi, 2002.

COURSE LEARNING OUTCOME (for Mapping with POs and PSOs):

Students will be able to

CLO 1: Understand Banach spaces, continuous linear transformations, Hahn-Banach theorem, and fundamental properties of bounded operators.

CLO 2: Analyze Hilbert spaces, orthogonal complements, orthonormal sets, and conjugate spaces.

CLO 3: Study adjoint operators, self-adjoint, normal, unitary operators, and projections in Hilbert spaces.

CLO 4: Apply finite-dimensional spectral theory, determinants, spectra of operators, and spectral theorem in linear analysis.

CLO 5: Understand Banach algebras, spectral radius, regular and singular elements, radicals, and semi-simple algebras.

	POs									
	1	2	3	4	5	6	7	8	9	10
CLO1	3	2	3	2	2	2	1	2	2	1
CLO2	3	3	3	2	2	2	2	2	2	1
CLO3	3	3	3	2	2	2	2	2	2	1
CLO4	3	3	3	3	2	2	2	3	2	1
CLO5	3	3	3	3	2	2	2	3	2	1

	PSOs					
	1	2	3	4	5	6
CLO1	3	3	1	2	2	2
CLO2	3	3	1	2	2	2
CLO3	3	3	1	2	2	2
CLO4	3	3	2	3	3	2
CLO5	3	3	1	3	2	3

Year: II

CORE COURSE 11

Semester: IV

Code:

**DIFFERENTIAL GEOMETRY
(Theory)**

Credits: 4

COURSE OBJECTIVES:

To introduce space curves and their intrinsic properties of a surface and geodesics. Further the non-intrinsic properties of surfaces and the differential geometry of surfaces are explored.

UNIT - I:

Definition of a space curve – Arc length – tangent, normal and binormal – Curvature and torsion of the curve given as the intersection of two surfaces – Contact between curves and surfaces- Tangent surface, involutes and evolutes- Intrinsic equations, Fundamental existence theorem for space curves –Helices.

UNIT - II:

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 – Canonical geodesic equations – Normal property of geodesics- Existence theorems- Geodesic parallels – Geodesics curvature- Gauss-Bonnet Theorem – Gaussian curvature- Surface of constant curvature.

UNIT - IV:

The second fundamental form – Principle curvature – Lines of curvature – Developables – Developables associated with space curves – Developables associated with curves on surface – Minimal surfaces – Ruled surfaces.

UNIT - V:

Compact surfaces whose points are umbilics – Hilbert's lemma – Compact surface of constant curvature – Complete surface and characterization – Hilbert's Theorem – Conjugate points on geodesics.

TEXTBOOK(S):

1. **T.J. Willmore**, An Introduction to Differential Geometry, Oxford University Press (Indian Print), 17th Impression, New Delhi, 2002.
Unit I - Chapter I: Sections 1-9
Unit II - Chapter II: Sections 1-9
Unit III - Chapter II: Sections 10-18
Unit IV - Chapter III: Sections 1-8
Unit V - Chapter IV: Sections 1-8

REFERENCES:

1. Struik, D.T. Lectures on Classical Differential Geometry, Addison – Wesley, Mass. 1950.

2. Kobayashi. S. and Nomizu. K. Foundations of Differential Geometry, Inter science Publishers, 1963.
3. Wilhelm Klingenberg: A course in Differential Geometry, Graduate Texts in Mathematics, Springer-Verlag, 1978.
4. J.A. Thorpe Elementary topics in Differential Geometry, Under- graduate Texts in Mathematics, Springer – Verlag, 1979.

COURSE LEARNING OUTCOME (for Mapping with POs and PSOs):

Students will be able to

CLO 1: Understand the geometry of space curves, including curvature, torsion, helices, involutes, evolutes, and intrinsic equations of curves.

CLO 2: Analyze surfaces, curves on surfaces, surfaces of revolution, helicoids, and intrinsic properties of surfaces.

CLO 3: Apply geodesic equations, Gaussian curvature, and Gauss–Bonnet theorem in the study of curved surfaces.

CLO 4: Study second fundamental form, principal curvatures, developable surfaces, minimal surfaces, and ruled surfaces.

CLO 5: Examine compact surfaces, surfaces of constant curvature, Hilbert’s theorem, and conjugate points on geodesics.

	POs									
	1	2	3	4	5	6	7	8	9	10
CLO1	3	2	3	2	2	2	1	1	2	1
CLO2	3	3	3	2	2	2	2	2	2	1
CLO3	3	3	3	3	2	2	3	2	2	1
CLO4	3	3	3	3	2	2	2	2	2	1
CLO5	3	3	3	3	2	2	2	3	2	1

	PSOs					
	1	2	3	4	5	6
CLO1	3	2	1	1	2	1
CLO2	3	3	1	1	2	2
CLO3	3	3	1	2	3	2
CLO4	3	3	1	2	3	2
CLO5	3	3	1	3	2	3

Year: II

CORE COURSE 12

Semester: IV

Code:

**NUMERICAL ANALYSIS
(Theory)**

Credits: 4

OBJECTIVES:

To introduce numerical methods for solving algebraic equations, interpolation problems, ordinary differential equations (ODE) and partial differential equations (PDE). The course aims to develop computational and analytical skills required for obtaining approximate solutions to mathematical problems arising in science and engineering.

Unit - I: Solutions of Equations in One Variable

Newton's Method and its Extensions – Error Analysis for Iterative Methods – interpolation and Polynomial Approximation - Interpolation and the Lagrange Polynomial – Cubic Spline Interpolation.

Unit - II: Numerical Differentiation and Integration

Numerical Differentiation – Elements of Numerical Integration – Romberg Integration.

Unit - III: Initial Value Problems for ODE

Elementary Theory of Initial Value Problems – Euler's Method – Taylor Method – Runge-Kutta Methods.

Unit - IV: Initial Value Problems for ODE(Continued) Multistep Methods – Higher-Order Equations and Systems of Differential Equations – Stability.

Unit - V: Numerical Solutions to PDE

Elliptic Partial Differential Equations – Parabolic Partial Differential Equations - Hyperbolic Partial Differential Equations.

TEXT BOOK(S):

1. R. L. Burden and J.D. Faires, Numerical Analysis, 9th Edition, Thomson Learning. Inc., Stanford, Connecticut, 2011.
Unit I - Chapters 2&3: Sections 2.3, 2.4, 3.1, 3.5
(Algorithms are not included)
Unit II - Chapter4: Sections 4.1,4.3,4.5 (Algorithms are not included)
Unit III- Chapter 5: Sections 5.1-5.4 (Algorithms are not included)
Unit IV- Chapter5: Sections 5.6,5.9,5.10 (Algorithms are not included)
Unit V - Chapter12: Sections 12.1-12.3 (Algorithms are not included)

REFERENCES:

1. **C.F. Gerald and P.O. Wheatley**, "Applied Numerical Analysis" Sixth Edition, Addison- Wesley, Reading, 1998.
2. **M.K. Jain**, "Numerical Methods for Scientific and Engineering Computation" New Age International, 2003.

COURSE LEARNING OUTCOME (for Mapping with POs and PSOs):

Students will be able to

CLO 1: Apply numerical methods such as Newton's method, interpolation techniques, and spline approximations for solving equations and polynomial approximations.

CLO 2: Analyze numerical differentiation and integration methods including Romberg integration for approximate computations.

CLO 3: Solve initial value problems for ordinary differential equations using Euler, Taylor, and Runge–Kutta methods.

CLO 4: Apply multistep methods, higher-order differential equation techniques, and stability analysis for ordinary differential equations.

CLO 5: Analyze numerical methods for solving elliptic, parabolic, and hyperbolic partial differential equations.

	POs									
	1	2	3	4	5	6	7	8	9	10
CLO1	3	3	3	2	2	2	3	2	2	1
CLO2	3	3	3	3	2	2	3	2	2	1
CLO3	3	3	3	3	2	2	3	2	2	1
CLO4	3	3	3	3	2	2	3	3	2	1
CLO5	3	3	3	3	2	2	3	3	2	1

	PSOs					
	1	2	3	4	5	6
CLO1	3	3	2	1	3	1
CLO2	3	3	2	1	3	1
CLO3	3	3	2	2	3	2
CLO4	3	3	2	2	3	2
CLO5	3	3	2	2	3	2

Year: II

**ENTREPRENEURSHIP /
INDUSTRY BASED COURSE**

Semester: IV

Code:

**INDUSTRIAL MATHEMATICS
(Theory)**

Credits: 3

OBJECTIVES:

To introduce mathematical modeling techniques and industrial applications of mathematics in engineering and physical sciences. The course aims to develop analytical, computational, and problem-solving skills through real-world industrial case studies involving diffusion, heat transfer, filtration, laser drilling and combustion processes.

UNIT - I: DIMENSIONAL ANALYSIS

Mathematical Industry – Overview of the case studies – Unit and dimensions – Diffusion equations – Heat conduction equations – Boundary conditions – Solving the heat/diffusion equation – Scaling equations – Dimensional analysis

UNIT - II: CONTINUOUS CASTING

Introduction to the case study problem – The Boltzmann similarity solution – A moving boundary problem – The pseudo-steady-state approximate solution – Solving the continuous casting case study.

UNIT - III: WATER FILTRATION

Introduction to the case study problem – Stretching transformations – Diffusion from a point source – Solving the water filtration case study.

UNIT - IV: LASER DRILLING

Introduction to the case study problem – Method of perturbations – Boundary perturbations – Solving the laser drilling case study.

UNIT - V: FACTORY FIRES

Bifurcations and spontaneous ignition – ignition with conduction – Solving the factory fire case study.

TEXT BOOK(S):

1. **Glenn R. Fulford** and **Philip Broadbridge**, Industrial Mathematics: Case studies in the Diffusion of Heat and Matter, Cambridge University Press, Cambridge, UK, 2002.
Unit I - Chapter 1: Sections 1.1-1.10
Unit II - Chapter 2: Sections 2.1 - 2.5
Unit III - Chapter 3: Sections 3.1 - 3.4
Unit IV- Chapter 4: Sections 4.1 – 4.4
Unit V - Chapter 5: Sections 5.1 - 5.4

REFERENCES:

1. Aziz and T.Y. Na, Perturbation Methods in Heat Transfer, Springer-Verlag, Berlin, 1984,
2. G.L. Barenblatt, Dimensional Analysis, Gordon and Breach, 1987.

3. N.D. Fowkeys and J.J. Mahony, An Introduction to Mathematical Modelling, Wiley Publishers, UK, 1994.
4. Edward L. Cussler, Diffusion-Mass Transfer in Fluid Systems, Cambridge University Press, 3rd Edition, 2009.

COURSE LEARNING OUTCOME (for Mapping with POs and PSOs):

Students will be able to

CLO 1: Apply dimensional analysis, scaling techniques, and diffusion equations in industrial and physical problems.

CLO 2: Analyze continuous casting problems using similarity solutions, moving boundary problems, and pseudo-steady-state approximations.

CLO 3: Apply stretching transformations and diffusion models to solve water filtration problems.

CLO 4: Use perturbation methods and boundary perturbation techniques in modeling and solving laser drilling problems.

CLO 5: Analyze bifurcation phenomena, spontaneous ignition, and conduction models in industrial fire and combustion problems.

	POs									
	1	2	3	4	5	6	7	8	9	10
CLO1	3	3	3	3	2	2	3	2	2	1
CLO2	3	3	3	3	2	2	3	3	2	1
CLO3	3	3	3	3	2	2	3	3	2	1
CLO4	3	3	3	3	2	2	3	3	2	1
CLO5	3	3	3	3	2	3	3	3	2	2

	PSOs					
	1	2	3	4	5	6
CLO1	2	3	2	1	3	1
CLO2	2	3	2	2	3	2
CLO3	2	3	2	1	3	1
CLO4	2	3	2	2	3	2
CLO5	2	3	2	2	3	2

Year: II

VALUE ADDED COURSE 2

Semester: IV

Code:

**MATHEMATICS FOR
COMPETITIVE EXAMINATIONS-II
(Theory)**

Credits: 2*

OBJECTIVES:

To develop quantitative aptitude and analytical problem-solving skills required for competitive examinations. The course aims to strengthen mathematical reasoning, computational efficiency, and practical application of arithmetic concepts in solving real-world and examination-oriented problems.

UNIT - I

Profit & Loss – Ratio & Proportion.

UNIT - II

Partnership – Chain Rule.

UNIT - III

Time & Work – Pipes & Cistern.

UNIT - IV

Time & Distance – Problems on Trains.

UNIT - V

Boats & Streams – Alligation or Mixture.

TEXTBOOK(S)

1. R.S. Aggarwal, Quantitative Aptitude for Competitive Examinations, S.Chand co Ltd., 152. Anna Salai, Chennai, 2010
Unit I - Chapter – 11 & 12
Unit II - Chapter – 13 & 14
Unit III- Chapter – 15 & 16
Unit IV- Chapter – 17 & 18
Unit V - Chapter – 19 & 20

REFERENCES:

1. Quantitative Aptitude _by Abhijit Guha, Tata McGraw Hill Publishing Company Limited, New Delhi (2005)
2. <https://nptel.ac.in>

COURSE LEARNING OUTCOME (for Mapping with POs and PSOs):

Students will be able to

CLO 1: Apply concepts of profit and loss, ratio, and proportion to solve quantitative aptitude problems accurately.

CLO 2: Analyze partnership and chain rule problems using logical and mathematical reasoning techniques.

CLO 3: Solve problems related to time and work, pipes, and cisterns using efficient computational methods.

CLO 4: Apply mathematical techniques to solve problems involving time, distance, and trains.

CLO 5: Analyze and solve aptitude problems involving boats and streams, alligation, and mixtures.

	POs									
	1	2	3	4	5	6	7	8	9	10
CLO1	2	3	3	1	2	1	3	1	2	1
CLO2	2	3	3	1	2	1	3	1	2	1
CLO3	2	3	3	1	2	1	3	1	2	1
CLO4	2	3	3	1	2	1	3	1	2	1
CLO5	2	3	3	1	2	1	3	1	2	1

	PSOs					
	1	2	3	4	5	6
CLO1	2	3	1	2	2	1
CLO2	2	3	1	2	2	1
CLO3	2	3	1	2	2	1
CLO4	2	3	1	2	2	1
CLO5	2	3	1	2	2	1

Year: I

**DISCIPLINE CENTRIC ELECTIVE
COURSE 1**

Semester: I

Code:

**1. GRAPH THEORY
(Theory)**

Credits: 4

OBJECTIVES:

To introduce the fundamental concepts and applications of graph theory including graphs, trees, connectivity, matchings, colorings, and planar graphs. The course aims to develop analytical and problem-solving skills for modeling and solving combinatorial and real-world network problems.

UNIT - I: Graphs and Digraphs

Basic concepts – subgraphs – degrees of vertices – paths and connectedness – automorphism of a simple graphs – line graphs – operations on graphs – applications to social psychology - basic concepts in digraphs – tournaments.

UNIT - II: Connectivity and trees

Vertex cuts and edge cuts – connectivity and edge connectivity – Cyclical edge connectivity of a graph - Definition, Characterization and simple properties of trees – centers and centroids - counting the Number of spanning trees – Cayley's formula – Applications: Connector Problem – Kruskal's Algorithm.

UNIT - III: Independent sets, Matchings and Cycles

Independents sets and coverings (both vertex & edge) – matchings and factors – matchings in bipartite graphs – Eulerian graphs and Hamiltonian graphs – Introduction – Eulerian Graphs – Hamiltonian Graphs – 2-Factorable Graphs.

UNIT - IV: Graph colorings

Vertex colorings – applications of graph coloring - critical graphs – Brooks Theorem – other coloring parameters – b-colorings; Edge colorings – the time table problem – Vizings theorem – Kirkman's Schoolgirl Problem – chromatic polynomials.

UNIT - V: Planar Graphs

Planar and non planar graphs – Euler formula and its consequences – K_5 and $K_{3,3}$ are non planar graphs – dual of a plane graph – The four color theorem and the Heawood five color theorem – Hamiltonian plane graphs – Tait coloring.

TEXT BOOK(S):

1. **R. Balakrishnan** and **K. Ranganathan**, "A Textbook of Graph Theory" (2nd edition), Springer, New York, 2012.
Unit I: Chapter 1: Sections 1.1 to 1.8, 1.11 &
Chapter 2: Sections 2.1 to 2.3
Unit II: Chapter 3: Sections 3.1 to 3.3, 3.5 &
Chapter 4: Sections 4.1 to 4.5, 4.7.1 and 4.7.2
Unit III: Chapter 5: Sections 5.1 to 5.5 &
Chapter 6: Sections 6.1 to 6.3, 6.6
Unit IV: Chapter 7: Sections 7.1 to 7.4, 7.6, 7.8, 7.9

REFERENCES:

1. J. Clark and D.A. Holton, A First look at Graph Theory, Allied Publishers, New Delhi, 1995.
2. R.J. Wilson and J.J. Watkins, Graphs: An Introductory Approach, John Wiley and Sons, New York, 1989.
3. S.A. Choudum, A First Course in Graph Theory, MacMillan India Ltd. 1987.
4. J.A. Bondy and U.S.R. Murty, Graph Theory and Applications, Macmillan, London, 1976.

COURSE LEARNING OUTCOME (for Mapping with POs and PSOs):

Students will be able to

CLO 1: Understand the basic concepts of graphs and digraphs, including subgraphs, paths, connectedness, automorphisms, and tournaments.

CLO 2: Analyze connectivity properties, trees, spanning trees, and apply algorithms such as Kruskal's algorithm in network problems.

CLO 3: Study independent sets, coverings, matchings, Eulerian graphs, Hamiltonian graphs, and factorization concepts.

CLO 4: Apply graph coloring techniques, edge and vertex colorings, chromatic polynomials, and related theorems in practical problems.

CLO 5: Analyze planar and non-planar graphs, Euler's formula, graph duality, and coloring theorems for planar graphs.

	POs									
	1	2	3	4	5	6	7	8	9	10
CLO1	3	2	3	1	2	2	2	1	2	1
CLO2	3	3	3	2	2	2	3	2	2	1
CLO3	3	3	3	2	2	2	3	2	2	1
CLO4	3	3	3	2	2	2	3	2	2	1
CLO5	3	3	3	2	2	2	3	3	2	1

	PSOs					
	1	2	3	4	5	6
CLO1	3	2	2	1	2	1
CLO2	3	3	2	2	3	2
CLO3	3	3	2	2	2	2
CLO4	3	3	2	2	3	2
CLO5	3	3	2	3	2	3

Year: I

**DISCIPLINE CENTRIC ELECTIVE
COURSE 1**

Semester: I

Code:

**2. NUMBER THEORY
(Theory)**

Credits: 4

OBJECTIVES:

To introduce the fundamental concepts of number theory, finite fields, quadratic residues, and cryptographic systems. The course aims to develop logical reasoning, algebraic problem-solving skills, and understanding of mathematical techniques used in modern cryptography and information security.

UNIT - I: Elementary Number theory

Time estimates for doing arithmetic – divisibility and the Euclidean algorithm

UNIT - II: Elementary Number theory

Congruences – Some applications to factoring.

UNIT - III: Finite Fields and Quadratic Residues

Finite Fields - Quadratic residues and reciprocity.

UNIT - IV: Cryptography

Some simple cryptosystems – Enciphering matrices

UNIT - V: Public Key Cryptography

Public key cryptography – RSA

TEXT BOOK(S):

1. **Neal Koblitz**, A Course in Number Theory and Cryptography, Second Edition, Springer – Verlag, New York, 1994.
Unit I: Chapter I: Sections 1, 2
Unit I: Chapter I: Sections 3, 4
Unit I: Chapter II: Sections 1, 2
Unit I: Chapter III: Sections 1, 2
Unit I: Chapter IV: Sections 1,2

REFERENCES:

1. Niven and H. S. Zuckermann, An Introduction to Theory of Numbers (Edition 3), Wiley Eastern Ltd, New Delhi 1976.
2. D. M. Burton, Elementary Number Theory, Brown Publishers, Iowa, 1989.
3. K. Ireland and M. Rosen, A classic Introduction to Modern Number Theory, Springer – Verlag, 1972.
4. N. Koblitz, Algebraic Aspects of Cryptography, Springer-Verlag, 1998.

COURSE LEARNING OUTCOME (for Mapping with POs and PSOs):

Students will be able to

CLO 1: Understand divisibility properties, Euclidean algorithm, and computational aspects of elementary number theory.

CLO 2: Apply congruence relations and factorization techniques in solving number theoretic problems.

CLO 3: Analyze finite fields, quadratic residues, and quadratic reciprocity laws in algebraic number theory.

CLO 4: Study basic cryptographic systems and apply enciphering matrix techniques for secure communication.

CLO 5: Understand public key cryptography and implement the principles of RSA cryptosystem.

	POs									
	1	2	3	4	5	6	7	8	9	10
CLO1	3	2	3	1	2	2	2	1	2	1
CLO2	3	3	3	2	2	2	3	2	2	1
CLO3	3	3	3	2	2	2	2	2	2	1
CLO4	3	3	3	3	2	2	3	2	2	1
CLO5	3	3	3	3	2	2	3	3	2	1

	PSOs					
	1	2	3	4	5	6
CLO1	3	2	1	1	2	1
CLO2	3	3	1	2	2	1
CLO3	3	3	2	2	2	2
CLO4	2	3	3	2	3	1
CLO5	2	3	3	3	3	2

Year: I

**DISCIPLINE CENTRIC ELECTIVE
COURSE 2**

Semester: II

Code:

**1. FUZZY MATHEMATICS
(Theory)**

Credits: 4

COURSE OBJECTIVES:

To introduce the fundamental concepts of fuzzy sets, fuzzy relations, fuzzy arithmetic, and fuzzy decision-making techniques. The course aims to develop analytical and computational skills for handling uncertainty and imprecision in mathematical modeling and real-world applications.

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.

TEXTBOOK(S):

1. George J. Klir and Bo Yuan, Fuzzy sets and Fuzzy Logic Theory and Applications, Prentice Hall of India, (2005).
UNIT I - Chapter 1 Sec1.3, 1.4, Chapter :2 Sec 2.1, 2.3
UNIT II - Chapter 3 Sec 3.1, 3.2, 3.3, 3.4, 3.5.
UNIT III - Chapter 4 Sec4.1,4.2, 4.3, 4.4.
UNIT IV - Chapter 5 Sec 5.3 ,5.4, 5.5, 5.6, 5.7, 5.8.
UNIT V - Chapter 15 Sec 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).
3. <https://cours.etsmtl.ca/sys843/REFS/Books/ZimmermannFuzzySetTheory2001.pdf>

COURSE LEARNING OUTCOME (for Mapping with POs and PSOs):

Students will be able to

CLO 1: Understand the concepts of fuzzy sets, α -cuts, extension principles, and the differences between fuzzy and crisp sets.

CLO 2: Apply operations on fuzzy sets including fuzzy complements, t-norms, t-conorms, and combinations of fuzzy operations.

CLO 3: Analyze fuzzy numbers, linguistic variables, and perform arithmetic operations on intervals and fuzzy numbers.

CLO 4: Study binary fuzzy relations, fuzzy equivalence relations, compatibility relations, ordering relations, and fuzzy morphisms.

CLO 5: Apply fuzzy decision-making techniques, ranking methods, multiperson decision-making, and fuzzy linear programming in practical problems.

	POs									
	1	2	3	4	5	6	7	8	9	10
CLO1	3	2	3	1	2	2	1	1	2	1
CLO2	3	3	3	2	2	2	2	2	2	1
CLO3	3	3	3	2	2	2	3	2	2	1
CLO4	3	3	3	2	2	2	2	2	2	1
CLO5	3	3	3	3	2	2	3	3	2	2

	PSOs					
	1	2	3	4	5	6
CLO1	3	2	1	1	2	1
CLO2	3	3	1	1	2	1
CLO3	3	3	2	1	3	1
CLO4	3	3	2	2	2	2
CLO5	3	3	2	2	3	2

Year: I

**DISCIPLINE CENTRIC ELECTIVE
COURSE 2**

Semester: II

Code:

**2. DISCRETE MATHEMATICS
(Theory)**

Credits: 4

OBJECTIVES:

To introduce the fundamental concepts of discrete mathematics including logic, counting techniques, recurrence relations, Boolean algebra, and computational models. The course aims to develop logical reasoning, analytical thinking, and problem-solving skills essential for mathematics, computer science, and theoretical computation.

UNIT - I: The Foundation of Logic

Logic – Propositional equivalence – Predicates and quantifiers – Proof Methods and Strategy – The growth of functions.

UNIT - II: Counting

Basics of counting – The pigeonhole principle – permutations and combinations – Generalized permutations and combinations – Generating permutations and combinations.

UNIT - III: Advanced counting techniques

Recurrence relation – Solving recurrence relations – Generating functions.

UNIT - IV: Boolean Algebra

Boolean functions – Representing Boolean functions – Logic Gates –Minimization of circuits.

UNIT - V: Modeling Computations

Finite – state machines with output, finite – State machines with no output – Turing machines

TEXTBOOK(S):

1. Kenneth H. Rosen, Discrete Mathematics and its Applications, Seventh Edition, WCB/ McGraw Hill Publications, New Delhi, 2011.
Unit I - Chapter 1 & 3 – Sections 1.1–1.3 &1.8, 3.2
Unit II - Chapter 5: Sections 5.1–5.6
Unit III- Chapter 6: Sections 6.1, 6.2, 6.4
Unit IV- Chapter 10: Sections 10.1–10.4
Unit V - Chapter 12: Sections 12.2, 12.3,12.5

REFERENCES:

1. Edward A. Bender and S. Gill Williamson, “A Short Course in Discrete Mathematics”, Dover Publications, 2006.
2. M.O. Albertson and J.P. Hutchinson, “Discrete Mathematics with Algorithms”, John Wiley & Sons, 2008.
3. Rajendra Akerkar and Rupali Akarkar, “Discrete Mathematics”, Pearson Education Pvt. Ltd, Singapore,2004.
4. J.P. Trembley and R. Manohar, “Discrete Mathematical Structures”, Tata McGraw Hill, New Delhi,1997.

5. Martin Aigner, "A Course in Enumeration", Springer-Verlag, Heidelberg, 2007.
6. J.H. Van Lint and R.M. Wilson, "A Course in Combinatorics", 2nd Edition, Cambridge University Press, Cambridge, 2001.

COURSE LEARNING OUTCOME (for Mapping with POs and PSOs):

Students will be able to

CLO 1: Understand propositional logic, predicates, quantifiers, proof techniques, and growth of functions.

CLO 2: Apply counting principles, permutations, combinations, and pigeonhole principle in combinatorial problems.

CLO 3: Analyze recurrence relations and generating functions for solving advanced counting problems.

CLO 4: Study Boolean functions, logic gates, and minimization techniques for digital circuits.

CLO 5: Understand finite-state machines, automata models, and Turing machines in computational theory.

	POs									
	1	2	3	4	5	6	7	8	9	10
CLO1	3	3	3	1	2	2	2	1	2	1
CLO2	3	3	3	2	2	2	3	1	2	1
CLO3	3	3	3	2	2	2	3	2	2	1
CLO4	3	3	3	2	2	2	3	2	2	1
CLO5	3	3	3	3	2	2	3	2	2	1

	PSOs					
	1	2	3	4	5	6
CLO1	3	2	2	1	2	1
CLO2	3	3	2	1	2	1
CLO3	3	3	2	2	2	2
CLO4	2	3	3	1	3	1
CLO5	2	3	3	2	3	2

Year: II

**DISCIPLINE CENTRIC ELECTIVE
COURSE 3**

Semester: III

Code:

**1. METHODS OF APPLIED
MATHEMATICS
(Theory)**

Credits: 4

OBJECTIVES:

To introduce advanced methods of applied mathematics including calculus of variations, integral equations, and approximation techniques. The course aims to develop analytical and problem-solving skills for modeling and solving problems arising in physics, engineering, and applied sciences.

UNIT - I: Calculus of variations

Maxima and Minima – The simplest case – Examples - Natural and transition boundary conditions – The variational notation – The more general case – Constraints and Lagrange's multipliers – Variable end points – Sturm-Liouville problems.

UNIT - II: Applications of Calculus of variations

Hamilton's principle – Lagrange's equation – Generalized dynamical entities – Constraints in dynamical systems – Small vibrations about equilibrium. Normal coordinates – Variational problems for deformable bodies – Rayleigh – Ritz method.

UNIT - III: Integral Equations

Integral equations – Relations between differential and integral equations – The Green's function – Fredholm equations with separable kernels – Example.

UNIT - IV: Integral Equations Continued...

Hilbert – Schmidt theory – Iterative method for solving equations of the second kind – The Neumann Series – Fredholm theory – Singular integral equations.

UNIT - V: Special Devices

Special devices – Iterative approximation to characteristic functions – Approximation of Fredholm equations by sets of algebraic equations.

TEXT BOOK(S):

1. **F.B. Hildebrand**, "Methods of Applied Mathematics", Prentice-Hall of India Pvt., New Delhi, 1965.
Unit I - Chapter 5: Sections 2.1 to 2.9
Unit II - Chapter 5: Sections 2.10 to 2.14, 2.16, 2.19
Unit III- Chapter 5: Sections 3.1 to 3.3, 3.6, 3.7
Unit IV- Chapter 5: Sections 3.8 to 3.12
Unit V - Chapter 5: Sections 3.13 to 3.15

REFERENCES:

1. A.S. Gupta, "Calculus of Variations with Application", Prentice-Hall of India, New Delhi, 2005.
2. L. Elsgolts, "Differential Equations and Calculus of Variations", University Press of the Pacific, 2003.

3. I.M. Gelfand and S.V. Fomin, “Calculus of Variations”, Prentice Hall, New Jersey, 1963.
4. R.P. Kanwal, “Linear integral equation: Theory and Techniques”, 2nd Edition, Birkhäuser, 1996.

COURSE LEARNING OUTCOME (for Mapping with POs and PSOs):

Students will be able to

CLO 1: Apply the principles of calculus of variations to solve optimization problems involving boundary conditions, constraints, and Sturm–Liouville problems.

CLO 2: Analyze applications of variational methods in mechanics, dynamical systems, vibrations, and deformable bodies using Hamilton’s principle and Rayleigh–Ritz method.

CLO 3: Understand integral equations, Green’s functions, and the relationship between differential and integral equations.

CLO 4: Apply Hilbert–Schmidt theory, Neumann series, Fredholm theory, and iterative methods for solving integral equations.

CLO 5: Analyze approximation techniques for characteristic functions and Fredholm equations using algebraic methods.

	POs									
	1	2	3	4	5	6	7	8	9	10
CLO1	3	3	3	2	2	2	3	2	2	1
CLO2	3	3	3	3	2	2	3	2	2	1
CLO3	3	2	3	2	2	2	2	2	2	1
CLO4	3	3	3	3	2	2	3	3	2	1
CLO5	3	3	3	3	2	2	3	3	2	1

	PSOs					
	1	2	3	4	5	6
CLO1	3	3	1	2	3	2
CLO2	3	3	2	2	3	2
CLO3	3	3	1	2	3	2
CLO4	3	3	1	3	3	3
CLO5	3	3	1	2	3	2

Year: II

**DISCIPLINE CENTRIC ELECTIVE
COURSE 3**

Semester: III

Code:

**2. NONLINEAR DIFFERENTIAL
EQUATIONS
(Theory)**

Credits: 4

OBJECTIVES:

To introduce nonlinear dynamical systems, perturbation techniques, periodic solutions, and stability theory in applied mathematics. The course aims to develop analytical and modeling skills for studying oscillatory phenomena, equilibrium behavior, and stability of linear and nonlinear systems arising in science and engineering.

UNIT - I: Plane autonomous systems and linearization

The general phase plane - Some population models - Linear approximation at equilibrium points - Linear systems in matrix form.

UNIT - II: Periodic Solutions and Averaging Methods

An energy balance method for limit cycles - Amplitude and frequency estimates - Slowly varying amplitudes; Nearly periodic solutions - Periodic solutions: Harmonic 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: Stability

Poincare stability - Paths and solution curves for general systems - Stability of time solutions: Liapunov stability - Liapunov stability of plane autonomous linear systems.

UNIT - V: Stability

Structure of the solutions of n-dimensional linear systems - Structure of n-dimensional inhomogeneous linear systems - Stability and boundedness for linear systems - Stability of linear systems with constant coefficients.

TEXT BOOK(S):

1. **D.W. Jordan** and **P. Smith**, "Nonlinear Ordinary Differential Equations", 4th Edition, Oxford University Press, New York, 2007.
Unit I - Chapter 2: Sections 2.1 - 2.5
Unit II - Chapter 4: Sections 4.1 - 4.5
Unit III- Chapter 5: Sections 5.1 - 5.5, 5.8 - 5.11
Unit IV- Chapter 8: Sections 8.1 - 8.4
Unit V - Chapter 8: Sections 8.5 - 8.8

REFERENCES:

1. **G.F. Simmons**, "Differential Equations", Tata McGraw-Hill, New Delhi, 1995.
2. **D.A. Sanchez**, "Ordinary Differential Equations and Stability Theory", Dover, New York, 1979.
3. **J.K. Aggarwal**, "Notes on Nonlinear Systems", Van Nostrand, 1972.

COURSE LEARNING OUTCOME (for Mapping with POs and PSOs):

Students will be able to

CLO 1: Analyze plane autonomous systems, equilibrium points, population models, and linear approximations using matrix methods.

CLO 2: Apply harmonic balance and averaging methods to study periodic solutions, limit cycles, and oscillatory systems.

CLO 3: Use perturbation techniques such as Lindstedt's method and Fourier series approaches to solve forced oscillation and nonlinear vibration problems.

CLO 4: Analyze Poincaré and Liapunov stability concepts for autonomous and linear dynamical systems.

CLO 5: Study the structure, boundedness, and stability properties of n-dimensional linear and inhomogeneous systems with constant coefficients.

	POs									
	1	2	3	4	5	6	7	8	9	10
CLO1	3	3	3	2	2	2	3	2	2	1
CLO2	3	3	3	3	2	2	3	2	2	1
CLO3	3	3	3	3	2	2	3	3	2	1
CLO4	3	3	3	3	2	3	3	3	2	1
CLO5	3	3	3	3	2	3	3	3	2	1

	PSOs					
	1	2	3	4	5	6
CLO1	3	3	2	1	3	1
CLO2	3	3	2	2	3	2
CLO3	3	3	2	2	3	2
CLO4	3	3	1	2	3	2
CLO5	3	3	2	3	3	2

Year: II

**DISCIPLINE CENTRIC ELECTIVE
COURSE 3**

Semester: III

Code:

**3. PROBABILITY THEORY
(Theory)**

Credits: 4

OBJECTIVES:

To introduce the fundamental concepts of probability theory including random variables, probability distributions, characteristic functions, and limit theorems. The course aims to develop analytical and statistical reasoning skills necessary for advanced studies in mathematics, statistics, data science, and applied probability.

UNIT - I: Random Events and Random Variables

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

UNIT - II: Parameters of the Distribution

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

UNIT - III: Characteristic Functions

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

UNIT - IV: Some Probability Distributions

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

UNIT - V: Limit Theorems

Stochastic convergence – Bernoulli 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 – Lindeberg Theorem – Lapunov Theroem – Borel-Cantelli Lemma - Kolmogorov Inequality and Kolmogorov Strong Law of large numbers.

TEXT BOOK(S):

1. **M. Fisz**, Probability Theory and Mathematical Statistics, John Wiley and Sons, New York, 1963.
Unit I - Chapter 1& 2: Sections 1.1 – 1.7, 2.1 – 2.9
Unit II - Chapter 3: Sections 3.1 – 3.8
Unit III - Chapter 4: Sections 4.1 – 4.7
Unit IV - Chapter 5: Sections 5.1 – 5.10
Unit V - Chapter 6: Sections 6.1 – 6.4, 6.6 – 6.9, 6.11 and 6.12

REFERENCES:

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

COURSE LEARNING OUTCOME (for Mapping with POs and PSOs):

Students will be able to

CLO 1: Understand probability axioms, conditional probability, Bayes theorem, random variables, and joint probability distributions.

CLO 2: Analyze expectations, moments, inequalities, regression, and parameters associated with probability distributions.

CLO 3: Apply characteristic functions, probability generating functions, and related properties in the study of random variables and distributions.

CLO 4: Study and apply important discrete and continuous probability distributions in statistical modeling.

CLO 5: Analyze stochastic convergence and fundamental limit theorems including laws of large numbers and central limit type theorems.

	POs									
	1	2	3	4	5	6	7	8	9	10
CLO1	3	2	3	2	2	2	2	1	2	1
CLO2	3	3	3	2	2	2	3	2	2	1
CLO3	3	3	3	2	2	2	3	2	2	1
CLO4	3	3	3	3	2	2	3	2	2	1
CLO5	3	3	3	3	2	2	3	3	2	1

	PSOs					
	1	2	3	4	5	6
CLO1	3	3	1	1	2	1
CLO2	3	3	2	2	3	2
CLO3	3	3	2	2	2	2
CLO4	3	3	2	1	3	1
CLO5	3	3	2	3	3	3

Year: II

**DISCIPLINE CENTRIC ELECTIVE
COURSE 4**

Semester: IV

Code:

**1. STOCHASTIC PROCESS
(Theory)**

Credits: 4

OBJECTIVES:

To introduce the fundamental concepts of stochastic processes including probability spaces, Poisson processes, Markov chains, and Markov processes. The course aims to develop analytical and probabilistic modeling skills for studying random systems and processes arising in science, engineering, finance, and operations research.

UNIT - I: Probability Spaces and Random Variables

Probability spaces, Random Variables and Stochastic Processes, Conditional Probability, Expected Value, Conditional Expectations

UNIT - II: Bernoulli Process and Poisson Process

Bernoulli Process, Number of Successes, Times of Successes, Sum of Independent Random Variables, Arrival Counting Process, Times of Arrival

UNIT - III: Markov Chains

Forward Recurrence Times, Superposition of Poisson Processes, Decomposition of Poisson Processes, Compound Poisson Processes, Introduction to Markov Chain, Visits to a Fixed State

UNIT - IV: Limiting Behaviour and Applications of Markov Chains

Classification of States, Computation of R and F , Recurrent States and the Limiting probabilities, Periodic States, Transient States

UNIT - V: Markov Processes

Markov Processes, Sample path behavior, Structure of a Markov Process Potentials and Generators, Limit Theorem.

TEXT BOOKS:

1. **K. Erhan Cinlar, Introduction to Stochastic Processes, First Edition, Dover Publication, Inc. Mineola, New York, 2013.**

Unit I - Chapter 1 & 2: Sections 1.1 – 1.3, 2.1, 2.2

Unit II - Chapter 3 & 4: Sections 3.1 – 3.4, 4.1, 4.2

Unit III - Chapter 4 & 5: Sections 4.3 – 4.6, 5.1, 5.2

Unit IV - Chapter 5 & 6: Sections 5.3, 6.1 – 6.1

Unit V - Chapter 8: Sections 8.1 – 8.5

COURSE LEARNING OUTCOME (for Mapping with POs and PSOs):

Students will be able to

CLO 1: Understand probability spaces, random variables, stochastic processes, conditional probability, and conditional expectations.

CLO 2: Analyze Bernoulli and Poisson processes, arrival counting processes, and sums of independent random variables.

CLO 3: Apply Markov chain concepts including recurrence times, visits to states, and decomposition of Poisson processes.

CLO 4: Study classification of states, limiting probabilities, recurrent and transient states, and applications of Markov chains.

CLO 5: Analyze Markov processes, sample path behavior, generators, potentials, and limit theorems in stochastic modeling.

	POs									
	1	2	3	4	5	6	7	8	9	10
CLO1	3	2	3	2	2	2	2	1	2	1
CLO2	3	3	3	3	2	2	3	2	2	1
CLO3	3	3	3	3	2	2	3	2	2	1
CLO4	3	3	3	3	2	2	3	3	2	1
CLO5	3	3	3	3	2	3	3	3	2	1

	PSOs					
	1	2	3	4	5	6
CLO1	3	3	1	1	2	1
CLO2	3	3	2	2	3	2
CLO3	3	3	2	2	3	2
CLO4	3	3	2	2	3	2
CLO5	3	3	2	3	3	3

Year: II

**DISCIPLINE CENTRIC ELECTIVE
COURSE 4**

Semester: IV

Code:

**2. MATHEMATICAL MODELING
(Theory)**

Credits: 4

OBJECTIVES:

To introduce the principles and techniques of mathematical modeling using differential equations, difference equations, and graph theory. The course aims to develop analytical and problem-solving skills for formulating and analyzing real-world problems arising in science, engineering, economics, biology, and social sciences.

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 – Simple 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 – Simple problems.

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– Simple problems.

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–Simple problems.

UNIT - V: MATHEMATICAL MODELLING THROUGH GRAPHS

Situations that can be modelled through Graphs – Mathematical Modelling in Terms of Directed Graphs, Signed Graphs, Weighted Digraphs – Simple problems.

TEXT BOOK:

1. **J.N. Kapur**, Mathematical Modelling, Wiley Eastern Limited, New Delhi, 4th Reprint, May 1994.
Unit I - Chapter 2: Sections 2.1 - 2.6
Unit II - Chapter 3: Sections 3.1 - 3.6
Unit III- Chapter 4: Sections 4.1 - 4.4
Unit IV- Chapter 5: Sections 5.1 - 5.6
Unit V - Chapter 7: Sections 7.1 - 7.4

REFERENCES:

1. M. Braun, C.S. Coleman and D. A. Drew, Differential Equation Models, 1994.

2. A.C. Fowler, Mathematical Models in Applied Sciences, Cambridge University Press, 1997.
3. Walter J. Meyer, Concepts of Mathematical Modeling.
4. Edward A. Bender, Introduction to Mathematical Modelling, Dover Publications, 1st ed., 2000.

COURSE LEARNING OUTCOME (for Mapping with POs and PSOs):

Students will be able to

CLO 1: Apply first-order ordinary differential equations to model growth, decay, compartmental, and dynamical systems.

CLO 2: Analyze systems of first-order differential equations in applications involving population dynamics, epidemics, economics, and international trade.

CLO 3: Develop mathematical models using second-order differential equations for planetary motion, satellite motion, and related physical systems.

CLO 4: Apply difference equations in modeling problems arising in economics, finance, genetics, and probability theory.

CLO 5: Construct and analyze graph-based mathematical models using directed graphs, signed graphs, and weighted digraphs.

	POs									
	1	2	3	4	5	6	7	8	9	10
CLO1	3	3	3	3	2	2	3	2	2	1
CLO2	3	3	3	3	2	2	3	3	2	1
CLO3	3	3	3	3	2	2	3	2	2	1
CLO4	3	3	3	3	2	2	3	2	2	1
CLO5	3	3	3	3	2	2	3	3	2	2

	PSOs					
	1	2	3	4	5	6
CLO1	2	3	2	1	3	1
CLO2	2	3	2	2	3	2
CLO3	2	3	2	2	3	2
CLO4	2	3	2	1	3	1
CLO5	3	3	2	2	3	2

Year: II

**DISCIPLINE CENTRIC ELECTIVE
COURSE 4**

Semester: IV

Code:

**3. MATHEMATICAL STATISTICS
(Theory)**

Credits: 4

OBJECTIVES:

To introduce the fundamental principles of statistical inference, estimation theory, hypothesis testing, sequential analysis, and analysis of variance. The course aims to develop analytical and statistical reasoning skills for interpreting data and solving real-world problems using mathematical statistics.

UNIT - I: THEORY OF ESTIMATION

Preliminary notions – consistent estimates – unbiased estimate – sufficient estimate – efficient estimate – asymptotically most efficient estimate – method of finding estimate.

UNIT - II: THEORY OF HYPOTHESIS TESTING

Definition of Hypothesis – power function and OC function – Most powerful tests – uniformly most powerful test – unbiased tests – power and consistency of non-parametric tests.

UNIT - III: SEQUENTIAL ANALYSIS

Introduction – sequential probability ratio test – theorems – fundamental identity – the OC and ASN function of SPRT – expected value $E(n)$ – determination of A and B – testing a hypothesis concerning the parameter p of a zero – one distribution and expected value m of a normal distribution.

UNIT - IV: SIGNIFICANCE TEST

The concept of statistical test – parametric test for small samples – parametric test for large samples – the chi-square test.

UNIT - V: ANALYSIS OF VARIANCE

Introduction of ANOVA – definition – assumptions – ANOVA for one-way classification – ANOVA for two – way classification – examples – multiple classification – modified regression problems.

TEXT BOOK(S):

1. **M. Fisz**, Probability Theory and Mathematical Statistics, John Wiley and sons, 3rd Edition, 1963.
Unit I - Chapter 13: Sections 13.1 – 13.8
Unit II - Chapter 16: Sections 16.1 – 16.6
Unit III - Chapter 17: 17.1 – 17.9
Unit IV - Chapter 12: Sections 12.1 – 12.5
Unit V - Chapter 14: Sections 14.1 – 14.5

REFERENCES:

1. T. Veerarajan , Fundamentals of Mathematical Statistics, Yesdee Publishing, 2017
2. P.R. Vittal, "Mathematical Statistics", Margham Publications , 2002.
3. T. Veerarajan, Probability, Statistics and Random Processes, Mc Graw Hill Education (India) Private Limited, Third Edition, 2015.
4. R.S.N. Pillai and V. Bagavathi, Statistics, S.Chand & CO, 2010.
5. Singaravelu.A, S. Sivasubramanian, Probability & Random Processes , Meenakshi Agency 2008,
6. DN Elhance, Veena Elhance and BM Aggarwal, Fundamentals of Statistics, Kitab Mahal.
7. S. C. Gupta and V. K. Kapoor, Fundamentals of Mathematical Statistics, Sultan Chand & Sons, Edition 2008.

COURSE LEARNING OUTCOME (for Mapping with POs and PSOs):

Students will be able to

CLO 1: Understand the concepts of estimation theory including unbiasedness, consistency, sufficiency, and efficiency of estimators.

CLO 2: Apply hypothesis testing procedures, power functions, uniformly most powerful tests, and non-parametric testing methods.

CLO 3: Analyze sequential probability ratio tests, OC and ASN functions, and apply sequential analysis techniques to statistical problems.

CLO 4: Perform statistical significance tests for small and large samples, including chi-square tests for practical data analysis.

CLO 5: Apply analysis of variance techniques for one-way and two-way classifications and analyze regression-related statistical problems.

	POs									
	1	2	3	4	5	6	7	8	9	10
CLO1	3	3	3	2	2	2	2	2	2	1
CLO2	3	3	3	3	2	2	3	2	2	1
CLO3	3	3	3	3	2	2	3	3	2	1
CLO4	3	3	3	3	2	2	3	2	2	1
CLO5	3	3	3	3	2	2	3	3	2	1

	PSOs					
	1	2	3	4	5	6
CLO1	3	3	2	2	3	2
CLO2	3	3	2	2	3	2
CLO3	3	3	2	2	3	2
CLO4	2	3	2	1	3	1
CLO5	3	3	3	2	3	2

Year: I

GENERIC ELECTIVE COURSE 1

Semester: I

Code:

**1. FOUNDATIONS OF
MATHEMATICS
(Theory)**

Credits: 3

COURSE OBJECTIVES:

To introduce the foundational concepts of mathematics including logic, set theory, functions, relations, induction principles, countability, and order relations. The course aims to develop rigorous mathematical reasoning, proof-writing skills, and abstract thinking necessary for advanced studies in mathematics.

UNIT - I

Statements and Logic: Statements - Statements with quantifiers - Compound statements - Implications - Proofs in Mathematics – Sets: Basic terminologies - Operations on sets - Family of sets - Power sets - Cartesian product of sets.

UNIT - II

Functions: Basic definitions - One-one, onto functions and bijections - Composition of functions - Inverse of a function - Image of subsets under functions - Inverse image of subsets under functions. Relation: Relations on sets - Types of relations - Equivalence relations - Equivalence classes and partitions of a set.

UNIT - III

Induction Principles - The Induction Principle - The Strong Induction Principle - The Well-ordering Principle - Equivalence of the three principles.

UNIT - IV

Countability of Sets: Sets with same cardinality - Finite sets - Countable sets - Comparing cardinality.

UNIT - V

Order Relations: Partial and Total Orders - Chains, bounds and maximal elements - Axiom of Choice and its Equivalents.

TEXT BOOK(S):

1. Ajit Kumar, S. Kumaresan, Bhaba Kumar Sarma, A Foundation Course in Mathematics, Alpha Science International Ltd., 2018.
Unit I - Chapter 1 & 2
Unit II - Chapter 3 & 4
Unit III - Chapter 5
Unit IV - Chapter 6
Unit V - Chapter 7

REFERENCE BOOK(S):

1. B.S.Grewal, Higher Engineering Mathematics, 42nd Edition, Khanna Publishers, 2012

2. Seymour Lipschutz, Marc Lipson. Discrete Mathematics, 3rd Edition, Schaum's outline, 2007.
3. Thomas Koshy, Elementary Number Theory with Applications, 2nd Edition, Academic Press, 2007.

COURSE LEARNING OUTCOME (for Mapping with POs and PSOs):

Students will be able to

CLO 1: Understand statements, logical operations, mathematical proofs, and fundamental concepts of set theory.

CLO 2: Analyze functions and relations including equivalence relations, partitions, and properties of mappings between sets.

CLO 3: Apply induction principles and well-ordering concepts in proving mathematical statements.

CLO 4: Study finite, countable, and uncountable sets and compare cardinalities of sets.

CLO 5: Understand partial and total order relations, chains, maximal elements, and the Axiom of Choice with its equivalents.

	POs									
	1	2	3	4	5	6	7	8	9	10
CLO1	3	3	3	1	2	2	2	1	2	1
CLO2	3	3	3	1	2	2	2	1	2	1
CLO3	3	3	3	2	2	2	3	1	2	1
CLO4	3	3	3	2	2	2	2	2	2	1
CLO5	3	3	3	2	2	2	2	2	2	1

	PSOs					
	1	2	3	4	5	6
CLO1	3	2	1	1	1	1
CLO2	3	3	1	1	1	1
CLO3	3	3	1	2	1	2
CLO4	3	2	1	2	1	2
CLO5	3	3	1	3	1	3

Year: I

GENERIC ELECTIVE COURSE 1

Semester: I

Code:

**2. AUTOMATA THEORY
(Theory)**

Credits: 3

OBJECTIVES:

To introduce the theoretical foundations of automata theory, formal languages, Boolean algebra, and computational models. The course aims to develop logical reasoning, formal problem-solving skills, and understanding of language recognition and computation models used in computer science and mathematics.

UNIT - I: Lattices and Boolean Algebra

Lattices as partially ordered sets – Boolean algebra – Boolean Functions – Representations and Minimization of Boolean Functions.

Chapter 4 (TB1): Sections 4.1.1 – 4.4.2

UNIT - II: Grammars and Languages

Discussion of Grammars – Formal Definition of a Language – Notation of Syntax Analysis. Chapter 3 (TB1): Sections 3.3.1 – 3.3.3

UNIT - III: Finite Automata, Regular Expressions and Languages

An Informal picture of Finite Automata – Deterministic Finite Automata – Nondeterministic Finite Automata – An Application: Text Search – Finite Automata with Epsilon Transitions – Regular Expressions – Finite Automata and Regular Expressions – Applications of Regular Expressions – Algebraic Laws for Regular Expressions. Chapters 2 and 3

UNIT - IV: Properties of Regular Languages

Proving languages not to be regular – Closure properties of Regular Languages – Decision properties of Regular Languages – Equivalence and Minimization of Automata.

Context-Free Grammars and Languages

Context-Free Grammars – Parse Trees – Applications of Context-Free Grammars – Ambiguity in Grammars and Languages. Chapters 4 and 5

UNIT - V: Pushdown Automata

Definition of the Pushdown Automaton – The languages of a PDA – Equivalence of PDA's and CFG's – Deterministic Pushdown Automata.

Properties of Context-Free Languages

Normal Forms for Context – Free Grammars – The Pumping Lemma for CFL's – Closure properties of CFL's – Decision properties of CFL's. Chapters 6 and 7

TEXT BOOK(S):

1. **J.P Tremblay** and **R.P. Manohar**, "Discrete mathematical Structures with Applications to Computer Science" McGraw Hill Publishing company, reprint 2016.

2. **John E. Hopcroft, Rajeev Motwani and Jeffrey D. Ullman**, “Introduction to Automata Theory, languages and Computation” Pearson Education, 2nd Edition, reprint 2005.

REFERENCES:

1. P. Linz, Introduction to formal Language & Automata, Jones & Bartlett Learning, Fifth Edition, 2012.
2. T. Santha and P. Radha, Discrete Mathematics for Computer Science and Applications, Kalaikathir Publications, 2003.
3. J. Truss, Discrete Mathematics for Computer Scientists, Pearson Education Ltd, 2nd Edition, 2001.
4. T. Veerarajan, Discrete Mathematics with Graph Theory and Combinatorics, Tata McGraw-Hill Publishing company Ltd, 2008.
5. M.K. Venkatraman, Dr. N. Sridharan and N. Chandrasekaran, Discrete Mathematics, First Edition Reprint, The National Publishing Company, Chennai, 2003.

COURSE LEARNING OUTCOME (for Mapping with POs and PSOs):

Students will be able to

CLO 1: Understand lattices, Boolean algebra, Boolean functions, and minimization techniques for Boolean expressions.

CLO 2: Analyze grammars, formal languages, and syntax analysis used in language theory.

CLO 3: Apply deterministic and nondeterministic finite automata, regular expressions, and regular languages in computational problems.

CLO 4: Study properties of regular and context-free languages, parse trees, ambiguity, and minimization of automata.

CLO 5: Analyze pushdown automata, equivalence between PDA and CFG, normal forms, pumping lemma, and closure properties of context-free languages.

	POs									
	1	2	3	4	5	6	7	8	9	10
CLO1	3	3	3	2	2	2	2	1	2	1
CLO2	3	3	3	2	2	2	2	2	2	1
CLO3	3	3	3	3	2	2	3	2	2	1
CLO4	3	3	3	3	2	2	3	2	2	1
CLO5	3	3	3	3	2	2	3	3	2	1

	PSOs					
	1	2	3	4	5	6
CLO1	3	2	2	1	2	1
CLO2	3	3	2	1	2	1
CLO3	3	3	3	2	3	2
CLO4	3	3	2	2	2	2
CLO5	3	3	3	3	3	2

Year: I

GENERIC ELECTIVE COURSE 1

Semester: I

Code:

**3. INTEGRAL TRANSFORMS
(Theory)**

Credits: 3

OBJECTIVES:

To introduce the theory and applications of Laplace and Fourier transforms in solving differential and partial differential equations. The course aims to develop analytical skills in transform methods, inversion techniques, asymptotic analysis, spectral methods, and mathematical modeling of physical phenomena such as heat conduction, potential problems, and wave propagation.

Unit - I

Laplace transforms- Important properties- Simple Applications- Asymptotic Properties- Watson's Lemma.

Unit - II

Inversion Integral- The Riemann- Lebesgue Lemma- Dirichlet Integrals- the Inversion- Watson's Lemma for loop integrals- Heaviside series expansion.

Unit - III

Application to ordinary differential equations- Elementary examples- Higher order equations- Partial differential equations- Heat diffusion integral equations.

Unit - IV

Fourier transforms- Exponential- Sine and Cosine transforms- Important properties- Spectral analysis.

Unit - V

Partial differential equations- Potential problems-Water waves- Basic equations Waves generated by a Surface displacement

TEXT BOOK(S):

1. B. Davies, Integral Transforms and Their Applications, Springer, Texts in Applied Mathematics, 41 Third Edition, 2009
Unit I: Chapter 2
Unit II: Chapter 3
Unit III: Chapter 4,5 and 6
Unit IV: Chapter 7
Unit V: Chapter 8

REFERENCES:

1. Ian N. Snedden, The Use of Integral Transforms, McGraw Hill, 1972.
2. Lokenath Debnath and D. Bhatta, Integral Transforms and Their Applications, 2nd edn., CRC, 2006

COURSE LEARNING OUTCOME (for Mapping with POs and PSOs):

Students will be able to

CLO 1: Understand Laplace transforms, their fundamental properties, asymptotic behavior, and applications to elementary mathematical problems.

CLO 2: Apply inversion techniques, Riemann–Lebesgue lemma, Dirichlet integrals, Watson’s lemma, and Heaviside expansion methods in transform analysis.

CLO 3: Solve ordinary and partial differential equations using Laplace transform techniques and integral equation methods.

CLO 4: Analyze Fourier transforms, sine and cosine transforms, spectral representations, and their mathematical properties.

CLO 5: Apply integral transform methods to model and solve physical problems involving heat conduction, potential theory, and water wave propagation.

	POs									
	1	2	3	4	5	6	7	8	9	10
CLO1	3	2	3	2	2	2	2	1	2	1
CLO2	3	3	3	2	2	2	3	2	2	1
CLO3	3	3	3	3	2	2	3	2	2	1
CLO4	3	3	3	3	2	2	3	2	2	1
CLO5	3	3	3	3	2	3	3	3	2	1

	PSOs					
	1	2	3	4	5	6
CLO1	3	2	1	2	2	1
CLO2	3	3	1	2	2	2
CLO3	3	3	2	2	3	2
CLO4	3	3	2	2	3	2
CLO5	3	3	2	3	3	2

Year: I

GENERIC ELECTIVE COURSE 2

Semester: II

Code:

**1. MECHANICS
(Theory)**

Credits: 3

OBJECTIVES:

To introduce the fundamental principles of classical mechanics using variational methods, Lagrangian and Hamiltonian formulations. The course aims to develop analytical and mathematical modeling skills for studying dynamical systems and advanced theoretical mechanics.

UNIT - I: Mechanical Systems

The Mechanical system – Generalized coordinates – Constraints – Virtual work – Energy and Momentum.

UNIT - II: Lagrange's Equations

Derivation of Lagrange's Equations – Examples – Integrals of the motion.

UNIT - III: Hamilton's Equations

Hamilton's Principle – Hamilton's Equations – other variational principles.

UNIT - IV: Hamilton – Jacobi Theory

Hamilton Principle Function – Hamilton-Jacobi Equation – Separability.

UNIT - V: Canonical Transformation

Differential forms and Generating Functions – Special Transformations – Lagrange and Poisson Brackets.

TEXT BOOK(S):

1. D.T. Greenwood, "Classical Dynamics", Prentice Hall of India, New Delhi, 1985.
Unit I - Chapter 1: Sections 1.1 - 1.4
Unit II - Chapter 2: Sections 2.1 - 2.3
Unit III- Chapter 4: Sections 4.1 - 4.3
Unit III- Chapter 5: Sections 5.1 - 5.3
Unit V - Chapter 6: Sections 6.1 - 6.3

REFERENCES:

1. H. Goldstein, "Classical Mechanics", 2nd Edition, Narosa Publishing House, New Delhi.
2. R.D. Gregory, "Classical Mechanics", Cambridge University Press, 2006
3. J.L. Synge and B.A. Griffith, "Principles of Mechanics", 3rd Edition, McGraw Hill Book Co., New York, 1970.

COURSE LEARNING OUTCOME (for Mapping with POs and PSOs):

Students will be able to

CLO 1: Understand mechanical systems, generalized coordinates, constraints, virtual work, energy, and momentum concepts.

CLO 2: Derive and apply Lagrange's equations for analyzing the motion of mechanical systems.

CLO 3: Apply Hamilton's principle, Hamilton's equations, and variational principles in classical mechanics.

CLO 4: Analyze Hamilton–Jacobi theory, Hamilton principal functions, and separability techniques for dynamical systems.

CLO 5: Study canonical transformations, generating functions, and Poisson and Lagrange brackets in advanced mechanics.

	POs									
	1	2	3	4	5	6	7	8	9	10
CLO1	3	2	3	3	2	2	2	1	2	1
CLO2	3	3	3	3	2	2	3	2	2	1
CLO3	3	3	3	3	2	2	3	2	2	1
CLO4	3	3	3	3	2	2	3	3	2	1
CLO5	3	3	3	3	2	2	3	3	2	1

	PSOs					
	1	2	3	4	5	6
CLO1	2	3	1	1	3	1
CLO2	3	3	1	2	3	2
CLO3	3	3	1	2	3	2
CLO4	3	3	1	2	3	2
CLO5	3	3	1	3	2	3

Year: I

GENERIC ELECTIVE COURSE 2

Semester: II

Code:

**2. NEURAL NETWORKS
(Theory)**

Credits: 3

OBJECTIVES:

To introduce the fundamental concepts of neural networks, learning algorithms, and optimization techniques used in artificial intelligence and computational modeling. The course aims to develop analytical, computational, and problem-solving skills in neural network architectures and machine learning methods.

UNIT - I: Evolution Of Neural Networks

Mathematical Neuron Model – Network Architectures – Perceptron –Hamming Network-Hopfield Network-Learning Rules.

UNIT - II: Perceptron Learning Rule

Perceptron Architectures and Learning Rule with Proof of Convergence. Supervised Hebbian Learning-Linear Associator.

UNIT - III: Multi-Layer Perceptrons

The Hebb Rule-Pseudo inverse Rule - Variations of Hebbian Learning - Back Propagation –Multilayer Perceptions.

UNIT - IV: Back Propagation

Back propagation Algorithm - Convergence and Generalization –Performances Surfaces and Optimum Points - Taylor series.

UNIT - V: Optimisation in Neural Network

Directional Derivatives - Minima-Necessary Conditions for Optimality – Quadratic Functions-Performance Optimizations – Steepest Descent - Newton's Method – Conjugate Gradient.

TEXT BOOK(S):

1. Martin T Hagan., Howard B Demuth., and Mark Beale., (2014). Neural Network Design, Vikas, Publishing House, New Delhi,
2. James A Freeman., and David M Skapura., (2011). Neural Networks Algorithms, Applications and Programming Techniques, Pearson Education.
3. Robert J Schalkoff., Artificial Neural Network, McGraw-Hill International Edition, 2000.

COURSE LEARNING OUTCOME (for Mapping with POs and PSOs):

Students will be able to

CLO 1: Understand neuron models, neural network architectures, perceptrons, Hopfield networks, Hamming networks, and learning rules.

CLO 2: Apply perceptron learning algorithms, supervised Hebbian learning, and linear associator models with convergence analysis.

CLO 3: Analyze multilayer perceptrons, Hebbian learning variations, pseudo-inverse methods, and backpropagation techniques.

CLO 4: Study backpropagation algorithms, convergence properties, generalization, performance surfaces, and Taylor series approximations.

CLO 5: Apply optimization techniques such as steepest descent, Newton's method, conjugate gradient methods, and optimality conditions in neural network training.

	POs									
	1	2	3	4	5	6	7	8	9	10
CLO1	3	2	3	2	2	2	2	1	2	1
CLO2	3	3	3	3	2	2	3	2	2	1
CLO3	3	3	3	3	2	2	3	2	2	1
CLO4	3	3	3	3	2	3	3	3	2	1
CLO5	3	3	3	3	2	3	3	3	3	2

	PSOs					
	1	2	3	4	5	6
CLO1	2	3	3	1	3	1
CLO2	2	3	3	2	3	2
CLO3	2	3	3	2	3	2
CLO4	2	3	3	2	3	2
CLO5	2	3	3	3	3	2

Year: I

GENERIC ELECTIVE COURSE 2

Semester: II

Code:

**3. DIFFERENCE EQUATIONS
(Theory)**

Credits: 3

OBJECTIVES:

To introduce the theory and applications of difference equations, generating functions, stability analysis, and asymptotic methods. The course aims to develop analytical and computational skills for modeling and solving discrete dynamical systems arising in mathematics, engineering, economics, and applied sciences.

UNIT - I: Difference Calculus

The Difference operator - Summation – Generating functions and approximate summation.

UNIT - II: Linear Difference Equations

First order equations - General results for linear equations - Solving linear equations.

UNIT - III: Linear Difference Equations

Equations with variable coefficients – The z -transform.

UNIT - IV: Stability Theory

Initial value problems for linear systems – Stability of linear systems.

UNIT - V: Asymptotic Methods

Introduction – Asymptotic analysis of sums – Linear equations.

TEXT BOOK(S):

1. **W.G. Kelley and A.C. Peterson**, “Difference Equations”, 2nd Edition, Academic Press, New York, 2001.
Unit I - Chapter 2: Sections 2.1 – 2.3
Unit II - Chapter 3: Sections 3.1 – 3.3
Unit III - Chapter 3: Sections 3.5, 3.7
Unit IV - Chapter 4: Sections 4.1, 4.2
Unit V - Chapter 5: Sections 5.1 – 5.3

REFERENCES:

1. R.P. Agarwal, “Difference Equations and Inequalities”, 2nd Edition, Marcel Dekker, New York, 2000.
2. S.N. Elaydi, “An Introduction to Difference Equations”, 3rd Edition, Springer, India, 2008.
3. R. E. Mickens, “Difference Equations”, 3rd Edition, CRC Press, 2015.

COURSE LEARNING OUTCOME (for Mapping with POs and PSOs):

Students will be able to

CLO 1: Understand the concepts of difference calculus, summation techniques, and generating functions in discrete analysis.

CLO 2: Analyze and solve first-order and general linear difference equations.

CLO 3: Apply methods for solving linear difference equations with variable coefficients and use the z-transform in discrete systems.

CLO 4: Study initial value problems and analyze the stability of linear discrete systems.

CLO 5: Apply asymptotic methods and asymptotic analysis techniques to linear difference equations and discrete models.

	POs									
	1	2	3	4	5	6	7	8	9	10
CLO1	3	2	3	1	2	2	2	1	2	1
CLO2	3	3	3	2	2	2	3	2	2	1
CLO3	3	3	3	2	2	2	3	2	2	1
CLO4	3	3	3	3	2	3	3	2	2	1
CLO5	3	3	3	3	2	3	3	3	2	1

	PSOs					
	1	2	3	4	5	6
CLO1	3	2	1	1	2	1
CLO2	3	3	1	2	3	2
CLO3	3	3	2	2	3	2
CLO4	3	3	1	2	3	2
CLO5	3	2	1	2	2	2

Code:

**1. OPTIMIZATION TECHNIQUES
(Theory)**

Credits: 3

OBJECTIVES:

To provide students with advanced optimization and decision-making techniques through linear programming, integer programming, decision analysis, replacement models, and simulation methods. The course aims to develop analytical and computational skills for solving complex managerial, industrial, and real-world problems under deterministic and uncertain environments.

Unit - I: Linear programming problems:

Duality in linear programming problems - Dual Simplex method- Revised simplex method-Procedures and problems

Unit - II: Integer programming problem:

Mathematical form of integer programming problem -Methods of integer programming problems -Cutting plane algorithm or Fractional algorithm - Gomary's Cutting plane method- Branch and bond method - problems.

UNIT - III: Decision Analysis:

Introduction - Decision-making problem - Decision-making environment - Decisions under uncertainty: the max-min or min-max criterion - the savage regret criterion the Hurwitz criterion.

Unit - IV: Replacement Problems:

Introduction - Replacement of equipment/asset that deteriorates gradually - Replacement of equipment that fails suddenly-Group replacement policy

Unit - V: Simulation Models:

Introduction- Classification of simulation models- Advantages of simulation- limitations of simulation technique- Monte carlo simulation- simulation problems related to queuing theory and inventory models.

TEXT BOOK(S):

1. **Kanti Swarup, P.K. Gupta, Manmohan Sulthan Chand & Sons,** Operations Research, 2016.
Unit I: Chapter V: Sections: 5.1, 5.3, 5.7, 5.9
Unit II: Chapter VII: Sections: 7.1, 7.2, 7.3, 7.4, 7.5, 7.7
Unit III: Chapter XVI: Sections: 16.1, 16.2, 16.4, 16.5
Unit IV: Chapter XVIII: Sections: 18.1, 18.2, 18.3
Unit V: Chapter XXII: Sections: 22.3, 22.4, 22.7, 22.8, 22.9

REFERENCES:

1. Gupta, P.K. and Hira, D.S. Operations Research. [Eighth Edition]. Sulthan Chand and Company, New Delhi .2020.
2. Kalavathy. S. Operations Research[Fourth Edition], Vikas Publishing House,Chennai.2012.

COURSE LEARNING OUTCOME (for Mapping with POs and PSOs):

Students will be able to

CLO 1: Apply duality theory, dual simplex method, and revised simplex method to solve advanced linear programming problems.

CLO 2: Formulate and solve integer programming problems using Gomory's cutting plane method, branch and bound method, and related optimization techniques.

CLO 3: Analyze decision-making problems under conditions of certainty, risk, and uncertainty using various decision criteria.

CLO 4: Apply replacement models to determine optimal replacement policies for deteriorating and suddenly failing equipment.

CLO 5: Develop and analyze simulation models using Monte Carlo techniques and apply them to queuing and inventory systems.

	POs									
	1	2	3	4	5	6	7	8	9	10
CLO1	3	3	3	2	2	2	3	2	2	1
CLO2	3	3	3	2	2	2	3	2	2	1
CLO3	2	3	3	2	2	2	3	2	2	2
CLO4	2	3	3	3	2	2	3	2	2	2
CLO5	3	3	3	3	2	3	3	3	2	2

	PSOs					
	1	2	3	4	5	6
CLO1	3	3	2	2	3	1
CLO2	3	3	2	2	3	2
CLO3	2	3	3	2	3	1
CLO4	2	3	2	2	3	1
CLO5	2	3	3	2	3	2

Year: II

GENERIC ELECTIVE COURSE 3

Semester: III

Code:

**2. FINANCIAL MATHEMATICS
(Theory)**

Credits: 3

OBJECTIVES:

To introduce the fundamental concepts of financial mathematics including arbitrage theory, option pricing models, martingales, Markov processes, and Brownian motion. The course aims to develop analytical and probabilistic modeling skills required for mathematical finance and financial risk analysis.

Unit - I: Single Period Models

Definitions from Finance – Pricing of a Forward – One – step Binary Model

Unit - II: Single Period Models (Contn..)

A characterization of no arbitrage – Risk – Neutral Probability Measure

UNIT - III: Binomial trees and discrete parameter Martingales

Multi period Binary Model – American options

Unit - IV: Binomial trees and Discrete parameter Martingales (Contn..)

parameter martingales and Markov processes – Martingale theorems

Unit - V: Brownian Motion

Definition of the process – Levy's construction of Brownian Motion

TEXT BOOK(S):

1. **Etheridge**, A Course in Financial Calculus, Cambridge University Press, 2002.
Unit I: Chapter 1: Sections 1.1 – 1.3
Unit II: Chapter 1: Sections 1.5, 1.6
Unit III: Chapter 2: Sections 2.1, 2.2
Unit IV: Chapter 2: Sections 2.3, 2.4
Unit V: Chapter 3: Sections 3.1, 3.2

REFERENCES:

1. M. Boxter and A. Rennie, Financial calculus: An Introduction to Derivatives Pricing, Cambridge University Press, 1996
2. D. Lamberton and B. Lapeyre, Introduction to Stochastic Calculus Applied to Finance, Chapman and Hall, 1996
3. M. Musiela and M. Rutkowski, Martingale Methods in Financial Modeling, Springer, New York, 1988
4. R.J. Elliott and P. Ekkehard Kopp, Mathematics of Financial Markets, Springer, New York, 2001 (3rd Printing)

COURSE LEARNING OUTCOME (for Mapping with POs and PSOs):

Students will be able to

CLO 1: Understand basic financial concepts, forward pricing, and one-step binary models in financial markets.

CLO 2: Analyze arbitrage opportunities and apply risk-neutral probability measures in financial modeling.

CLO 3: Apply multi-period binomial models and study the pricing of American options.

CLO 4: Analyze discrete parameter martingales, Markov processes, and fundamental martingale theorems in finance.

CLO 5: Understand Brownian motion, stochastic processes, and Levy's construction in continuous-time financial modeling.

	POs									
	1	2	3	4	5	6	7	8	9	10
CLO1	3	2	3	2	2	2	2	1	2	1
CLO2	3	3	3	3	2	2	3	2	2	1
CLO3	3	3	3	3	2	2	3	2	2	1
CLO4	3	3	3	3	2	2	3	3	2	1
CLO5	3	3	3	3	2	3	3	3	2	1

	PSOs					
	1	2	3	4	5	6
CLO1	2	3	2	1	3	1
CLO2	2	3	2	2	3	2
CLO3	2	3	2	2	3	2
CLO4	3	3	2	3	3	2
CLO5	3	3	2	3	3	3

Code:

**3. FLUID DYNAMICS
(Theory)**

Credits: 3

OBJECTIVES:

To introduce the fundamental principles of fluid dynamics including inviscid flow, viscous flow, vortex motion, two-dimensional flow, and boundary layer theory. The course aims to develop analytical and mathematical modeling skills for studying fluid motion and its applications in engineering, aerodynamics, and physical sciences.

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 Hydro dynamical 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 Quadratic and Principle Stresses - Some further properties of the rate of strain quadratic - 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 BOOKS:

1. **F. Chorlton**, "Text Book of Fluid Dynamics", CBS Publications, 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 III: 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.

REFERENCES:

1. **R.K. Bansal**, "An Introduction to Fluid Dynamics", Firewall Media, 2005.
2. **G.K. Batchelor**, "An Introduction to Fluid Dynamics", Cambridge University Press, 2000.
3. **L.M. Milne Thomson**, "Theoretical Hydrodynamics", Dover, 1996.
4. **D.E. Rutherford**, "Fluid Dynamics", Oliver and Boyd, 1959.

COURSE LEARNING OUTCOME (for Mapping with POs and PSOs):

Students will be able to

CLO 1: Understand the basic concepts of fluid motion including streamlines, continuity equations, Bernoulli's theorem, and equations of motion for inviscid fluids.

CLO 2: Analyze Euler's momentum theorem, circulation, vortex motion, and conservation principles in ideal fluid flow.

CLO 3: Apply two-dimensional flow theory, complex potential methods, singularities, and aerofoil theory in fluid dynamics problems.

CLO 4: Study viscous fluid motion using Navier-Stokes equations, vorticity concepts, and flow through plates and pipes.

CLO 5: Analyze boundary layer theory, Blasius solutions, momentum integral methods, and boundary layer characteristics in fluid flow.

	POs									
	1	2	3	4	5	6	7	8	9	10
CLO1	3	2	3	3	2	2	2	1	2	1
CLO2	3	3	3	3	2	2	3	2	2	1
CLO3	3	3	3	3	2	2	3	2	2	1
CLO4	3	3	3	3	2	2	3	3	2	1
CLO5	3	3	3	3	2	3	3	3	2	1

	PSOs					
	1	2	3	4	5	6
CLO1	2	3	1	1	3	1
CLO2	2	3	1	2	3	2
CLO3	2	3	2	2	3	2
CLO4	2	3	1	2	3	2
CLO5	2	3	1	2	3	2