JP COLLEGE OF ARTS & SCIENCE

(AUTONOMOUS)

(Run by DMI Sisters)

(Affiliated to Manonmaniam Sundaranar University – Tirunelveli)

Accredited by NAAC with "B++" Grade

2(f) status of UGC Act, 1956 | ISO 9001:2015 Certified Institution

Ayikudy, Tenkasi District - 627852.

SYLLABUS

Master of Mathematics

Choice Based Credit System (CBCS)
(w.e.f. June 2026-2027)

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SYLLABUS

PROGRAMME OUTCOMES (PO) FOR PG PROGRAMME

The successful completion of the M.Sc Maths programme shall enable the students to:

PO1	**Problem Solving Skill:** Apply knowledge of Management theories and Human Resource practices to solve business problems through research in Global context.
PO2	**Decision Making Skill:** Foster analytical and critical thinking abilities for data-based decision-making.
PO3	**Ethical Value:** Ability to incorporate quality, ethical and legal value-based perspectives to all organizational activities.
PO4	**Communication Skill:** Ability to develop communication, managerial and interpersonal skills.
PO5	**Individual and Team Leadership Skill:** Capability to lead themselves and the team to achieve organizational goals.
PO6	**Employability Skill:** Inculcate contemporary business practices to enhance employability skills in the competitive environment.
PO7	**Entrepreneurial Skill:** Equip with skills and competencies to become an entrepreneur.
PO8	**Contribution to Society:** Succeed in career endeavours and contribute significantly to society.
PO9	**Multicultural competence:** Possess knowledge of the values and beliefs of multiple cultures and a global perspective.
PO10	**Moral and ethical awareness/reasoning:** Ability to embrace moral/ethical values in conducting one's life.

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Regulations 2026–2027 for Undergraduate Programme

Learning Outcomes Based Curriculum Framework–(LOCF) model with Choice Based Credit System (CBCS)

Programme: Master of Science in Mathematics (M. Sc)
Programme code: M. Sc

(Applicable for the Students admitted during the Academic Year 2026-27 onwards)

Mathematics

Mathematics is the foundation of scientific inquiry, technological advancement, and analytical reasoning. The M.Sc. Mathematics programme is designed to impart advanced knowledge in Pure and Applied Mathematics while nurturing research aptitude, logical thinking, and problem-solving skills among students.

In alignment with the principles of Outcome Based Education (OBE), this autonomous curriculum has been structured to ensure academic rigor, industry relevance, and research orientation. The programme integrates theoretical depth with computational and application-oriented components, enabling students to address complex mathematical and interdisciplinary problems effectively.

The curriculum is carefully designed to:

- Strengthen core areas such as Algebra, Analysis, Differential Equations, Topology, and Functional Analysis.
- Provide exposure to emerging domains like Artificial Intelligence, Machine Learning, Computational Mathematics, Cryptography, and Industry-aligned modules.
- Encourage research through project work, internships, and industry interaction.
- Develop communication skills, ethical values, leadership qualities, and professional competencies.
- Promote the use of modern mathematical software tools such as LaTeX, Python, R, Matlab, scilab and C++.

The programme emphasizes continuous assessment, skill enhancement, and experiential learning through internships and project work. Bloom's Taxonomy framework is adopted to measure cognitive development from foundational knowledge to higher-order analytical and creative skills.

This curriculum aims to prepare graduates for higher research (Ph.D.), competitive examinations (NET, SET, GATE, etc.), academic careers, data science and analytics industries, financial sectors, and various interdisciplinary professional fields.

The autonomous structure provides flexibility for periodic revision, incorporation of contemporary topics, and strengthening of institution–industry interaction to meet evolving academic and societal needs.

Vision

- To provide exceptional mathematics education that fosters analytical thinking, encourages innovation, and supports impactful research, preparing students for success in both academic and practical fields.

Mission

- To offer a strong mathematics program that aligns with the goals of providing quality education at both undergraduate and masters levels
- To meet the diverse needs of students by teaching them practical mathematical skills for various fields.
- To deliver quality mathematics education that helps students develop strong skills in math and its applications.

Program Outcomes (POs)

The successful completion of the M.Sc Mathematics programme shall enable the students to:

PO1	**Problem Solving Skill:** Apply knowledge of Management theories and Human Resource practices to solve business problems through research in Global context.
PO2	**Decision Making Skill:** Foster analytical and critical thinking abilities for data-based decision-making.
PO3	**Ethical Value:** Ability to incorporate quality, ethical and legal value-based perspectives to all organizational activities.
PO4	**Communication Skill:** Ability to develop communication, managerial and interpersonal skills.
PO5	**Individual and Team Leadership Skill:** Capability to lead themselves and the team to achieve organizational goals.
PO6	**Employability Skill:** Inculcate contemporary business practices to enhance employability skills in the competitive environment.
PO7	**Entrepreneurial Skill:** Equip with skills and competencies to become an entrepreneur.
PO8	**Contribution to Society:** Succeed in career endeavours and contribute significantly to society.
PO9	**Multicultural competence:** Possess knowledge of the values and beliefs of multiple cultures and a global perspective.
PO10	**Moral and ethical awareness/reasoning:** Ability to embrace moral/ethical values in conducting one's life.

Program Specific Outcomes (PSOs)

Upon completion of the M.Sc. Mathematics programme, students will be able to:

PSO1	Placement**:** To prepare the students who will demonstrate respectful engagement with others' ideas, behaviours and beliefs. Also apply diverse frames of reference to decisions and actions.
PSO2	Entrepreneur**:** To create effective entrepreneurs by enhancing their critical thinking, problem solving, decision making and leadership skills that will facilitate start ups and high potential organizations
PSO3	Research and Development**:** Design and implement HR systems and practices grounded in research that complies with employment laws, leading the organization towards growth and development.
PSO4	Contribution to Business World**:** To produce employability, ethical and innovative professionals to sustain in the dynamic business world.
PSO5	Contribution to the Society**:** To contribute to the development of the society by collaborating with stakeholders for mutual benefits.

Choice Based Credit System (CBCS), Learning Outcomes Based Curriculum Framework (LOCF) Guideline Based Credit and Hours Distribution System for all PG courses including Lab Hours

First Year – Semester-I

Part	List of Courses	Credit	No. of Hours
Part-A	Core Courses	14	18
	Electives -I	6	12
		20	**30**

Semester-II

Part	List of Courses	Credit	No. of Hours
Part-A	Core Courses	14	18
	Electives- I & II	6	10
Part-B	**Skill Enhancement Course - I**	2	2
		22	**30**

Second Year – Semester-III

Part	List of Courses	Credit	No. of Hours
Part-A	Core Courses	18	23
	Electives-III & IV	4	4
Part-B	**Skill Enhancement Course - II**	2	3
	Internship / Industrial Activity /Field visit/ Research Knowledge updation Activity / Literacy	2	-
		26	**30**

Semester-IV

Part	List of Courses	Credit	No. of Hours
Part-A	Core Courses	10	12
	Project with Viva Voce	6	10
	Electives-V	3	5
Part-B	**Skill Enhancement Course - III**	2	3
Part-C	**Extension Activity /Pollution Awareness/Literacy / Voluntary Services**	1	-
		22	**30**

Total Credits: 90

Consolidated Semester wise and Component wise Credit distribution

Credits	**Sem I**	**Sem II**	**Sem III**	**Sem IV**	**Total**
Core	14	14	18	9	55
Elective	6	6	4	4	20
Project				6	6
Skill Enhancement Course		2	2	2	6
Internship / Industrial training			2		2
Extension activity				1	1
Total	**20**	**22**	**26**	**22**	**90**

* Part - A component Core Courses (CC) and Part - B (i) will be taken into account for CGPA calculation for the Postgraduate programme and the other components Part - B and Part - C have to be completed during the duration of the programme as per the norms, to be eligible for obtaining the PG degree

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Part A – Core Papers, Electives and Project
Part B – Skill Enhancement Courses and Internship
Part C – Extension Activity

Curriculum

Semester–1									
Course Code	**Part**	**Course Category**	**Course Name**	**Hours/ Week**	**Examination**				**Credits**
					Duration in Hours.	**Max Marks**			
						CIA	**ESE**	**Total**	
26PCMA11	A	Core- I	**Group Theory**	6	3	50	50	100	5
26PCMA12	A	Core -II	**Real Analysis – I**	6	3	50	50	100	5
	A	Core -III	**Ordinary Differential Equations**	6	3	50	50	100	4
26PEMA11	A	EC - I	Graph Theory and Applications	6	3	50	50	100	3
26PEMA12			Formal Languages and Automata Theory						
26PEMA13			Mathematical Statistics						
26PEMA14	A	EC - II	Number Theory and Cryptography	6	3	50	50	100	3
26PEMA15			Analytic Number Theory						
26PEMA16			Fuzzy Sets and Their Applications						
Total				**30**				**500**	**20**

Semester–2									
Course Code	**Part**	**Course Category**	**Course Name**	**Hours/ Week**	**Examination**				**Credits**
					Duration in Hours	**Max Marks**			
						CIA	**ESE**	**Total**	
26PCMA21	A	Core-IV	Ring Theory and Lattices	6	3	50	50	100	5
26PCMA22		Core - V	Real Analysis - II	6	3	50	50	100	5
26PCMA23		Core - VI	Probability Theory	5	3	50	50	100	4
26PEMA21	A	EC - III	Research Methodology	5	3	50	50	100	3
26PEMA22			Algebraic Number Theory						
26PEMA23			Partial Differential Equations						
26PEMA24	A	EC - IV	Wavelets	5	3	50	50	100	3
26PEMA25			Operations Research						
26PEMA26			Neural Networks						
26PSMA21	B	SEC- I	Mathematical Documentation using LaTex.	3	3	50	50	100	**2**
			Total	**30**				**600**	**22**

Semester–3									
Course Code	**Part**	**Course Category**	**Course Name**	**Hours/ Week**	**Examination**				**Credits**
					Duration in Hours	**Max Marks**			
						CIA	**ESE**	**Total**	
26PCMA31	A	Core– VII	Advanced Algebra - I	6	3	50	50	100	5
26PCMA32	A	Core –VIII	Complex Analysis	6	3	50	50	100	5
26PCMA33	A	Core –IX	Topology	5	3	50	50	100	5
26PCMA34	A	Core –X (**Core Industry Module)**	Calculus of Variations and Integral Equations	5	3	50	50	100	4
26PEMA31	A	EC - V	Mechanics	5	3	50	50	100	3
26PEMA32			Mathematical Python Theory						
26PEMA33			Stochastic Process						
26PSMA31	B	SEC - II	Mathematical Foundations of Artificial Intelligence	3	3	50	50	100	2
26PSMA32			R – Programming						
26PSMA33			Programming in C++						
26PFIK31	C	**Internship**	**Internship / Industrial Activity / Field Visit**(Minimum 20 hours – Internship Report Submission)	**External Valuation required**	2	50	50	100	2
Total				**30**				**700**	**26**

Semester–4									
Course Code	**Part**	**Course category**	**Course Name**	**Hours/ Week**	**Examination**				**Credits**
					Duration in Hours	**Max Marks**			
						CIA	**ESE**	**Total**	
26PCMA41	A	Core– IX	Advanced Algebra -II	6	3	50	50	100	5
26PCMA42	A	Core –X	Functional Analysis	6	3	50	50	100	5
26PPMA41	A	Project	Project with Viva Voce	10	3	50	50	100	6
26PEMA41	A	EC - VI	Differential Geometry	5	3	50	50	100	3
26PEMAP1			Mathematical Python – Practical						
26PEMA42			Algebraic Topology						
26PSMA41	B	SEC – III	Introduction to Machine Learning and Applications	3	3	50	50	100	2
26PSMA42			Financial Mathematics						
26PSMAP1			Programming in C++ – Practical						
26P3EA41	C	**Extension Activity**	**Extension Activity /Pollution Awareness/Literacy / Voluntary Services** Report to be submitted to the Department	**External Valuation required**	3	50	50	100	1
			Total	**30**				**600**	**22**

Internship (minimum of 30 hours): The students should submit certificate of attendance from the industry stating the nature of work done, duration and role played along with report (minimum of 20 pages) at the end of III semester for external evaluation.

Industrial Visit/ Field Visit : A report based on the observation and learning outcome to be submitted (minimum of 10 pages) along with suitable evidences at the end of III semester for external evaluation.

Knowledge Updation Activity :A report to be submitted (minimum of 10 pages) based on the study made along with the completion certificate stating the work done (MOOC/NPTEL) at the end of V semester for external evaluation.

Internship/Industrial Visit/Field Visit/Knowledge Updation Activity: Internal –50 Marks, External – 50 Marks

Project : Group Project report should be submitted for external evaluation. Internal – 50 Marks, External – 50 Marks

Extension Activity (NSS/ NCC/ YRC/ RRC/ Games and Sports/ Youth Welfare Activities Outreach Programmes/Migration Awareness in the Tamil Nadu Education System): Individual report should be submitted at the end of VI semester for external evaluation.
Internal – 50 Marks, External – 50 Marks

Ability Enhancement Compulsory Course: Empowered Vocational English and Design Thinking subjects is given to students.

Internal Marks – 50 Marks, External – 50 Marks

Semester-1

Semester–1									
Course Code	**Part**	**Course Category**	**Course Name**	**Hours/ Week**	**Examination**				**Credits**
					Duration in Hours.	**Max Marks**			
						CIA	**ESE**	**Total**	
26PCMA11	A	Core- I	**Group Theory**	6	3	50	50	100	5
26PCMA12	A	Core -II	**Real Analysis – I**	6	3	50	50	100	5
26PCMA13	A	Core -III	**Ordinary Differential Equations**	6	3	50	50	100	4
26PEMA11	A	EC - I	Graph Theory and Applications	6	3	50	50	100	3
26PEMA12			Formal Languages and Automata Theory						
26PEMA13			Mathematical Statistics						
26PEMA14	A	EC - II	Number Theory and Cryptography	6	3	50	50	100	3
26PEMA15			Analytic Number Theory						
26PEMA16			Fuzzy Sets and Their Applications						
Total				**30**				**500**	**20**

FIRST YEAR – SEMESTER – I

CORE – I: GROUP THEORY

Subject Code	L	T	P	S	Credits	Inst. Hours	Marks		
							CIA	External	Total
26PCMA11	**6**	**0**	0	I	**5**	**6**	**50**	**50**	**100**

Learning Objectives	
LO1	To introduce advanced structural theory of groups.
LO2	To understand homomorphisms, automorphisms and quotient structures.
LO3	To study Sylow theory and solvable groups.
LO4	To classify finite abelian groups.
LO5	To develop rigorous proof techniques in abstract algebra.

Prerequisites:

Unit	Contents	No. of Hours
I	**Groups:** A Counting Principle – Normal Subgroups – Quotient Groups – Homomorphisms (Sections 2.5 – 2.7)	**18**
II	**Automorphisms:** Automorphisms – Inner and Outer Automorphisms – Cayley's Theorem – Solvable Groups (Sections 2.8, 2.9)	**18**
III	**Permutation Groups:** Permutation Groups – Another Counting Principle – Applications to Symmetric Groups (Sections 2.10, 2.11)	**18**
IV	**Sylow's Theorems:** Sylow's Theorems and Applications (Section 2.12)	**18**
V	**Direct Products:** Internal and External Direct Products – Structure Theorem for Finite Abelian Groups (Sections 2.13, 2.14)	**18**
TOTAL		**90**

CO	**Course Outcomes**
CO1	Analyze subgroup structures and apply fundamental isomorphism theorems.
CO2	Examine automorphism groups and classify solvable groups.
CO3	Investigate permutation groups and alternating groups structurally.
CO4	Apply Sylow theorems to determine the structure of finite groups.
CO5	Classify finite abelian groups using invariant factor and primary decomposition methods.

Textbooks

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

Reference Books

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

CO/PO/PSO	POs						PSOs		
	1	2	3	4	5	6	1	2	3
CO1	3	1	3	2	3	3	3	2	1
CO2	2	1	3	1	3	3	3	2	1
CO3	3	2	3	1	3	3	3	2	1
CO4	1	2	3	2	3	3	3	2	1
CO5	3	1	2	3	3	3	3	2	1
Weightage of course contributed to each PSO	12	7	14	9	15	15	15	10	5

CORE – II: REAL ANALYSIS

Subject Code	L	T	P	S	Credits	Inst. Hours	Marks		
							CIA	External	Total
26PCMA12	6	0	0	I	5	6	50	50	100

Learning Objectives

LO1	Understand functions of bounded variation and learn their basic properties and representations.
LO2	Study the Riemann–Stieltjes integral and apply its properties such as integration by parts and change of variables.
LO3	Learn the conditions for existence of integrals and apply important theorems related to them.
LO4	Understand infinite series, double series, and infinite products along with their convergence properties.
LO5	Analyze sequences of functions and learn concepts of pointwise and uniform convergence and their applications.

Prerequisites:

Unit	Contents	No. of Hours
I	**Functions of bounded variation:** Introduction – Properties of monotonic functions – Total variation – Additivity of total variation – Representation as difference of increasing functions – Continuous functions of bounded variation – Curves and paths – Rectifiable paths and arc length – Additive and continuity properties of arc length – Equivalence of paths – Change of parameter. *(Chapter 6: Sections 6.1–6.12)*	**18**
II	**Riemann–Stieltjes Integral** – Definition and notation – Linear properties – Integration by parts – Change of variables – Monotonically increasing integrators – Upper and lower integrals – Riemann's condition – Comparison theorems. *(Chapter 7: Sections 7.1–7.6, 7.11–7.14)*	**18**
III	**Riemann–Stieltjes Integral:** Integrators of bounded variation – Sufficient and necessary conditions for existence – Mean value theorems – Integrals as functions of the interval – Second fundamental theorem of calculus – Interchange of order of integration – Complex-valued Riemann–Stieltjes integrals. *(Chapter 7: Sections 7.15–7.20)*	**18**
IV	**Infinite series and infinite products:** Double sequences – Double series – Rearrangement theorem – Equality of iterated series – Multiplication of series – Cesàro summability – Infinite products – Euler's product formula for the Riemann zeta function. *(Chapter 8: Sections 8.20–8.27)*	**18**
V	**Sequences of functions:** Pointwise and uniform convergence – Cauchy condition – Uniform convergence of series of functions – Term-by-term integration – Uniform convergence and differentiation – Sufficient conditions for uniform convergence – Mean convergence. *(Chapter 9: Sections 9.1–9.6, 9.9–9.11)*	**18**
Total		**90**

CO	Course Outcomes
CO1	Analyze and evaluate functions of bounded variation and rectifiable curves.
CO2	Explain the concept and properties of the Riemann–Stieltjes integral.
CO3	Apply convergence tests to infinite series and products.
CO4	Construct rigorous proofs involving uniform convergence and limiting operations.
CO5	Examine the interplay between differentiation, integration, and convergence of function sequences.
Textbooks	
➢	Tom M. Apostol, *Mathematical Analysis*, 2nd Edition, Addison-Wesley Publishing Company, New York, 1974.
Reference Books	
1	R.G. Bartle, *Real Analysis*, John Wiley & Sons, 1976.
2	W. Rudin, *Principles of Mathematical Analysis*, 3rd Edition, McGraw Hill, 1976.
3	S.C. Malik and Savita Arora, *Mathematical Analysis*, Wiley Eastern Limited, 1991.
4	Sanjay Arora and Bansi Lal, *Introduction to Real Analysis*, Satya Prakashan, 1991.
5	B.R. Gelbaum and J. Olmsted, *Counter Examples in Analysis*, Holden-Day, 1964

CO/PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	**3**	**1**	**3**	**2**	**3**	**3**	**3**	**2**	**1**
CO2	**2**	**1**	**3**	**1**	**3**	**3**	**3**	**2**	**1**
CO3	**3**	**2**	**3**	**1**	**3**	**3**	**3**	**2**	**1**
CO4	**1**	**2**	**3**	**2**	**3**	**3**	**3**	**2**	**1**
CO5	**3**	**1**	**2**	**3**	**3**	**3**	**3**	**2**	**1**
Weightage of course contributed to each PSO	**12**	**7**	**14**	**9**	**15**	**15**	**15**	**10**	**5**

CORE – III: ORDINARY DIFFERENTIAL EQUATIONS

Subject Code	L	T	P	S	Credits	Inst. Hours	Marks		
							CIA	External	Total
26PCMA13	**6**	**0**	0	I	**5**	**6**	**50**	**50**	**100**

Learning Objectives	
LO1	To develop a strong foundation in the theory of linear ordinary differential equations.
LO2	To understand methods for solving higher order differential equations with constant and variable coefficients.
LO3	To study existence and uniqueness theorems for first order differential equations.
LO4	To analyze differential equations with regular singular points and special functions such as Legendre and Bessel functions.
LO5	To introduce series solutions and approximation methods for differential equations.

Prerequisites:

Unit	Contents	No. of Hours
I	**Linear equations with constant coefficients** : Second order homogeneous equations – Initial value problems – Linear dependence and independence – Wronskian and formula for Wronskian – Non-homogeneous equations of order two. *(Chapter 2: Sections 1–6)*	**18**
II	**Linear equations with constant coefficients** : Homogeneous and non-homogeneous equations of order *n* – Initial value problems – Annihilator method – Algebra of constant coefficient operators – Cauchy–Euler method – Introduction to systems of linear differential equations. *(Chapter 2: Sections 7–12)*	**18**
III	**Linear equations with variable coefficients** : Initial value problems – Existence and uniqueness theorems – Reduction of order – Homogeneous equations with analytic coefficients – Legendre equation. *(Chapter 3: Sections 1–8)*	**18**
IV	**Linear equations with regular singular points** : Euler equation – Second order equations with regular singular points – Bessel functions and their properties. *(Chapter 4: Sections 1–4, 7–8)*	**18**
V	**Existence and uniqueness of solutions of first order equations** : Variable separation – Exact equations – Method of successive approximations – Lipschitz condition – Convergence of successive approximations – Existence theorem – Picard's theorem (Proof). *(Chapter 5: Sections 1–6)*	**18**
	TOTAL	**90**

CO	Course Outcomes
CO1	Solve higher order linear ordinary differential equations using appropriate analytical techniques.
CO2	Apply annihilator method, reduction of order, and power series methods to obtain general solutions.
CO3	Analyze equations with regular singular points and derive special function solutions such as Legendre and Bessel functions.
CO4	Demonstrate the existence and uniqueness of solutions using Lipschitz condition and Picard's

	theorem.
CO5	Model physical and real-world problems using ordinary differential equations and analyze their qualitative behavior.
Textbooks	
➢	E.A. Coddington, *An Introduction to Ordinary Differential Equations*, Prentice-Hall of India, 1987.
Reference Books	
1	W.E. Boyce and R.C. DiPrima, *Elementary Differential Equations and Boundary Value Problems*, John Wiley & Sons, 1967.
2	G.F. Simmons, *Differential Equations with Applications and Historical Notes*, Tata McGraw Hill, 1974.
3	N.N. Lebedev, *Special Functions and Their Applications*, Prentice Hall of India, 1965
4	W.T. Reid, *Ordinary Differential Equations*, John Wiley & Sons, 1971
5	M.D. Raisinghania, *Advanced Differential Equations*, S. Chand & Co., 2001
6	B. Rai, D.P. Choudary and H.I. Freedman, *A Course in Ordinary Differential Equations*, Narosa Publishing House, 2002.

CO/PO/PSO	Pos						PSOs		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PSO1**	**PSO2**	**PSO3**
CO1	**3**	**1**	**3**	**2**	**3**	**3**	**3**	**2**	**1**
CO2	**2**	**1**	**3**	**1**	**3**	**3**	**3**	**2**	**1**
CO3	**3**	**2**	**3**	**1**	**3**	**3**	**3**	**2**	**1**
CO4	**1**	**2**	**3**	**2**	**3**	**3**	**3**	**2**	**1**
CO5	**3**	**1**	**2**	**3**	**3**	**3**	**3**	**2**	**1**
Weightage of course contributed to each PSO	**12**	**7**	**14**	**9**	**15**	**15**	**15**	**10**	**5**

DISCIPLINE CENTRIC ELECTIVE – I
GRAPH THEORY AND APPLICATIONS

Subject Code	L	T	P	S	Credits	Inst. Hours	Marks		
							CIA	External	Total
26PEMA11	**6**	**0**	0	I	**3**	**6**	**50**	**50**	**100**

Learning Objectives	
LO1	Understand the basic concepts of graphs such as vertices, edges, paths, and subgraphs.
LO2	Learn how to analyze connectivity using vertex cuts, edge cuts, and related ideas.
LO3	Study trees and their properties, including spanning trees and their applications.
LO4	Understand independent sets, coverings, and matchings in different types of graphs.
LO5	Apply graph theory concepts to solve practical problems in networks and related areas.

Prerequisites:

Unit	Contents	No. of Hours
I	**Basic results**: Subgraphs – Degrees of vertices – Paths and connectedness – Automorphisms of simple graphs – Line graphs – Operations on graphs – Graph products. *(Chapter 1: Sections 1.1–1.9)*	**18**
II	**Connectivity:** Vertex cuts and edge cuts – Connectivity and edge connectivity – Blocks – Menger's Theorem (Statement and Applications). *(Chapter 3: Sections 3.1–3.4)*	**18**
III	**Trees:** Definition, characterization and properties – Centres and centroids – Counting spanning trees – Cayley's formula – Applications of spanning trees in network design. *(Chapter 4: Sections 4.1–4.5)*	**18**
IV	**Independent sets and matchings:** Vertex independent sets – Vertex coverings – Edge independent sets – Matchings and factors – Matching in bipartite graphs – Perfect matching – Tutte matrix. *(Chapter 5: Sections 5.1–5.6)*	**18**
V	**Eulerian and Hamiltonian graphs** : Hamilton's "Around the World" Game – Graph coloring – Vertex coloring – Applications of graph coloring – Critical graphs – Brooks' Theorem. *(Chapter 6: Sections 6.1–6.3; Chapter 7: Sections 7.1–7.3 up to Brooks' theorem)*	**18**
TOTAL		**90**

CO	Course Outcomes
CO1	Apply fundamental concepts of graphs including connectivity, paths, and graph operations.
CO2	Analyze trees, spanning trees, and network optimization problems.

CO3	Examine matchings, independent sets, and bipartite graph structures.
CO4	Differentiate Eulerian and Hamiltonian graphs and apply graph coloring techniques.
CO5	Formulate and solve real-world problems using graph-theoretic models.
Textbooks	
➢	R. Balakrishnan and K. Ranganathan, *A Textbook of Graph Theory*, Springer, 2012.
Reference Books	
1.	H.J.A. Bondy and U.S.R. Murty, *Graph Theory with Applications*, North Holland, 2008.
2.	D.B. West, *Introduction to Graph Theory*, Pearson Education, 2011.
3.	Robin J. Wilson, *Graph Theory*, Pearson Education Asia, 2002.
4.	P.J. Cameron and J.H. Van Lint, *Graph Theory, Coding Theory and Block Designs*, Cambridge University Press, 2013.
5.	Kenneth H. Rosen, *Discrete Mathematics and Its Applications*, McGraw Hill, 2007.

CO/PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	2	3	3	2	2	3	2	2
CO2	2	3	3	2	3	2	3	3	2
CO3	2	3	3	2	2	3	3	2	2
CO4	2	3	3	2	3	3	3	3	3
CO5	3	3	2	2	2	2	3	3	2
Weightage of course contributed to each PSO	**12**	**14**	**14**	**11**	**12**	**12**	**15**	**13**	**11**

DISCIPLINE CENTRIC ELECTIVE – I
FORMAL LANGUAGES AND AUTOMATA THEORY

Subject Code	L	T	P	S	Credits	Inst. Hours	Marks		
							CIA	External	Total
26PEMA12	**6**	**0**	0	I	**3**	**6**	**50**	**50**	**100**

Learning Objectives	
LO1	Understand the basic concepts of graphs such as subgraphs, degrees, paths, connectedness, and graph operations.
LO2	Learn how to analyze connectivity using vertex cuts, edge cuts, and important results like Menger's Theorem.
LO3	Study trees, their properties, and applications including spanning trees and Cayley's formula.
LO4	Understand independent sets, vertex coverings, and matching concepts in graphs including bipartite and perfect matchings.
LO5	Learn Eulerian and Hamiltonian graphs and apply graph coloring techniques and related theorems.

Prerequisites:

Unit	Contents	No. of Hours
I	**Basic results**: Subgraphs – Degrees of vertices – Paths and connectedness – Automorphisms of simple graphs – Line graphs – Operations on graphs – Graph products. *(Chapter 1: Sections 1.1–1.9)*	**18**
II	**Connectivity:** Vertex cuts and edge cuts – Connectivity and edge connectivity – Blocks – Menger's Theorem (Statement and Applications). *(Chapter 3: Sections 3.1–3.4)*	**18**
III	**Trees:** Definition, characterization and properties – Centres and centroids – Counting spanning trees – Cayley's formula – Applications of spanning trees in network design. *(Chapter 4: Sections 4.1–4.5)*	**18**
IV	**Independent sets and matchings:** Vertex independent sets – Vertex coverings – Edge independent sets – Matchings and factors – Matching in bipartite graphs – Perfect matching – Tutte matrix. *(Chapter 5: Sections 5.1–5.6)*	**18**
V	**Eulerian and Hamiltonian graphs** : Hamilton's "Around the World" Game – Graph coloring – Vertex coloring – Applications of graph coloring – Critical graphs – Brooks' Theorem. *(Chapter 6: Sections 6.1–6.3; Chapter 7: Sections 7.1–7.3 up to Brooks' theorem)*	**18**
TOTAL		**90**

CO	Course Outcomes
CO1	Apply fundamental concepts of graphs including connectivity, paths, and graph operations.
CO2	Analyze trees, spanning trees, and network optimization problems.
CO3	Examine matchings, independent sets, and bipartite graph structures.
CO4	Differentiate Eulerian and Hamiltonian graphs and apply graph coloring techniques.

CO5	Formulate and solve real-world problems using graph-theoretic models.
Textbooks	
➢	R. Balakrishnan and K. Ranganathan, *A Textbook of Graph Theory*, Springer, 2012.
Reference Books	
6.	H.J.A. Bondy and U.S.R. Murty, *Graph Theory with Applications*, North Holland, 2008.
7.	D.B. West, *Introduction to Graph Theory*, Pearson Education, 2011.
8.	Robin J. Wilson, *Graph Theory*, Pearson Education Asia, 2002.
9.	P.J. Cameron and J.H. Van Lint, *Graph Theory, Coding Theory and Block Designs*, Cambridge University Press, 2013.
10.	Kenneth H. Rosen, *Discrete Mathematics and Its Applications*, McGraw Hill, 2007.

CO/PO/PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PSO1**	**PSO2**	**PSO3**
CO1	**3**	**2**	**3**	**3**	**2**	**2**	**3**	**2**	**2**
CO2	**2**	**3**	**3**	**2**	**3**	**2**	**3**	**3**	**2**
CO3	**2**	**3**	**3**	**2**	**2**	**3**	**3**	**2**	**2**
CO4	**2**	**3**	**3**	**2**	**3**	**3**	**3**	**3**	**3**
CO5	**3**	**3**	**2**	**2**	**2**	**2**	**3**	**3**	**2**
Weightage of course contributed to each PSO	**12**	**14**	**14**	**11**	**12**	**12**	**15**	**13**	**11**

DISCIPLINE CENTRIC ELECTIVE – I
MATHEMATICAL STATISTICS

Subject Code	L	T	P	S	Credits	Inst. Hours	Marks		
							CIA	External	Total
26PEMA13	**6**	**0**	0	I	**3**	**6**	**50**	**50**	**100**

Learning Objectives	
LO1	Understand basic concepts of probability, random variables, and expectation.
LO2	Learn discrete and continuous probability distributions.
LO3	Study special distributions like normal, gamma, and chi-square.
LO4	Apply sampling theory and moment generating functions.
LO5	Understand limiting distributions and the Central Limit Theorem.

Prerequisites:

Unit	Contents	No. of Hours
I	**Distributions of Random Variables**: Probability set function – Random variables – Probability density and distribution functions – Mathematical expectation – Special expectations – Chebyshev's inequality.	**18**
II	**Conditional Probability and Stochastic Independence:** Conditional probability – Marginal and conditional distributions – Stochastic independence – Binomial distribution – Poisson distribution.	**18**
III	**Some Special Distributions:** Gamma and Chi-square distributions – Normal distribution – Bivariate normal distribution – Distribution of functions of random variables – Sampling theory – Transformations of discrete and continuous random variables.	**18**
IV	**Distributions of Functions of Random 'Variables :** Student's *t* and *F* distributions – Order statistics – Moment generating function technique – Expectations of functions of random variables - Chi-square (χ^2).	**18**
V	**Limiting Distributions:** Limiting distributions – Stochastic convergence – Limiting moment generating functions – Central Limit Theorem – Theorems on limiting distributions.	**18**
TOTAL		**90**

CO	Course Outcomes
CO1	Explain probability measures, random variables, and mathematical expectations.
CO2	Analyze discrete probability distributions such as binomial and Poisson distributions.
CO3	Examine continuous distributions including normal, gamma, and chi-square distributions.
CO4	Apply sampling distributions and moment generating function techniques in statistical inference.
CO5	Demonstrate convergence concepts and apply the Central Limit Theorem in probabilistic models.

Textbooks	
➢	Robert V. Hogg and Allen T. Craig, *Introduction to Mathematical Statistics*, 4th Edition. (Chapter 1 & 2 – excluding 1.1, 1.2, 1.3, 1.8 & 2.3; Chapter 3 & 4 – excluding 4.5; Chapter 5.)

Reference Books

1	M. Fisz, *Probability Theory and Mathematical Statistics*, John Wiley & Sons, 1963
2	E.J. Dudewicz and S.N. Mishra, *Modern Mathematical Statistics*, John Wiley & Sons, 1988.
3	V.N. Rohatgi, *An Introduction to Probability Theory and Mathematical Statistics*, Wiley Eastern Limited, 1988.

CO/PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	**3**	**3**	**2**	**3**	**3**	**3**	**3**	**3**	**2**
CO2	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**2**	**2**
CO3	**2**	**3**	**2**	**3**	**2**	**3**	**3**	**3**	**3**
CO4	**2**	**3**	**3**	**3**	**2**	**3**	**3**	**3**	**2**
CO5	**2**	**3**	**3**	**3**	**2**	**3**	**3**	**2**	**2**
Weightage of course contributed to each PSO	**12**	**15**	**13**	**15**	**12**	**15**	**15**	**13**	**11**

ELECTIVE – II

NUMBER THEORY AND CRYPTOGRAPHY

Subject Code	L	T	P	S	Credits	Inst. Hours	Marks		
							CIA	External	Total
26PEMA14	**6**	**0**	0	I	**3**	**6**	**50**	**50**	**100**

Learning Objectives	
LO1	Understand divisibility, prime numbers, and basic number theory concepts.
LO2	Learn congruences and solve modular arithmetic problems.
LO3	Study arithmetical and multiplicative functions.
LO4	Understand classical cryptographic methods.
LO5	Learn modern cryptography concepts like RSA and discrete logarithms.

Prerequisites:

Unit	Contents	No. of Hours
I	**Fundamental Theorem of Arithmetic:** Divisibility – Greatest Common Divisor – Least Common Multiple – Euclidean Algorithm.	**18**
II	**Congruences:** Basic properties – Residue classes – Complete residue systems – Linear congruences – Polynomial congruences modulo p – Lagrange's theorem and applications – Chinese Remainder Theorem.	**18**
III	**Arithmetical functions:** Möbius function – Euler's totient function – Dirichlet product – Mangoldt function – Multiplicative functions – Liouville's function – Bell series – Derivatives of arithmetical functions.	**18**
IV	**Cryptography:** Classical cryptosystems – Enciphering matrices – Simple substitution and transposition ciphers.	**18**
V	**Public key cryptography:** Concept of public key cryptosystems – RSA algorithm – Discrete logarithm problem – Knapsack cryptosystem.	**18**
TOTAL		**90**

CO	Course Outcomes
CO1	Explain congruences and prove fundamental results in modular arithmetic.
CO2	Analyze properties of arithmetical functions and multiplicative functions.
CO3	Apply number-theoretic techniques in solving classical problems and estimating arithmetic functions.
CO4	Implement simple classical cryptosystems and enciphering methods.
CO5	Explain and demonstrate public key cryptography including RSA and discrete logarithm methods.

Textbooks

➢	Neal Koblitz, *A Course in Number Theory and Cryptography*, Graduate Texts in Mathematics, Springer-Verlag, 1987. (Chapter 3, Chapter 4: Sections 4.1–4.4).
➢	Tom M. Apostol, *Introduction to Analytic Number Theory*, Narosa Publishing House, 1998. (Chapters 1–2, Sections 5.1–5.7).
Reference Books	
1	David M. Burton, *Elementary Number Theory*, 6th Edition, Tata McGraw Hill, 2007.
2	Wade Trappe and Lawrence C. Washington, *Introduction to Cryptography with Coding Theory*, 2nd Edition, Pearson Education, 2007.

CO/PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	1	2	3	2	3	2	3	2
CO2	3	1	2	3	2	2	2	2	2
CO3	3	1	2	3	1	2	1	2	1
CO4	3	3	2	3	2	3	2	3	1
CO5	3	3	2	3	2	3	2	3	3
Weightage of course contributed to each PSO	**15**	**9**	**10**	**15**	**9**	**13**	**9**	**13**	**9**

ELECTIVE – II
ANALYTIC NUMBER THEORY

Subject Code	L	T	P	S	Credits	Inst. Hours	Marks		
							CIA	External	Total
26PEMA15	**6**	**0**	0	I	**3**	**6**	**50**	**50**	**100**

Learning Objectives	
LO1	Understand fundamental concepts of number theory.
LO2	Study arithmetical functions and their properties.
LO3	Learn multiplicative functions and Dirichlet products.
LO4	Analyze averages and identities of arithmetical functions.
LO5	Understand basic ideas related to the Prime Number Theorem.

Prerequisites:

Unit	Contents	No. of Hours
I	The Fundamental Theorem of Arithmetic. *(Chapter 1: Sections 1.1–1.8)* Exercise Problems: Chapter 1 (1–11)	**18**
II	Arithmetical Functions. *(Chapter 2: Sections 2.1–2.8)* Exercise Problems: Chapter 2 (1–6)	**18**
III	Multiplicative Functions and Dirichlet Multiplication. *(Chapter 2: Sections 2.9–2.14)* Exercise Problems: Chapter 2 (21–23, 25, 26)	**18**
IV	Averages of Arithmetical Functions. *(Chapter 3: Sections 3.1–3.9)* Exercise Problems: Chapter 3 (1–4)	**18**
V	Partial sums of Dirichlet products – Chebyshev's functions – Equivalent forms of the Prime Number Theorem. *(Chapter 3: Sections 3.10, 3.11; Chapter 4: Sections 4.1–4.4)* Exercise Problems: Chapter 4 (3, 4, 5, 8)	**18**
TOTAL		**90**

CO	Course Outcomes
CO1	Explain fundamental concepts of elementary and analytic number theory.
CO2	Analyze arithmetical functions and establish relationships among them.
CO3	Apply algebraic structures such as multiplicative functions and Dirichlet convolution.

CO4	Derive and interpret identities and average order results for arithmetical functions.
CO5	Examine Chebyshev functions, Möbius function μ(n), Mangoldt function Λ(n), and understand equivalent formulations of the Prime Number Theorem.
Textbooks	
➢	Tom M. Apostol, *Introduction to Analytic Number Theory*, Springer (International Student Edition).
Reference Books	
1	M. Ram Murty, *Problems in Analytic Number Theory*, Springer, 2001.
2	Paul Pollack and Akash Singha Roy, *Steps into Analytic Number Theory*, Springer, 2021.

CO/PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	**3**	**2**	**3**	**3**	**2**	**2**	**3**	**2**	**2**
CO2	**3**	**3**	**2**	**2**	**3**	**3**	**3**	**2**	**2**
CO3	**3**	**3**	**2**	**3**	**2**	**2**	**3**	**3**	**2**
CO4	**2**	**2**	**3**	**3**	**3**	**2**	**2**	**2**	**3**
CO5	**3**	**3**	**2**	**2**	**3**	**2**	**2**	**3**	**2**
Weightage of course contributed to each PSO	**14**	**13**	**12**	**13**	**13**	**11**	**13**	**12**	**11**

ELECTIVE – II
FUZZY SETS AND THEIR APPLICATIONS

Subject Code	L	T	P	S	Credits	Inst. Hours	Marks		
							CIA	External	Total
26PEMA16	**6**	**0**	0	I	**3**	**6**	**50**	**50**	**100**

Learning Objectives	
LO1	Understand basic concepts of fuzzy sets and membership functions.
LO2	Learn operations and properties of fuzzy sets.
LO3	Study fuzzy relations and fuzzy graphs.
LO4	Apply fuzzy logic in decision-making problems.
LO5	Understand laws of fuzzy composition and their applications.

Prerequisites:

Unit	Contents	No. of Hours
I	**Fundamental notions of fuzzy sets** – Basic definitions – Membership functions – Operations on fuzzy sets – α-cuts – Properties of fuzzy sets. *(Chapter I: Sections 1–8)*	**18**
II	**Fuzzy graphs** – Definitions – Types of fuzzy graphs – Properties and applications of fuzzy graphs. *(Chapter II: Sections 10–18)*	**18**
III	**Fuzzy relations** – Composition of fuzzy relations – Properties – Equivalence and ordering relations in fuzzy context. *(Chapter II: Sections 19–29)*	**18**
IV	**Fuzzy logic** – Fuzzy propositions – Logical operations – Fuzzy inference – Applications (Sections 37 & 38 omitted). *(Chapter III: Sections 31–40)*	**18**
V	**Laws of fuzzy composition** – Max-min and max-product composition – Associativity and distributive laws – Applications. *(Chapter IV: Sections 43–49)*	**18**
TOTAL		**90**

CO	Course Outcomes
CO1	Explain the fundamental concepts of fuzzy sets and related operations.
CO2	Define and analyze fuzzy graphs and their properties.
CO3	Examine fuzzy relations and their compositions.
CO4	Apply principles of fuzzy logic in decision-making problems.
CO5	Analyze and interpret the laws of fuzzy compositions in theoretical and practical contexts.

Textbooks	
➢	A. Kaufmann, *Introduction to the Theory of Fuzzy Subsets*, Vol. I, Academic Press, New York, 1975.

Reference Books

1	H.J. Zimmermann, *Fuzzy Set Theory and Its Applications*, Allied Publishers, Chennai, 1996.
2	George J. Klir and Bo Yuan, *Fuzzy Sets and Fuzzy Logic: Theory and Applications*, Prentice Hall India, New Delhi, 2001.

CO/PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	2	1	2	3	2	3	2	1
CO2	3	2	1	3	1	2	3	2	1
CO3	3	2	3	1	2	1	3	2	1
CO4	2	1	2	3	1	1	3	2	1
CO5	2	3	1	2	1	1	3	2	1
Weightage of course contributed to each PSO	**13**	**10**	**8**	**11**	**8**	**7**	**15**	**10**	**5**

Semester-2

Semester–2									
Course Code	**Part**	**Course Category**	**Course Name**	**Hours/ Week**	**Examination**				**Credits**
					Duration in Hours	**Max Marks**			
						CIA	**ESE**	**Total**	
26PCMA21	A	Core-IV	Ring Theory and Lattices	6	3	50	50	100	5
26PCMA22		Core - V	Real Analysis – II	6		50	50	100	5
26PCMA23		Core - VI	Probability Theory	5	3	50	50	100	4
26PEMA21	A	EC - III	Research Methodology	5	3	50	50	100	3
26PEMA22			Algebraic Number Theory						
26PEMA23			Partial Differential Equations						
26PEMA24	A	EC - IV	Wavelets	5	3	50	50	100	3
26PEMA25			Operations Research						
26PEMA26			Neural Networks						
26PSMA21	B	SEC- I	Mathematical Documentation using LaTex.	3	2	50	50	100	**2**
			Total	**30**				**600**	**22**

FIRST YEAR - SEMESTER – II
RING THEORY AND LATTICES

Subject Code	L	T	P	S	Credits	Inst. Hours	Marks		
							CIA	External	Total
26PCMA21	6	0	0	II	5	6	50	50	100

Learning Objectives	
LO1	Understand basic concepts of rings, ideals, and homomorphisms.
LO2	Learn different types of rings such as PID and UFD.
LO3	Study polynomial rings and irreducibility tests.
LO4	Understand radicals and special types of rings.
LO5	Learn lattices, Boolean algebra, and their applications.

Prerequisites:

Unit	Contents	No. of Hours
I	**Ring Homomorphisms** – Ideals and Quotient Rings – Field of Quotients of an Integral Domain, First, Second and Third Isomorphism Theorems (Detailed Study) Text 1: Sections: 3.3 – 3.6	18
II	**Euclidean Rings** – A Particular Euclidean Ring, Principal Ideal Domains (PID) – Unique Factorization Domains (UFD). Text 1: Sections: 3.7 and 3.8	18
III	**Polynomial Rings** – Polynomials over Rational Field – Polynomial Rings over Commutative Rings, Irreducibility Criteria (Eisenstein's Criterion) – *Gauss Lemma* Text 1: Sections: 3.9 – 3.11.	18
IV	**Certain Radicals of a Ring** – Jacobson Radical of a Ring –Semisimple Ring – Nil Radical Text 2: Chapter 8: Definition 8.1 –Theorem 8.10.	18
V	**Posets and Lattices** – Distributivity and Modularity – Jordan–Holder Theorem – Boolean Algebra, Complemented Lattices – Applications of Boolean Algebra in Switching Circuits Chapter 8 Sections 8.1-8.3 & 8.5	18
TOTAL		**90**

CO	Course Outcomes
CO1	Demonstrate knowledge of ring structures, ideals and quotient rings and apply isomorphism theorems in rings.
CO2	Classify rings using structural properties such as prime ideals, maximal ideals, PID, UFD and Euclidean domains.
CO3	Analyze polynomial rings and apply irreducibility tests including Eisenstein's criterion.
CO4	Examine module structures over rings and distinguish between free modules and torsion modules

CO5	Investigate lattice structures and explain distributive, modular and Boolean lattices with suitable examples.
Textbooks	
1.	Topics in Algebra, I.N. Herstein, 2nd Edition, Wiley Student edition
2.	A first Course in Rings and Ideals, David M. Burton, Addison - Wesley Publishing Company.
Reference Books	
1	Basic Algebra I, Nathan Jacbson Yale University, W.H.Freeman and company. New York, 2nd Edition

CO/PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO 1	3	2	2	3	2	2	2	2	3	2
CO 2	3	2	3	3	2	3	2	2	3	2
CO 3	3	2	3	3	3	2	2	2	2	3
CO 4	2	3	2	3	2	2	3	2	2	2
CO 5	3	2	2	3	2	3	2	2	3	3
Weightage of course contributed to each PSO	14	11	12	15	11	12	11	10	13	12

CORE COURSE – V (CC–V)
REAL ANALYSIS – II

Subject Code	L	T	P	S	Credits	Inst. Hours	Marks		
							CIA	External	Total
26PCMA22	6	0	0	II	5	6	50	50	100

Learning Objectives	
LO1	Understand measure theory and measurable functions.
LO2	Learn Lebesgue integration and compare it with Riemann integration.
LO3	Study Fourier series and their convergence.
LO4	Learn multivariable differentiation and Jacobians.
LO5	Apply concepts to solve extrema and implicit function problems

Prerequisites:

Unit	Contents	No. of Hours
I	**Measure on the real line** – Lebesgue outer measure – Measurable sets – Regularity – Measurable functions – Borel and Lebesgue measurability – Hausdorff measure on the real line (Hausdorff dimension omitted). *(Chapter 2: Sections 2.1–2.5, G. de Barra)*	18
II	**Integration of functions of a real variable** – Integration of non-negative functions – The general integral – Integration of series – Riemann and Lebesgue integrals. *(Chapter 3: Sections 3.1, 3.2, 3.4, G. de Barra)*	18
III	**Fourier series and Fourier integrals** – Orthogonal systems – Best approximation theorem – Fourier series relative to orthonormal systems – Properties of Fourier coefficients – Riesz–Fischer theorem – Convergence and representation problems – Riemann–Lebesgue lemma – Dirichlet integrals – Integral representation of partial sums – Riemann's localization theorem. *(Chapter 11: Sections 11.1–11.11, Apostol)*	18
IV	**Multivariable differential calculus** – Directional derivative – Total derivative – Partial derivatives – Matrix of linear function – Jacobian matrix – Chain rule and matrix form of the chain rule. *(Chapter 12: Sections 12.1–12.10, Apostol)*	18
V	**Implicit functions and extremum problems** – Functions with non-zero Jacobian – Inverse function theorem – Implicit function theorem – Extrema of functions of several variables – Extremum problems with constraints. *(Chapter 13: Sections 13.1–13.7, Apostol)*	18
	TOTAL	90

CO	Course Outcomes
CO1	Analyze measurable sets and functions and apply the concept of Lebesgue outer measure.
CO2	Compare and evaluate Riemann and Lebesgue integrals and their applications.
CO3	Explain Fourier series and Fourier integrals using orthogonal systems and study convergence properties.

CO4	Compute directional and total derivatives, apply the chain rule, and represent linear transformations using Jacobian matrices.
CO5	Apply implicit function theorem and solve constrained extremum problems in multivariable calculus.
Text books	
1	Tom M. Apostol, *Mathematical Analysis*, 2nd Edition, Addison-Wesley, 1974. (Units III, IV & V)
Reference Books	
1.	J.C. Burkill, *The Lebesgue Integral*, Cambridge University Press, 1951.
2.	M.E. Munroe, *Measure and Integration*, Addison-Wesley, 1971
3.	H.L. Royden, *Real Analysis*, Macmillan, 1988.
4.	W. Rudin, *Principles of Mathematical Analysis*, McGraw Hill, 1979.
5.	S.C. Malik and Savita Arora, *Mathematical Analysis*, Wiley Eastern, 1991.
6.	Sanjay Arora and Bansi Lal, *Introduction to Real Analysis*, Satya Prakashan, 1991.

CO/PO/PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PSO1**	**PSO2**	**PSO3**
CO1	**3**	**1**	**3**	**2**	**3**	**3**	**3**	**2**	**1**
CO2	**2**	**1**	**3**	**1**	**3**	**3**	**3**	**2**	**1**
CO3	**3**	**2**	**3**	**1**	**3**	**3**	**3**	**2**	**1**
CO4	**1**	**2**	**3**	**2**	**3**	**3**	**3**	**2**	**1**
CO5	**3**	**1**	**2**	**3**	**3**	**3**	**3**	**2**	**1**
Weightage of course contributed to each PSO	**12**	**7**	**14**	**9**	**15**	**15**	**15**	**10**	**5**

CORE COURSE – VI (CC–VI)
PROBABILITY THEORY

Subject Code	L	T	P	S	Credits	Inst. Hours	Marks		
							CIA	External	Total
26PCMA23	5	0	0	II	5	5	50	50	100

Learning Objectives	
LO1	Understand basic probability concepts and random variables.
LO2	Learn expectation, moments, and inequalities.
LO3	Study characteristic functions and their properties.
LO4	Analyze discrete and continuous probability distributions.
LO5	Understand limit theorems like the Law of Large Numbers.

Prerequisites:

Unit	Contents	No. of Hours
I	**Random events** – Probability axioms – Combinatorial formulae – Conditional probability – Bayes' theorem – Independent events – Random variables – Distribution function – Joint, marginal and conditional distributions. *(Chapter 1: Sections 1.1–1.7; Chapter 2: Sections 2.1–2.7)*	15
II	**Parameters of distributions** – Expectation – Moments – Chebyshev's inequality – Absolute moments – Order parameters – Moments of random vectors – Regression (first and second types). *(Chapter 3: Sections 3.1–3.8)*	15
III	**Characteristic functions** – Properties – Characteristic functions and moments – Semi-invariants – Characteristic function of sum of independent random variables – Determination of distribution by characteristic function – Multidimensional characteristic functions. *(Chapter 4: Sections 4.1–4.6)*	15
IV	**Discrete distributions:** One-point, two-point, Binomial, Polya, Hypergeometric, Poisson distributions. Continuous distributions: Uniform, Normal, Gamma, Beta, Cauchy and Laplace distributions. *(Chapter 5: Sections 5.1–5.10)*	15
V	**Limit theorems** – Stochastic convergence – Bernoulli law of large numbers – Convergence of sequence of distribution functions – Lévy–Cramér theorem – de Moivre–Laplace theorem – Poisson, Chebyshev, Khintchine weak laws – Lindeberg and Lyapunov theorems – Borel–Cantelli lemma. *(Chapter 6: Sections 6.1–6.4, 6.6–6.9)*	15
	TOTAL	75

CO	Course Outcomes
CO1	Apply axiomatic probability concepts to random variables and distribution functions including joint and conditional distributions.
CO2	Compute expectations, moments, regression functions, and apply Chebyshev's inequality.
CO3	Analyze and apply characteristic functions in determining distributions and sums of independent random variables.

CO4	Examine discrete and continuous probability distributions and solve related problems.
CO5	Interpret and prove fundamental limit theorems such as the Law of Large Numbers and the Central Limit Theorem.
Textbooks	
1.	M. Fisz, *Probability Theory and Mathematical Statistics*, John Wiley & Sons, New York, 1963.
Reference Books	
1	R.B. Ash, *Real Analysis and Probability*, Academic Press, 1972.
2	K.L. Chung, *A Course in Probability Theory*, Academic Press, 1974
3	R. Durrett, *Probability: Theory and Examples*, 2nd Edition, Duxbury Press, 1996.
4	V.K. Rohatgi, *An Introduction to Probability Theory and Mathematical Statistics*, Wiley Eastern Ltd., 1988.
5	S.I. Resnick, *A Probability Path*, Birkhäuser, 1999.
6	B.R. Bhat, *Modern Probability Theory*, 3rd Edition, New Age International, 1999.

CO/PO/PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PSO1**	**PSO2**	**PSO3**
CO1	**3**	**1**	**3**	**2**	**3**	**3**	**3**	**2**	**1**
CO2	**2**	**1**	**3**	**1**	**3**	**3**	**3**	**2**	**1**
CO3	**3**	**2**	**3**	**1**	**3**	**3**	**3**	**2**	**1**
CO4	**1**	**2**	**3**	**2**	**3**	**3**	**3**	**2**	**1**
CO5	**3**	**1**	**2**	**3**	**3**	**3**	**3**	**2**	**1**
Weightage of course contributed to each PSO	**12**	**7**	**14**	**9**	**15**	**15**	**15**	**10**	**5**

ELECTIVE – III
RESEARCH METHODOLOGY

Subject Code	L	T	P	S	Credits	Inst. Hours	Marks		
							CIA	External	Total
26PEMA21	**5**	**0**	0	II	**3**	**5**	**50**	**50**	**100**

Learning Objectives	
LO1	Develop academic writing and presentation skills.
LO2	Learn how to plan and conduct research.
LO3	Understand how to write research proposals.
LO4	Organize and structure research projects.
LO5	Learn methods for publishing and presenting research work.

Prerequisites:

Unit	Contents	No. of Hours
I	**Academic writing style** – Writing clearly and concisely – Levels of formality – Gender-neutral language – Reviewing research projects. *(Chapter 3: Sections 3.1–3.4)*	**15**
II	**Tips and strategies** – Planning research – Deciding writing approach – Sourcing and selecting information – Recording information and note-making. *(Chapter 4: Sections 4.1–4.4)*	**15**
III	**Research project fundamentals** – Difference between dissertation and thesis – Basic requirements of research degree – Writing a research proposal – Ethical considerations. *(Chapter 5: Sections 5.1, 5.2, 5.3, 5.6, 5.13)*	**15**
IV	**Components of a research project** – Title page – Abstract – Acknowledgement – Table of contents – Introduction – Literature review – Methodology – Style of presentation – Conclusion – Bibliography – Appendices. *(Chapter 6: Sections 6.1–6.4, 6.6, 6.7, 6.8.1, 6.9.1, 6.11–6.13)*	**15**
V	**Publishing and presenting research** – Journal articles – Writing a book – Conference presentation – Research tool kit – Academic punctuation and formatting. *(Chapters 7 & 8)*	**15**
TOTAL		**75**

CO	Course Outcomes
CO1	Demonstrate effective academic writing skills and apply appropriate research writing styles.
CO2	Apply strategic planning techniques in conducting and documenting research work.
CO3	Prepare research proposals and understand ethical considerations in research.
CO4	Organize and structure various components of a mathematical research project.
CO5	Publish and present research findings in journals and conferences using appropriate tools and formatting standards
Textbooks	
➢	Neil Murray and Geraldine Hughes, *Writing up Your University Assignments and Research Projects – A Practical Handbook*, McGraw Hill Open University Press.
Reference Books	
1	Kumaravelu and Suseela Kumaravelu, *Elements of Number Theory*, V Edition, Raja Shankar Printers, Sivakasi, 2002.

CO/PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	**3**	**3**	**2**	**3**	**3**	**3**	**3**	**2**	**3**
CO2	**3**	**3**	**3**	**3**	**3**	**3**	**2**	**2**	**3**
CO3	**2**	**3**	**2**	**3**	**2**	**3**	**3**	**3**	**3**
CO4	**2**	**3**	**3**	**2**	**3**	**3**	**3**	**2**	**3**
CO5	**2**	**3**	**3**	**3**	**2**	**3**	**3**	**2**	**2**
Weightage of course contributed to each PSO	**13**	**15**	**13**	**14**	**13**	**15**	**14**	**11**	**14**

ELECTIVE – III
ALGEBRAIC NUMBER THEORY

Subject Code	L	T	P	S	Credits	Inst. Hours	Marks		
							CIA	External	Total
26PEMA22	**5**	**0**	0	II	**3**	**5**	**50**	**50**	**100**

Learning Objectives	
LO1	Understand and solve Diophantine equations.
LO2	Study special number theory equations.
LO3	Learn continued fractions and their uses.
LO4	Understand quadratic fields and algebraic integers.
LO5	Study unique factorization and its applications.

Prerequisites:

Unit	Contents	No. of Hours
I	**Diophantine equations** – Linear Diophantine equation ax+by=cax + by = cax+by=c – Positive integer solutions – Other linear equations.	**15**
II	**Some special equations** – The equation $x^2+y^2=z^2$ – The equation $x^4+y^4=z^2$ – The equation $4x^2+y^2=z^2$.	**15**
III	**Infinite continued fractions** – Representation of irrational numbers – Solutions of quadratic equations using continued fractions.	**15**
IV	**Quadratic fields** – Approximation to irrational numbers – Algebraic integers in quadratic fields.	**15**
V	**Unique factorization** – Failure of unique factorization in certain number systems – Units in quadratic fields.	**15**
TOTAL		**75**

CO	Course Outcomes
CO1	Apply techniques to solve linear and classical Diophantine equations.
CO2	Solve special equations such as Pythagorean-type equations.
CO3	Analyze infinite continued fractions and their role in representing irrational numbers.
CO4	Examine quadratic fields and algebraic integers.
CO5	Explain the concept of unique factorization and determine units in quadratic fields.

Textbooks

- Ivan Niven and Herbert S. Zuckerman, *An Introduction to the Theory of Numbers*, 2nd Edition, Wiley Eastern Ltd.

	(Chapters 5, 6 and 9 – excluding Sections 5.13, 5.14, 7.7, 7.8 and 7.9.)
Reference Books	
1	Kumaravelu and Suseela Kumaravelu, *Elements of Number Theory*, V Edition, Raja Shankar Printers, Sivakasi, 2002.

CO/PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	1	2	3	2	3	2	3	2
CO2	3	1	2	3	2	2	2	2	2
CO3	3	1	2	3	1	2	1	2	1
CO4	3	3	2	3	2	3	2	3	1
CO5	3	3	2	3	2	3	2	3	3
Weightage of course contributed to each PSO	**15**	**9**	**10**	**15**	**9**	**13**	**9**	**13**	**9**

ELECTIVE – III
PARTIAL DIFFERENTIAL EQUATIONS

Subject Code	L	T	P	S	Credits	Inst. Hours	Marks		
							CIA	External	Total
26PEMA23	**5**	**0**	0	II	**3**	**5**	**50**	**50**	**100**

Learning Objectives

LO1	Understand classification of partial differential equations.
LO2	Solve wave and heat equations.
LO3	Learn separation of variables method.
LO4	Study boundary value problems.
LO5	Apply Green's functions to solve equations.

Prerequisites:

Unit	Contents	No. of Hours
I	**Mathematical Models and Classification of second order equation :** Classical equations-Vibrating string – Vibrating membrane – waves in elastic medium – Conduction of heat in solids – Gravitational potential – Second order equations in two independent variables – canonical forms – equations with constant coefficients – general solution Chapter 2 : Sections 2.1 to 2.6.Chapter 3 : Sections 3.1 to 3.4	**15**
II	**Cauchy Problem :**The Cauchy problem –Cauchy- Kowalewsky theorem – Homogeneous wave equation – Initial Boundary value problem- Non-homogeneous boundary conditions – Finite string with fixed ends – Non-homogeneous wave equation – Riemann method – Goursat problem – spherical wave equation.Chapter 4 : Sections 4.1 to 4.10	**15**
III	**Method of separation of variables:** Separation of variable- Vibrating string problem – Existence and uniqueness of solution of vibrating string problem - Heat conduction problem – Existence and uniqueness of solution of heat conduction problem – Laplace and beam equations.Non Homogeneous Equations.Chapter 6 : Sections 6.1 to 6.6 , 6.8	**15**
IV	**Boundary Value Problems :** Boundary value problems – Maximum and minimum principles – Uniqueness and continuity theorem – Dirichlet Problem for a circle, a circular annulus, a rectangle – Dirichlet problem involving Poisson equation – Neumann problem for a circle and a rectangle.Chapter 8 : Sections 8.1 to 8.9	**15**
V	**Green's Function:** The Delta function – Green's function – Method of Green's function – Dirichlet Problem for the Laplace and Helmholtz operators – Method of images and eigen functions – Higher dimensional problem – Neumann Problem.Chapter 10 : Section 10.1 to 10.9	**15**
TOTAL		**75**

CO	Course Outcomes
CO1	Understand and classify second-order equations and determine their general solutions.
CO2	Analyse and solve wave equations in various polar coordinate systems.

CO3	Solve vibrating string and heat conduction problems, and identify and solve Laplace and beam equations.
CO4	Apply maximum and minimum principles and solve Dirichlet and Neumann problems under different boundary conditions.
CO5	Apply Green's function to solve Dirichlet and Laplace problems, and use the Helmholtz operator to solve higher-dimensional problems.
Textbooks	
➢	TynMyint-U and Lokenath Debnath, *Partial Differential Equations for Scientists and Engineers* (Third Edition),North Holland, New York,1987.

Reference Books

1	M.M.Smirnov, *Second Order partial Differential Equations,* Leningrad, 1964.
2	I.N.Sneddon, *Elements of Partial Differential Equations,* McGraw Hill, New Delhi, 1983.
3	R. Dennemeyer, *Introduction to Partial Differential Equations and Boundary Value Problems,* McGraw Hill, New York, 1968.
4	M.D.Raisinghania, *Advanced Differential Equations,* S.Chand & Company Ltd., New Delhi, 2001.
5	S.Sankar Rao, *Partial Differential Equations,* 2nd Edition, Prentice Hall of India, New Delhi. 2004.

CO/PO/PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PSO1**	**PSO2**	**PSO3**
CO1	**3**	**1**	**3**	**2**	**3**	**3**	**3**	**2**	**1**
CO2	**2**	**1**	**3**	**1**	**3**	**3**	**3**	**2**	**1**
CO3	**3**	**2**	**3**	**1**	**3**	**3**	**3**	**2**	**1**
CO4	**1**	**2**	**3**	**2**	**3**	**3**	**3**	**2**	**1**
CO5	**3**	**1**	**2**	**3**	**3**	**3**	**3**	**2**	**1**
Weight age of course contributed to each PSO	**12**	**7**	**14**	**9**	**15**	**15**	**15**	**10**	**5**

ELECTIVE – IV
WAVELETS

Subject Code	L	T	P	S	Credits	Inst. Hours	Marks		
							CIA	External	Total
26PEMA24	5	0	0	I	3	5	50	50	100

Learning Objectives

LO1	Understand Fourier and wavelet transforms.
LO2	Learn Fourier series and wavelet analysis.
LO3	Study spline functions and their properties.
LO4	Understand multiresolution analysis.
LO5	Learn construction and applications of wavelets

Prerequisites:

Unit	Contents	No. of Hours
I	**An Overview :** Fourier to Wavelets – Integral Wavelets Transform and Time frequency analysis – Inversion formulas and duals – Classification of Wavelets – Multi resolution analysis – Spines and Wavelets. Fourier Analysis : Fourier and Inverse Fourier Transformation – Continuous Time Convolution – The delta function– Fourier Transformation of square integrable functions.	**15**
II	**Fourier Analysis (contd):** Fourier Series – Basic Convergence Theory– Poisson Summation Formula. Wavelet Transforms and Time Frequency Analysis : The Gabor Transforms – Short time Fourier Transforms and the uncertainty principle – The integral Wavelet Transform – Dyadic Wavelets – Inversion .	**15**
III	**Cardinal Spline Analysis :** Cardinal Spline spaces – B- splines and their basic properties – The time scale relation and an interpolating graphical display algorithm – B-Net representations and computation of cardinal splines – Constructions of cardinal splines – constructions of spline application formulas	**15**
IV	**Functions and Wavelets :** Multi-resolution analysis – Scaling functions with finite two scale relation – Direction sum Decompositions of L2 (R) - Wavelets and their duals.Linear phase filtering..	**15**
V	**Cardinal Splines Wavelets :** Interpolating splines wavelets – Compactly supported spline – Wavelets – Computation of Cardinal spline Wavelets – Euler - Orthogonal Wavelets : Examples of orthogonal Wavelets – Identification of orthogonal two scale symbols – Construction of compactly supported orthogonal wavelets.	**15**
TOTAL		**75**

CO	Course Outcomes
CO1	Compute and analyze the integral wavelet transform, Fourier transform, and inverse Fourier transform.
CO2	Explain the concepts of Fourier series and wavelet series and examine their fundamental
CO3	Describe spline functions and apply interpolation formulas in problem-solving contexts.
CO4	Analyze the principles of multiresolution analysis and its role in wavelet theory.
CO5	Compute and construct cardinal spline wavelets and examine their applications.
Textbooks	
➢	Content and Treatment as in Charles K. Chui, *An introduction to Wavelets*, Academic Press, New York, 1992.
Reference Books	
1	Chui C. K. (ed) *Approximation theory and Fourier Analysis,* Academic Press Boston, 1991.
2	Daribechies. I, Wavelets, CBMS-NSF Series in Appl, SIAM Philadelphia, 1992.
3	Schurnaker, L. L., *Spline Functions : Basic Theory*, Wiley, New York, 1981
4	Nurnberger, G, *Applications to Spline Functions*, Springer Verlag, New York, 1989.

CO/PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	**2**	**1**	**2**	**1**	**3**	**2**	**3**	**2**	**1**
CO2	**3**	**1**	**2**	**1**	**3**	**2**	**3**	**2**	**1**
CO3	**3**	**2**	**1**	**3**	**2**	**1**	**3**	**2**	**1**
CO4	**2**	**3**	**1**	**2**	**3**	**1**	**3**	**2**	**1**
CO5	**2**	**1**	**3**	**2**	**3**	**1**	**3**	**2**	**1**
Weightage of course contributed to each PSO	**12**	**8**	**9**	**9**	**14**	**7**	**15**	**10**	**5**

ELECTIVE – IV
OPERATIONS RESEARCH

Subject Code	L	T	P	S	Credits	Inst. Hours	Marks		
							CIA	External	Total
26PEMA25	**5**	**0**	0	II	**3**	**5**	**50**	**50**	**100**

Learning Objectives	
LO1	Understand transportation and assignment problems.
LO2	Learn network models like shortest path and spanning tree.
LO3	Study integer programming techniques.
LO4	Understand inventory management models.
LO5	Analyze queuing systems and their applications.

Prerequisites:

Unit	Contents	No. of Hours
I	**Transportation Models and its Variants:** Definition of the Transportation Model – Non-Traditional Transportation Model– Transportation Algorithm – The Assignment Model.Chapter 5: Sections 5.1, 5.2, 5.3, 5.4. Exercise problems.	**15**
II	**Network Analysis:** Network Definitions – Minimal Spanning Tree Algorithm – Shortest Route Problem – Maximum Flow Model – CPM –PERT. Chapter 6: Sections 6.2 to 6.7. Exercise problems.	**15**
III	**Integer Linear Programming:** Introduction – Applications – Integer Programming Solutions – Algorithms.Chapter 9: Sections 9.1 to 9.3. Exercise problems.	**15**
IV	**Inventory Theory:** Basic Elements of an Inventory Model –Deterministic Models: Single Item Stock Model With And Without Price Breaks –Multiple Items Stock Model With Storage Limitations – Probabilistic Models :Continuous Review Model-Single Period Models.Chapter 11 – Sections 11.1 to 11.3, Chapter 16 –Sections 16.1 to 16.3.Exercise problems.	**15**
V	**Queuing Theory:** Basic Elements of Queuing Model– Role of Poisson and Exponential Distributions – Pure Birth and Death Models –Specialised Poisson Queues - (M/G/1): GD/∞/∞)-Pollaczek- Khintechine Formula- .Chapter 17: Sections 17.2, 17.3, 17.4, 17.6, 17.7. Exercise problems.	**15**
TOTAL		**75**

CO	Course Outcomes
CO1	Be able to build and solve Transportation and Assignment problems using appropriate method
CO2	Learn the constructions of network and optimal scheduling using CPM and PERT
CO3	Ability to construct linear integer programming models and solve linear integer programming models using branch and bound method
CO4	Understand the need of inventory management.
CO5	To understand basic characteristic features of a queuing system and acquire skills in analyzing queuing models
Textbooks	
➢	*Operations Research* (Sixth Edition), Hamdy A. Taha, Prentice Hall of India Private Limited, New Delhi.
Reference Books	
1	*Operations Research*, H.K Pathak, Dr. Pradeep K. Joshi and C.Sharma,Shree Shiksha Sahitya Prakashan Publication, Reprint 2022-23.
2	*Operations Research: Principles and Applications*, Second Edition, G. Srinivasan, Eastern Economy Edition, PHI.

CO/PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	**3**	**2**	**3**	**3**	**2**	**2**	**3**	**2**	**2**
CO2	**3**	**3**	**2**	**2**	**3**	**3**	**3**	**2**	**2**
CO3	**3**	**3**	**2**	**3**	**2**	**2**	**3**	**3**	**2**
CO4	**2**	**2**	**3**	**3**	**3**	**2**	**2**	**2**	**3**
CO5	**3**	**3**	**2**	**2**	**3**	**2**	**2**	**3**	**2**
Weightage of course contributed to each PSO	**14**	**13**	**12**	**13**	**13**	**11**	**13**	**12**	**11**

ELECTIVE – IV
NEURAL NETWORKS

Subject Code	L	T	P	S	Credits	Inst. Hours	Marks		
							CIA	External	Total
26PEMA26	**5**	**0**	0	II	**3**	**5**	**50**	**50**	**100**

Learning Objectives

LO1	Understand basic neuron models and architectures.
LO2	Learn perceptron and learning algorithms.
LO3	Study backpropagation and training methods.
LO4	Understand convergence and performance analysis.
LO5	Apply optimization techniques in neural networks.

Prerequisites:

Unit	Contents	No. of Hours
I	**Neuron Model and Network Architectures:** Mathematical Neural Model-Network Architectures-Perceptron-Hamming Network-Hopfield Network-Learning Rules.	**15**
II	**Perceptron Architectures:** Perceptron Architectures and Learning Rules with proof of convergence-Supervised Hebbian Learning-Linear Associator.	**15**
III	**Supervised Hebbian Learning:** The Hebb Rule-Pseudo inverse rule-Variation of Hebbian Learning-Back Propagation- Multilayer Perceptrons.	**15**
IV	**Back Propagation**: Back Propagation algorithm- convergence and Generalization-Performances surfaces and optimum points-Taylor series.	**15**
V	**Performance surface and performance optimizations**: Directional derivatives-Minima-Necessary conditions for optimality- Quadratic functions-Performance optimizations-Steepest Descent Newton's method-Conjugate Gradient.	**15**
TOTAL		**75**

CO	Course Outcomes
CO1	Understand and analyze different neuron network models
CO2	Understand the basic ideas behind most common learning algorithms for multilayer perceptions, radial basis function networks.
CO3	Describe Hebb rule and analyze back propagation algorithms with examples.
CO4	Study convergence and generalization and implement common learning algorithms.
CO5	Study directional derivatives and necessary conditions for optimality and to evaluate quadratic functions.

Textbooks

➢	Martin T. Hagan, Howard B/Demuth and Mark Beale, *Neural Network Design*, Vikas Publishing House, New Delhi, 2002

Reference Books

1	James A.Freeman, David M.Skapura, *Neural Networks Algorithms, Applications and Programming Techniques*, Pearson Education, 2003.
2	Robert J. Schalkoff, *Artificial Neural Network*, McGraw-Hill International Edition, 1997.

CO/PO/PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PSO1**	**PSO2**	**PSO3**
CO1	**3**	**1**	**2**	**2**	**2**	**1**	**2**	**3**	**3**
CO2	**3**	**2**	**2**	**1**	**1**	**1**	**1**	**2**	**2**
CO3	**1**	**2**	**2**	**3**	**1**	**1**	**1**	**2**	**2**
CO4	**2**	**2**	**1**	**1**	**2**	**1**	**1**	**1**	**2**
CO5	**2**	**2**	**2**	**1**	**1**	**1**	**1**	**3**	**2**
Weightage of course contributed to each PSO	**11**	**9**	**8**	**8**	**7**	**5**	**6**	**9**	**11**

SKILL ENHANCEMENT COURSE- I (SEC-I)

MATHEMATICAL DOCUMENTATION USING LATEX

Subject Code	L	T	P	S	Credits	Inst. Hours	Marks		
							CIA	External	Total
26PSMA21	3	0	0	II	2	3	50	50	100

Learning Objectives	
LO1	Learn basic LaTeX commands and document structure.
LO2	Understand formatting and document organization.
LO3	Create lists, tables, and formatted text.
LO4	Write mathematical equations using LaTeX.
LO5	Prepare complete mathematical documents and reports.

Unit	Contents	No. of Hours
I	**Introduction** - Basics of a Latex file- Text, Symbols and Commands: Command names and arguments – Environments– Declarations – Lengths – Special characters	9
II	**Document Layout and Organization:** Document class –Page style – Parts of the document – Table of contents-	9
III	**Displayed Text:** Changing font style – Centering and indenting – Lists – Generalized lists Theorem like-declarations	9
IV	**Text in Boxes:** Boxes - Footnotes and marginal notes.Tables: Tabular stops – Tables.	9
V	**Mathematical Formulas:** Mathematical Environment – Main elements of math mode – Mathematical symbols – Additional Elements.	9
	TOTAL	45

CO	Course Outcomes
CO1	To learn the latest techniques in Latex for the preparation of printable documents
CO2	To avoid difficulty while typing a project or thesis comparing other mathematical software.
CO3	To write mathematical equations and to draw graphs using Latex
CO4	To fix footnotes and header
CO5	To create tables and type formulae in Mathematics

Textbooks

- *Guide to LaTeX,* Helmut Kopka and Patrick W.Daly, Fourth Edition, Addison – Wesley, Pearson Education, 2004.

Reference Books

1. E. Krishnan, LaTeX TUTORIALS — A Primer, Indian TEX Users Group, 2003
2. H. Kopka and P.W. Daly, A Guide to LaTeX, Addison - Wesley, 2003.

3.	3. Martin J. Erickson and Donald Bindner, A Student's Guide to the Study, Practice, and Tools of Modern Mathematics, CRC Press, Boca Raton, FL, 2011

MAPPING TABLE

CO/PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	1	3	2	3	1	3	3	2	1
CO2	3	2	3	1	3	1	3	2	1
CO3	3	1	2	1	3	2	3	2	1
CO4	1	3	2	1	3	2	3	2	1
CO5	3	1	2	3	2	1	3	2	1
Weightage of course contributed to each PSO	11	10	11	9	12	9	15	10	5

Semester-3

Semester–3									
Course Code	**Part**	**Course Category**	**Course Name**	**Hours/ Week**	**Examination**				**Credits**
					Duration in Hours	**Max Marks**			
						CIA	**ESE**	**Total**	
26PCMA31	A	Core– VII	Advanced Algebra –I	6	3	50	50	50	5
26PCMA32	A	Core –VIII	Complex Analysis	6	3	50	50	50	4
26PCMA33	A	Core –IX	Topology	5		50	50	50	5
26PCMA34	A	Core –X (**Core Industry Module)**	Calculus of Variations and Integral Equations	5	3	50	50	50	4
26PEMA31	A	EC – V	Mechanics	5	3	50	50	50	4
26PEMA32			Mathematical Python Theory						
26PEMA33			Stochastic Process						
26PSMA31	B	SEC – IV	3.6.1 Mathematical Foundations of Artificial Intelligence	3		50	50	50	2
26PSMA32			3.6.2 R – Programming						
26PSMA33			3.6.3 Programming in C++						
26PFIK31	C	**Internship**	**Internship / Industrial Activity / Field Visit**(Minimum 20 hours – Internship Report Submission)	**External Valuation required**	2	50	50	100	2
Total				**30**				**700**	**26**

SECOND YEAR – SEMESTER – III
CORE COURSE – VII : ADVANCED ALGEBRA -I

Subject Code	L	T	P	S	Credits	Inst. Hours	Marks		
							CIA	External	Total
26PCMA31	**6**	**0**	0	III	**5**	**6**	**50**	**50**	**100**

Learning Objectives	
LO1	Understand the structure and properties of vector spaces and dual spaces.
LO2	Analyze linear transformations and their algebraic properties.
LO3	Study matrices, characteristic roots, and triangular forms.
LO4	Explore canonical forms including Jordan and rational canonical forms.
LO5	Apply concepts of Hermitian, unitary, and normal transformations in algebra.

Prerequisites:

Unit	Contents	No. of Hours
I	**Vector Spaces:** Dual Space- Modules- The Algebra of Linear Transformation. Sections: 4.3 and 6.1	**18**
II	**Characteristic Roots** - Matrices- Triangular Form Sections:6.2- 6.4	**18**
III	**Nilpotent Form-** Jordan Form- Canonical Form Sections: 6.5-6.6	**18**
IV	**Rational Canonical Form**-Trace and Transpose – Determinants Sections:6.7–6.9	**18**
V	**Transformation :** Hermitian, unitary and normal transformations, Real Quadratic Forms. Section: 6.10, 6.11	**18**
TOTAL		**90**

CO	**Course Outcomes**
CO1	Explain dual space, modules and linear Transformation
CO2	Describe the concept of Triangular Matrices
CO3	Demonstrate the concept of Nilpotent and Jordan form of Matrices
CO4	Define Rational Canonical form of Matrix, Trace and Transpose and Determinants
CO5	Explain Hermitian, Unitary and Normal Transformations.

Textbooks	
1	Topics in Algebra, I.N. Herstein, 2nd Edition, Wiley Student edition

Reference Books	
1.	A course in Abstract algebra(Third edition)-Vijay.K.Khanna,S.K. Bhambri – Vikas Publishing House – New Delhi.
2.	Fields and Rings- Kalplesky, Irving (second edition)-University of Chicago- Chicago- 1972.

CO/PO/PSO	PO 1	PO 2	PO 3	PO 4	O 5	PO 6	PSO 1	PSO 2	PSO 3
CO1	**3**	**1**	**3**	**2**	**3**	**3**	**3**	**2**	**1**
CO2	**2**	**1**	**3**	**1**	**3**	**3**	**3**	**2**	**1**
CO3	**3**	**2**	**3**	**1**	**3**	**3**	**3**	**2**	**1**
CO4	**1**	**2**	**3**	**2**	**3**	**3**	**3**	**2**	**1**
CO5	**3**	**1**	**2**	**3**	**3**	**3**	**3**	**2**	**1**
Weightage of course contributed to each PSO	**12**	**7**	**14**	**9**	**15**	**15**	**15**	**10**	**5**

SECOND YEAR – SEMESTER – III

CORE COURSE- VIII : COMPLEX ANALYSIS

Subject Code	L	T	P	S	Credits	Inst. Hours	Marks		
							CIA	External	Total
26PCMA32	**6**	**0**	0	III	**5**	**6**	**50**	**50**	**100**

Learning Objectives	
LO1	Understand analytic functions and their fundamental properties.
LO2	Apply Cauchy's Integral Theorem and Formula in evaluating integrals.
LO3	Analyze singularities using Taylor and Laurent series expansions.
LO4	Use the Residue Theorem to evaluate complex and real integrals.
LO5	Study harmonic functions and conformal mappings with applications.

Prerequisites:

Unit	Contents	No. of Hours
I	**Analytic Functions** – Polynomials – Rational Functions – Power Series , Uniform Convergence of Power Series – Detailed Study of Radius of Convergence.	**18**
II	**Cauchy's Integral Formula** – Index of a Point w.r.t. Closed Curve – Integral Formula – Higher Derivatives Local Properties: Removable Singularities – Taylor's Theorem – Zeros and Poles – Local Mapping – Maximum Principle , Liouville's Theorem – Open Mapping Theorem (Statement)	**18**
III	**General Form of Cauchy's Theorem** – Chains and Cycles – Simple Connectivity – Homology – General Statement – Proof of Cauchy's Theorem – Multiply Connected Regions – Residue Theorem – Argument Principle , – Applications of Argument Principle in Root Counting.	**18**
IV	**Evaluation of Definite Integrals** – Harmonic Functions – Basic Properties – Mean Value Property – Poisson Formula.	**18**
V	**Harmonic Functions & Power Series Expansions** – Schwarz Theorem – Reflection Principle – Weierstrass Theorem – Taylor's Series – Laurent Series -Leffler Theorem (Statement)	**18**
	TOTAL	**90**

CO	Course Outcomes
CO1	Explain the algebraic and geometric properties of complex numbers and analyze analytic functions using Cauchy–Riemann equations.
CO2	Evaluate complex integrals using Cauchy's Integral Theorem and Cauchy's Integral Formula.
CO3	Expand analytic functions using Taylor and Laurent series and classify singularities.
CO4	Apply the Residue Theorem to compute contour integrals and evaluate real definite integrals.

CO5	Investigate conformal mappings and their applications in solving boundary value problems.
Textbooks	
1	Lars V.Ahlfors, *Complex Analysis*, (3rd edition) McGraw Hill Co., NewYork, 1979
Reference Books	
1	H.A. Presfly, *Introduction to Complex Analysis,* Clarendon Press, Oxford, 1990.
2	J.B. Conway, *Functions of one complex variables* Springer - Verlag, International Student Edition, Narosa Publishing Co.1978
3	E. Hille, *Analytic function Theory* (2 vols.), Gon & Co, 1959.
4	M.Heins, *Complex function Theory*, Academic Press, New York,1968..

CO/PO/PSO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**O 5**	**PO 6**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	**1**	**2**	**3**	**3**	**3**	**3**	**2**	**2**	**3**
CO2	**3**	**1**	**3**	**2**	**3**	**3**	**3**	**2**	**1**
CO3	**2**	**1**	**3**	**1**	**3**	**3**	**3**	**2**	**1**
CO4	**3**	**2**	**3**	**1**	**3**	**3**	**3**	**2**	**1**
CO5	**1**	**2**	**3**	**2**	**3**	**3**	**3**	**2**	**1**
Weightage of course contributed to each PSO	**10**	**8**	**15**	**9**	**15**	**15**	**14**	**10**	**7**

SECOND YEAR – SEMESTER – III
CORE COURSE – IX: TOPOLOGY

Subject Code	L	T	P	S	Credits	Inst. Hours	Marks		
							CIA	External	Total
26PCMA33	**5**	**0**	0	III	**5**	**5**	**50**	**50**	**100**

Learning Objectives	
LO1	Understand the concept of topological spaces and their basic properties.
LO2	Analyze continuous functions in different topological settings.
LO3	Study connectedness and its various forms.
LO4	Explore compactness and related concepts.
LO5	Understand countability and separation axioms in topology.

Prerequisites:

Unit	Contents	No. of Hours
I	**Topological spaces :** Topological spaces – Basis for a topology – The order topology – The product topology on X x Y – The subspace topology –. Chapter 2 : Sections 12 to 16	**15**
II	**Continuous functions:** Continuous functions – the product topology – The metric topology- The Quotient Topology. Chapter 2 : Sections 18 to 22	**15**
III	**Connectedness:** Connected spaces- Components and Local Connectedness Chapter 3 : Sections 23& 25.	**15**
IV	**Compactness :** Compact spaces – Limit Point Compactness. Chapter 3 : Sections 26 to 28(except 27).	**15**
V	**Countability and Separation Axiom:** The Countability Axioms – The Separation Axioms – Normal spaces – The Urysohn Lemma – The Urysohn Metrization Theorem-The Tietze Extension Theorem. Chapter 4 : Sections 30 to 35.	**15**
TOTAL		**75**

CO	**Course Outcomes**
CO1	Define and illustrate topological spaces and explain the fundamental concepts of open sets, neighbourhoods, interior, exterior, closure, and the axioms defining a topology.
CO2	Analyse continuous functions and examine the properties of product topology and metric topology.
CO3	Describe and evaluate connected spaces, components, and local connectedness.
CO4	Explain compact spaces, limit point compactness, and local compactness, and distinguish between these concepts.
CO5	Apply qualitative methods and theoretical tools to characterize and prove properties related to connectedness and compactness.

Textbooks	
1	James R. Munkres, *Topology* (2nd Edition) Pearson EducationPvt.Ltd., New Delhi-2002(Third Indian Reprint).

Reference Books	
1	James R. Munkres, *Topology* (2nd Edition) Pearson Education Pvt. Ltd., New Delhi 2002 (Third Indian Reprint)
2	H.K Pathak and J.P Chauhan, *Topology*, Shree Shiksha Sahitya Prakashan Publisher, Reprint 2023-2024.
3	J. Dugundji ,*Topology* , Prentice Hall of India, New Delhi, 1975.
4	George F.Simmons, *Introduction to Topology and Modern Analysis*, McGraw Hill Book Co., 1963
5	J.L. Kelly, *General Topology*, Van Nostrand, Reinhold Co., New york
6	L.Steen and J.Subhash, Counter Examples in Topology, Holt, Rinehart and Winston, New York, 1970.
7	S.Willard, *General Topology*, Addison - Wesley, Mass., 1970..

CO/PO/PSO	PO 1	PO 2	PO 3	PO 4	O 5	PO 6	PSO 1	PSO 2	PSO 3
CO1	**3**	**1**	**3**	**2**	**3**	**3**	**3**	**2**	**1**
CO2	**2**	**1**	**3**	**1**	**3**	**3**	**3**	**2**	**1**
CO3	**3**	**2**	**3**	**1**	**3**	**3**	**3**	**2**	**1**
CO4	**1**	**2**	**3**	**2**	**3**	**3**	**3**	**2**	**1**
CO5	**3**	**1**	**2**	**3**	**3**	**3**	**3**	**2**	**1**
Weightage of course contributed to each PSO	**12**	**7**	**14**	**9**	**15**	**15**	**15**	**10**	**5**

SECOND YEAR – SEMESTER – III
CORE COURSE – X (Core Industry Module):

CALCULUS OF VARIATIONS AND INTEGRAL EQUATIONS

Subject Code	L	T	P	S	Credits	Inst. Hours	Marks		
							CIA	External	Total
26PCMA34	**5**	**0**	0	III	**4**	**5**	**50**	**50**	**100**

Learning Objectives	
LO1	Formulate and solve variational problems using Euler–Lagrange equations.
LO2	Apply constraints and Lagrange multipliers in optimization problems.
LO3	Understand the theory of integral equations and their classifications.
LO4	Solve Fredholm and Volterra integral equations.
LO5	Apply Green's functions and Hilbert–Schmidt theory to boundary value problems.

Prerequisites:

Unit	Contents	No. of Hours
I	**Calculus of Variations and Applications** – Maxima and Minima – The Simplest Case – Illustrative Examples – Variational Notation – More General Case-Variational Problems with Several Dependent Variables	**15**
II	**Constraints and Lagrange's Multipliers** – Variable End Points – Sturm–Liouville Problems – Hamilton's Principle – Lagrange Equations	**15**
III	**Integral Equations** – Introduction – Relation between Differential and Integral Equations – Green's Function – Alternative Definition of Green's Function	**15**
IV	**Linear Equations in Cause and Effect** – Influence Function – Fredholm Equations with Separable Kernels – Illustrative Examples	**15**
V	**Hilbert**–Schmidt Theory – Iterative Methods for Solving Equations of Second Kind – Fredholm Theory-Compact Operators	**15**
TOTAL		**75**

CO	**Course Outcomes**
CO1	Formulate variational problems and derive Euler–Lagrange equations for functionals.
CO2	Solve extremum problems with fixed and variable boundary conditions, including isoperimetric constraints.

CO3	Apply Hamilton's principle and canonical equations to model physical systems.
CO4	Classify and solve Fredholm and Volterra integral equations using appropriate analytical techniques.
CO5	Analyze eigenvalue problems, Hilbert–Schmidt theory and apply Green's functions to boundary value problems.
Textbooks	
1	Methods of Applied Mathematics, Francis B. Hildebrand, sections 2.1 to 2.11, 3.1 to 3.9 and 3.11.

CO/PO/PSO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**O 5**	**PO 6**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	**3**	**1**	**3**	**2**	**3**	**3**	**3**	**2**	**2**
CO2	**2**	**1**	**3**	**1**	**3**	**3**	**3**	**1**	**1**
CO3	**3**	**2**	**3**	**1**	**3**	**3**	**3**	**2**	**1**
CO4	**1**	**2**	**3**	**2**	**3**	**3**	**3**	**1**	**2**
CO5	**3**	**1**	**2**	**3**	**3**	**3**	**3**	**2**	**1**
Weightage of course contributed to each PSO	**12**	**7**	**14**	**9**	**15**	**15**	**15**	**8**	**7**

Elective V: MECHANICS

Subject Code	L	T	P	S	Credits	Inst. Hours	Marks		
							CIA	External	Total
26PEMA31	5	0	0	III	3	5	50	50	100

Learning Objectives	
LO1	Understand mechanical systems using generalized coordinates.
LO2	Apply Newtonian and Lagrangian mechanics to physical systems.
LO3	Analyze motion using energy and momentum principles.
LO4	Study Hamiltonian mechanics and variational principles.
LO5	Apply Hamilton–Jacobi theory and canonical transformations.

Prerequisites:

Unit	Contents	No. of Hours
I	**Mechanical Systems :** The Mechanical system- Generalised coordinates – Constraints - Virtual work - Energy and Momentum-D'Alembert's Principle Chapter 1 : Sections 1.1 to 1.5	15
II	**Lagrange's Equations:** Derivation of Lagrange's equations- Examples- Integrals of motion Chapter 2 : Sections 2.1 to 2.3	15
III	**Hamilton's Equations :** Hamilton's Principle - Hamilton's Equation - Other variational principle. Chapter 4 : Sections 4.1 to 4.3	15
IV	**Hamilton-Jacobi Theory :** Hamilton Principle function – Hamilton-Jacobi Equation - Separability-Applications to Central Force Problem Chapter 5 : Sections 5.1 to 5.3	15
V	**Canonical Transformation :** Differential forms and generating functions – Special Transformations– Lagrange and Poisson brackets. Chapter 6 : Sections 6.1, 6.2 and 6.3	15
	TOTAL	75

CO	Course Outcomes
CO1	Analyze motion of particles using vector methods and coordinate systems.
CO2	Apply Newton's laws to solve problems involving variable forces and projectiles.
CO3	Use work-energy and momentum principles in mechanical systems.
CO4	Examine rigid body motion and compute moments of inertia.

CO5	Explain central force motion and derive Kepler's laws mathematically.
Textbooks	
1	D. Greenwood, *Classical Dynamics*, Prentice Hall of India, New Delhi, 1985.
Reference Books	
1	H. Goldstein, *Classical Mechanics*, (2nd Edition) Narosa Publishing House, New Delhi.
2	N.C.Rane and P.S.C.Joag, *Classical Mechanics*, Tata McGraw Hill, 1991.
3	J.L.Synge and B.A.Griffth, *Principles of Mechanics* (3rdEdition) McGraw Hill Book Co., New York, 1970

CO/PO/PSO	PO 1	PO 2	PO 3	PO 4	O 5	PO 6	PSO 1	PSO 2	PSO 3
CO1	**3**	**1**	**3**	**2**	**3**	**3**	**3**	**2**	**1**
CO2	**2**	**1**	**3**	**1**	**3**	**3**	**3**	**2**	**1**
CO3	**3**	**2**	**3**	**1**	**3**	**3**	**3**	**2**	**1**
CO4	**1**	**2**	**3**	**2**	**3**	**3**	**3**	**2**	**1**
CO5	**3**	**1**	**2**	**3**	**3**	**3**	**3**	**2**	**1**
Weightage of course contributed to each PSO	**12**	**7**	**14**	**9**	**15**	**15**	**15**	**10**	**5**

Elective V: MATHEMATICAL PYTHON – THEORY

Subject Code	L	T	P	S	Credits	Inst. Hours	Marks		
							CIA	External	Total
26PEMA32	5	0	0	III	3	5	50	50	100

Learning Objectives	
LO1	Understand problem-solving techniques using algorithms and pseudocode.
LO2	Develop logical thinking using iterative and recursive methods.
LO3	Learn Python basics including data types and operators.
LO4	Write modular programs using functions and control structures.
LO5	Work with strings, lists, and tuples for data manipulation.

Prerequisites:

Unit	Contents	No. of Hours
I	**PROBLEM SOLVING TECHNIQUES:** Problem solving Techniques – Algorithm, flowchart, pseudocode, programming; Algorithms: properties, quality (time, space); building blocks of algorithms - statements, state, control flow, functions, notation (pseudo code, flow chart, programming language)	15
II	**ALGORITHMIC PROBLEM SOLVING:** Algorithmic problem solving, simple strategies for developing algorithms (iteration, recursion), pseudocode for some Mathematical Problems – greatest of two numbers, print n natural numbers, greatest common divisor, fibonacci sequence upto n terms. Practical applications of algorithms.	15
III	**INTRODUCTION TO PYTHON**: Introduction to Python, Python interpreter, Modes of Python Interpreter, Values and Data Types, Variables, Keywords, Identifiers, Statements and Expressions, Input and Output, Comments, Docstring, Lines and Indentation, Quotation, Tuple Assignment, Operators and Types of Operators, Operator Precedence.	15
IV	**PYTHON FUNCTIONS:** Functions, Types of function, Function definition (Sub program), Flow of Execution, Function Prototypes, Parameters and Arguments; Modules; Conditionals: Boolean values and operators, conditional (if), alternative (if-else), chained conditional (if-else-if); Iteration: state, while, for, break, continue, pass; Fruitful functions: return values, parameters, local and global scope, function composition, recursion.	15
V	**STRING, LISTS, TUPLES IN PYTHON**:Strings: string slices, immutability, string functions and methods, string module; Lists as arrays. Lists: list operations, list slices, list methods, list loop, mutability, aliasing, cloning lists, list parameters; Tuples: tuple assignment, tuple as return value	15
	TOTAL	75

CO	Course Outcomes
CO1	Apply problem-solving techniques such as algorithms, flowcharts, and pseudocode to design structured solutions, and analyze algorithm efficiency in terms of time and space complexity.
CO2	Develop algorithms using iterative and recursive strategies to solve mathematical and logical problems (e.g., GCD, Fibonacci sequence, natural numbers generation).
CO3	Demonstrate understanding of Python fundamentals including data types, variables, operators, expressions, input/output handling, and interpreter modes.

CO4	Construct modular Python programs using functions, conditionals, loops, recursion, and modules while applying appropriate parameter passing and scope rules.
CO5	Manipulate and process data using strings, lists, and tuples in Python, applying concepts such as slicing, mutability, list methods, tuple assignment, and return values effectively.
Textbooks	
1	Allen B. Dowley, *Think Python: How to Think Like a Computer Scientist*, 2nd Edition.

Reference Books	
1	Wes McKinney, *Python for Data Analysis: Data Wrangling with Pandas, NumPy, and Ipython*, O'Reilly, 2nd Edition, 2018.
2	Jake VanderPlas, *Python Data Science Hand Book: Essential Tools*
3	Wesley J. Chun, *Core Python Programming*, Prentice Hall, 2006.
4	N.Safina Devi and C.Devamanoharan, *Algorithmic Problem Solving and Python- A Beginner's Guide*, Francidev Publications, 2023

CO/PO/PSO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**O 5**	**PO 6**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	**3**	**1**	**3**	**2**	**3**	**3**	**3**	**2**	**1**
CO2	**2**	**1**	**3**	**1**	**3**	**3**	**3**	**2**	**1**
CO3	**3**	**2**	**3**	**1**	**3**	**3**	**3**	**2**	**1**
CO4	**1**	**2**	**3**	**2**	**3**	**3**	**3**	**2**	**1**
CO5	**3**	**1**	**2**	**3**	**3**	**3**	**3**	**2**	**1**
Weightage of course contributed to each PSO	**12**	**7**	**14**	**9**	**15**	**15**	**15**	**10**	**5**

Elective V: STOCHASTIC PROCESS

Subject Code	L	T	P	S	Credits	Inst. Hours	Marks		
							CIA	External	Total
26PEMA33	5	0	0	III	3	5	50	50	100

Learning Objectives	
LO1	Understand the fundamentals of stochastic processes and Markov chains.
LO2	Analyze transition probabilities and classification of states.
LO3	Study Poisson processes and birth-death models.
LO4	Understand renewal processes and their applications.
LO5	Analyze Brownian motion and its probabilistic behavior.

Prerequisites:

Unit	Contents	No. of Hours
I	**Markov Chains :** Classification of general stochastic processes – markov chain – Examples – Transition probability matrix – Classification of states - Recurrence Chapter 1 : Section 3 only and Chapter 2 : sections 1 to 5	15
II	**Limit theorems of Markov chains :** Discrete renewal equation and its proof – Absorption probabilities – criteria for recurrence – Queuing models Chapter 3 : Sections 1 to 7	15
III	**Continuous time Markov Chains :** Poisson process – Pure Birth process – Birth and Death process - Birth and Death process with absorbing states-M/M/1 Queue Model Chapter 1 : Section 2 (Poisson process) Chapter 4 : Sections 1, 2 and 4 to 7	15
IV	**Renewal processes :** Definition and related concepts – Some special renewal processes-Elementary Renewal Theorem. Chapter 5 : sections 1 - 3	15
V	**Brownian Motion :** Definition – Joint probabilities for Brownian Motion – Continuity of paths and the maximum variables – Variations and extensions Chapter 1 : Section 2 (Brownian Motion) Chapter 6 : sections 1 to 4 and 7A only	15
	TOTAL	75

CO	Course Outcomes
CO1	Define Markov chain and Transition probability matrix.
CO2	Understand the concepts of queuing models and limit theorems on Markov chains.
CO3	Explain about the pure birth , death processes and Poisson process.
CO4	Acquire the knowledge of some special Renewal processes.

CO5	Describe the joint probabilities for Brownian motion
Text books	
1	S.Karlin and H.M. Taylor, *A first course in stochastic processes*(2nd edition) Academic Press, New York, 1975
Reference Books	
1	E. Cinler, *Introduction to stochastic processes*, Prentice Hall Inc, New Delhi, 1975
2	D.R.Cox and H.D.Miller, *Theory of stochastic processes* (3rd Edition) Chapman and hall, London, 1983
3	D.Kannan, *An introduction to stochastic processes*, North- Holland, New York,1979
4	S.M. Ross, *Stochastic processes*, John Wiley and Sons, New York, 1983
5	H.W.Taylor and S.Karlin, *An introduction to stochastic modelling*(3rd Edition), Academic Press, New York, 1998

CO/PO/PSO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**O 5**	**PO 6**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	**3**	**2**	**3**	**2**	**3**	**2**	**3**	**2**	**1**
CO2	**2**	**1**	**2**	**1**	**3**	**2**	**3**	**2**	**1**
CO3	**3**	**2**	**1**	**3**	**2**	**1**	**3**	**2**	**1**
CO4	**2**	**1**	**1**	**2**	**3**	**2**	**3**	**2**	**1**
CO5	**3**	**1**	**2**	**3**	**2**	**1**	**3**	**2**	**1**
Weightage of course contributed to each PSO	**13**	**7**	**9**	**11**	**13**	**8**	**15**	**10**	**5**

Skill Enhancement Course - II : Mathematical Foundations of Artificial Intelligence

Subject Code	L	T	P	S	Credits	Inst. Hours	Marks		
							CIA	External	Total
26PSMA31	3	0	0	III	2	3	50	50	100

Learning Objectives	
LO1	Understand the history and applications of artificial intelligence.
LO2	Study intelligent agents and their environments.
LO3	Learn problem-solving techniques using state space representation.
LO4	Apply heuristic search algorithms in AI problems.
LO5	Understand knowledge representation methods.

Prerequisites:

Unit	Contents	No. of Hours
I	**Topics of Artificial Intelligence-** imelines of Artificial Intelligence, Branches of Artificial Intelligence, Applications of Artificial Intelligence- History of AI Winters	09
II	**Intelligent agents:** structure and types of agents- Environment-Autonomous Agents-Rational Agents	09
III	**Problem Solving:** Production Systems – State Space Representation– Example problems	09
IV	**Heuristic Search Techniques:** Generate and Test-Hill Climbing-Simulated Annealing-Search Techniques	09
V	**Knowledge Representation:** Knowledge Management- Types of Knowledge- Knowledge Representation	09
TOTAL		45

CO	Course Outcomes
CO1	Create and compile basic LaTeX documents using proper structure and formatting commands.
CO2	Typeset complex mathematical expressions, matrices, alignments and theorems using LaTeX.
CO3	Prepare tables, figures and include graphics using appropriate LaTeX packages.
CO4	Generate structured academic documents such as assignments, articles and project reports with references and bibliography.
CO5	Design professional research manuscripts and presentations using LaTeX templates and document

	classes.
Text books	
1	Vinod Chandra S.S, Anand Hareendran .S- "Artificial Intelligence: Principles and Applications", Prentice Hall of India, New Delhi, 2020.
2	Stuart Russell and Peter Norvig –"Artificial Intelligence: A Modern Approach", 3rd Edition Prentice Hall of India, New Delhi, 2009
Reference Books	
1	Judith Hurwitz and Daniel Kirsch, Machine Learning For Dummies, IBM Limited Edition, Wiley, 2018.

CO/PO/PSO	PO 1	PO 2	PO 3	PO 4	O 5	PO 6	PSO 1	PSO 2	PSO 3
CO1	**3**	**1**	**3**	**2**	**3**	**3**	**3**	**2**	**2**
CO2	**2**	**1**	**3**	**1**	**3**	**3**	**3**	**1**	**1**
CO3	**3**	**2**	**3**	**1**	**3**	**3**	**3**	**2**	**1**
CO4	**1**	**2**	**3**	**2**	**3**	**3**	**3**	**1**	**2**
CO5	**3**	**1**	**2**	**3**	**3**	**3**	**3**	**2**	**1**
Weightage of course contributed to each PSO	**12**	**7**	**14**	**9**	**15**	**15**	**15**	**8**	**7**

Skill Enhancement Course - II: R-PROGRAMMING

Subject Code	L	T	P	S	Credits	Inst. Hours	Marks		
							CIA	External	Total
26PSMA32	**3**	**0**	0	III	**2**	**3**	**50**	**50**	**100**

Learning Objectives	
LO1	Understand the basics of R programming and environment setup.
LO2	Work with data types, vectors, and data structures in R.
LO3	Apply control structures and functions in R programs.
LO4	Handle and analyze datasets effectively.
LO5	Create statistical visualizations using graphs and packages.

Prerequisites:

Unit	Contents	No. of Hours
I	**Introduction to R programming** - Installing R and R Studio - R Studio over view working in the console.	**09**
II	**Arithmetic operators** -logical operators – functions- Data structures in R - creating variables -numeric, character and logical data – vectors .	**09**
III	**Data frames** – factors - sorting numeric, character, and factor vectors -Control statements in R –loop statements	**09**
IV	**R packages** - installing and loading packages- setting up your working directory - working with missing data	**09**
V	**Statistical graphs** - Scatter Plots - Box Plots- Histograms – Bar plots – pie chart - ggplot2 package to visualize data	**09**
TOTAL		**45**

CO	**Course Outcomes**
CO1	Understand the fundamentals of R.
CO2	Illustrate the loading, retrieval techniques of data.
CO3	Understand how data is analyzed using simple functions
CO4	Use flow control statements in simple programs
CO5	Explain Histograms, plots and ggplot 2 visualise data.

Text books

1 Sandip Rakshit, R Programming for Beginners, McGraw, Hill Education (India), 2017.

Reference Books

1 **George J. Klir and Bo Yuan**, *Fuzzy Sets and Fuzzy Logic: Theory and Applications*, Prentice Hall, 1995.

2 **Lotfi A. Zadeh**, *Fuzzy Sets, Fuzzy Logic and Fuzzy Systems: Selected Papers*, World

	Scientific Publishing, 1996.
3	**John N. Mordeson, Sunil Mathew and Davender S. Malik**, *Fuzzy Graph Theory*, Springer, 2019.

CO/PO/PSO	PO 1	PO 2	PO 3	PO 4	O 5	PO 6	PSO 1	PSO 2	PSO 3
CO1	**3**	**1**	**3**	**2**	**3**	**3**	**3**	**2**	**2**
CO2	**2**	**1**	**3**	**1**	**3**	**3**	**3**	**1**	**1**
CO3	**3**	**2**	**3**	**1**	**3**	**3**	**3**	**2**	**1**
CO4	**1**	**2**	**3**	**2**	**3**	**3**	**3**	**1**	**2**
CO5	**3**	**1**	**2**	**3**	**3**	**3**	**3**	**2**	**1**
Weightage of course contributed to each PSO	**12**	**7**	**14**	**9**	**15**	**15**	**15**	**8**	**7**

Skill Enhancement Course – II : PROGRAMMING IN C++

Subject Code	L	T	P	S	Credits	Inst. Hours	Marks		
							CIA	External	Total
26PSMA33	**3**	**0**	0	III	**2**	**3**	**50**	**50**	**100**

Learning Objectives	
LO1	Understand the structure and syntax of C++ programs.
LO2	Apply control structures and functions in problem-solving.
LO3	Learn object-oriented programming concepts.
LO4	Work with classes, objects, and member functions.
LO5	Understand constructors, destructors, and operator overloading.

Prerequisites:

Unit	Contents	No. of Hours
I	**Structure of C++ program** – Tokens – Keywords –Identifies and constants- all data types – Constants – all variables – All operators- Manipulator. Chapter 2 : Sec : 2.6 Chapter 3 : Sec : 3.1 – 3.18	**09**
II	**All Expressions** – Conversion – Operator overloading – Operator Precedence – Control Structures- Functions in C++ - Introduction – Main Function – Function Prototyping- Return by reference Chapter 3, Sec: 3.19 -3.24 Chapter 4, Sec : 4.1 – 4.5	**09**
III	**Inline Functions** – arguments – Function overloading – all functions classes and Objects. Chapter 4 , Sec: 4.6 -4.11 Chapter 5, Sec: 5.1 – 5.5	**09**
IV	**Nesting of member functions** – Private member function – Arrays with in a class and Objects – Friendly function – Returning Objects – Pointers to members – Local Classes Chapter 5, Sec 5.7 – 5.19	**09**
V	**Constructors and Destructors** – Operator over loading and Type conversions. Chapter 6 & 7.	**09**
	TOTAL	**45**

CO	Course Outcomes
CO1	To understand the **s**tructure of C++ program
CO2	Explain Control Structures- Functions in C++.
CO3	Explain all functions classes and Objects.
CO4	Explain the Nesting of member functions
CO5	Explain Constructors and Destructors

Text books

1 E.Balagurusamy, Object Oriented Programming with C++ , 4th Edition, The McGraw- Hill Company, New Delhi, 2008.

Reference Books

1	V.Ravichandran, Programming with C++, Second Edition Tata McGraw- Hill, New Delhi, 2006.

CO/PO/PSO	PO 1	PO 2	PO 3	PO 4	O 5	PO 6	PSO 1	PSO 2	PSO 3
CO1	**3**	**2**	**3**	**2**	**3**	**2**	**3**	**2**	**1**
CO2	**2**	**1**	**2**	**1**	**3**	**2**	**3**	**2**	**1**
CO3	**3**	**2**	**1**	**3**	**2**	**1**	**3**	**2**	**1**
CO4	**2**	**1**	**1**	**2**	**3**	**2**	**3**	**2**	**1**
CO5	**3**	**1**	**2**	**3**	**2**	**1**	**3**	**2**	**1**
Weightage of course contributed to each PSO	**13**	**7**	**9**	**11**	**13**	**8**	**15**	**10**	**5**

Internship / Industrial Activity /Field visit/ Research Knowledge updation Activity / Literacy

Subject Code	L	T	P	S	Credits	Inst. Hours	Marks		
							CIA	External	Total
26PFIK31	0	0	**0**	III	**2**	**-**	**50**	**50**	**100**

Learning Objectives	
LO1	To enhance student to work as team work.
LO2	To equipped the student with the skill and desire to solve societal problems
LO3	To developed work ethic.
LO4	To improve communication skill and responsibilities among students
LO5	To explore, experience and apply the academic knowledge in ground

Prerequisites:

Contents

CO	**Course Outcomes**
CO1	Enhance the professional competency to conduct fieldwork.
CO2	Gain practical knowledge related to their studies.
CO3	Help student to understand the subject theories and methodology better.
CO4	Gain particle skill and knowledge.
CO5	Increase the employment prospect of the student

Methods of Evaluation		
Internal Evaluation	Certificate from the Organisation	25 Marks
	Viva Voce Examination	25 Marks
External Evaluation	Internship report	50 Marks
	Total	100 Marks

Methods of Assessment	
Recall (K1)	Simple definitions, MCQ, Recall steps, Concept definitions
Understand/ Comprehend (K2)	MCQ, True/False, Short essays, Concept explanations, short summary or overview
Application (K3)	Suggest idea/concept with examples, suggest formulae, solve problems, Observe, Explain
Analyze (K4)	Problem-solving questions, finish a procedure in many steps, Differentiate between various ideas, Map knowledge

Evaluate(K5)	Longer essay/ Evaluation essay, Critique or justify with pros and cons
Create (K6)	Check knowledge in specific or offbeat situations, Discussion, Debating or Presentations

CO/PO/PSO	PO1	PO2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO1	**3**	**3**	**3**	**3**	**2**	**3**	**2**	**3**	**3**	**3**
CO2	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**
CO3	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**
CO4	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**2**	**3**	**3**
CO5	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**
Weightage of course contributed to each PSO	**15**	**15**	**15**	**15**	**14**	**15**	**14**	**14**	**15**	**15**

Semester-4

Semester–4									
Course Code	**Part**	**Course category**	**Course Name**	**Hours/ Week**	**Examination**				**Credits**
					Duration in Hours	**Max Marks**			
						CIA	**ESE**	**Total**	
26PCMA41	A	Core– IX	Advanced Algebra -II	6	3	50	50	100	5
26PCMA42	A	Core –X	Functional Analysis	6	3	50	50	100	5
26PPMA41	A	Project	Project with Viva Voce	10		50	50	100	6
26PEMA41	A	EC - VI	Differential Geometry	5	3	50	50	100	3
26PEMAP1			Mathematical Python – Practical						
26PEMA42			Algebraic Topology						
26PSMA41	B	SEC – III	Introduction to Machine Learning and Applications	3	3	50	50	100	2
26PSMA42			Financial Mathematics						
26PSMAP1			Programming in C++ – Practical						
26P3EA41	C	**Extension Activity**	**Extension Activity /Pollution Awareness/Literacy / Voluntary Services** Report to be submitted to the Department		3	50	50	100	1
			Total	**30**				**600**	**22**

SECOND YEAR – SEMESTER – IV

CORE COURSE – XI : ADVANCED ALGEBRA II

Subject Code	L	T	P	S	Credits	Inst. Hours	Marks		
							CIA	External	Total
26PCMA41	**6**	**0**	0	IV	**5**	**6**	**50**	**50**	**100**

Learning Objectives	
LO1	Understand the concept of field extensions and algebraic extensions.
LO2	Analyze the nature and behavior of roots of polynomials.
LO3	Develop a strong foundation in Galois Theory and its applications.
LO4	Study finite fields and properties of division rings.
LO5	Understand important theorems such as Frobenius theorem and four-square theorem.

Prerequisites:

Unit	Contents	No. of Hours
I	**Fields:** Extension fields Chapter 5: Section 5.1	**18**
II	**Roots of Polynomials**.- More about roots Chapter 5: Sections 5.3 and 5.5	**18**
III	**Galois Theory:** Elements of Galois theory. Chapter 5 : Section 5.6	**18**
IV	**Finite fields** - Wedderburn's theorem on finite division rings. Chapter 7: Sections 7.1 and 7.2 (Theorem 7.2.1 only)	**18**
V	**A theorem of Frobenius** - Integral Quaternions and the Four - Square theorem. Chapter 7 : Sections 7.3 and 7.4	**18**
TOTAL		**90**

CO	Course Outcomes
CO1	Prove theorems by applying algebraic ways of thinking like extension fields and Algebraic extensions.
CO2	Explain the nature of roots of Polynomials
CO3	Compose clear and accurate proofs using the concepts of Galois Theory.
CO4	Bring out insight into Finite fields
CO5	Demonstrate knowledge and understanding of fundamental concepts including a theorem of Frobenius , Integral Quaternions and the Four - Square theorem.

Textbooks

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

Reference Books

1 M.Artin, *Algebra,* Prentice Hall of India, 1991.

2 P.B.Bhattacharya, S.K.Jain, and S.R.Nagpaul, *Basic Abstract Algebra* (II Edition) Cambridge University Press, 1997 (Indian Edition)

3	I.S.Luther and I.B.S.Passi, *Algebra,* Vol. I –Groups(1996); Vol. II
4	*Rings,*Narosa Publishing House , New Delhi, 1999
5	D.S.Malik, J.N. Mordeson and M.K.Sen, *Fundamental of Abstract Algebra*, McGraw Hill (International Edition), New York. 1997.
6	N.Jacobson, *Basic Algebra,* Vol. I & IIHindustan Publishing Company, New Delhi.

CO/PO/PSO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PSO 1	PSO 2	PSO 3
CO1	**3**	**1**	**3**	**2**	**3**	**3**	**3**	**2**	**1**
CO2	**2**	**1**	**3**	**1**	**3**	**3**	**3**	**2**	**1**
CO3	**3**	**2**	**3**	**1**	**3**	**3**	**3**	**2**	**1**
CO4	**1**	**2**	**3**	**2**	**3**	**3**	**3**	**2**	**1**
CO5	**3**	**1**	**2**	**3**	**3**	**3**	**3**	**2**	**1**
Weightage of course contributed to each PSO	**12**	**7**	**14**	**9**	**15**	**15**	**15**	**10**	**5**

CORE COURSE – XII :

FUNCTIONAL ANALYSIS

Subject Code	L	T	P	S	Credits	Inst. Hours	Marks		
							CIA	External	Total
26PCMA42	**6**	**0**	0	IV	**5**	**6**	**50**	**50**	**100**

Learning Objectives	
LO1	Understand Banach spaces and continuous linear transformations.
LO2	Apply fundamental theorems like Hahn–Banach and Open Mapping Theorem.
LO3	Analyze operators including adjoint, self-adjoint, and unitary operators.
LO4	Study spectral theory and its applications.
LO5	Explore Banach algebras and their algebraic properties.

Prerequisites:

Unit	Contents	No. of Hours
I	**Banach Spaces:** The definition and some examples – Continuous linear transformations – The Hahn-Banach theorem – The natural imbedding of N in N^{**} Chapter 9:Sections 46-49	**18**
II	**The open mapping theorem** – The conjugate of an Operator. The definition and some simple properties–Orthogonal complements–Orthonormal sets Chapter 9:Sections 50 and 51 Chapter 10 : Sections 52-54	**18**
III	**The conjugate space H^*-**The adjoint of an operator–self- adjoint operators-Normal and unitary operators – Projections. Chapter10:Section 55-59	**18**
IV	**Finite Dimensional Spectral Theory:** Determinants and the spectrum of an operator –The spectral theorem. Chapter 11:Sections 61,62	**18**
V	**General Preliminaries on Banach Algebras:** The definition and some examples – Regular and singular elements – Topological divisors of zero – The spectrum. Chapter 12:Sections 64-67	**18**
TOTAL		**90**

CO	**Course Outcomes**
CO1	Understand the Banach spaces and Transformations on Banach Spaces.
CO2	Prove open mapping theorem.
CO3	Describe operators and fundamental theorems.
CO4	Validate spectral theorem.
CO5	Analyze and establish the regular and singular elements.

Textbooks	
1	G.F.Simmons, *Introduction to Topology and Modern Analysis*, McGraw Hill Education

	(India)Private Limited, New Delhi, 1963.
Reference Books	
1	W.Rudin, *Functional Analysis*, McGraw Hill Education (India) Private Limited, New Delhi, 1973.
2	B.V. Limaye, *Functional Analysis*, New Age International,1996.
3	C. Goffman and G. Pedrick, *First course in Functional Analysis*, Prentice Hall of India, NewDelhi,1987.
4	E. Kreyszig, *Introductory Functional Analysis with Applications*, John Wiley & Sons, New York, 1978.
5	M. Thamban Nair, *Functional Analysis*, A First course, Prentice Hall of India, New Delhi, 2002

CO/PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PSO 1	PSO 2	PSO 3
CO1	**3**	**1**	**3**	**2**	**3**	**3**	**3**	**2**	**1**
CO2	**2**	**1**	**3**	**1**	**3**	**3**	**3**	**2**	**1**
CO3	**3**	**2**	**3**	**1**	**3**	**3**	**3**	**2**	**1**
CO4	**1**	**2**	**3**	**2**	**3**	**3**	**3**	**2**	**1**
CO5	**3**	**1**	**2**	**3**	**3**	**3**	**3**	**2**	**1**
Weightage of course contributed to each PSO	**12**	**7**	**14**	**9**	**15**	**15**	**15**	**10**	**5**

PROJECT WITH VIVA VOCE

Subject Code	L	T	P	S	Credits	Inst. Hours	Marks		
							Internal	External	Total
26PPMA41	0	0	0	IV	6	10	50	50	100

Learning Objectives	
LO1	To assess the student dissertation for the award of degree, jointly by supervisor and one external examiner affiliated to Manonmaniam Sundaranar University .
LO2	To develop confident and empowers student for future career.
LO3	To better prepare students for solving real-world problems and issues while teaching them, encouraging giving additional information related to their topic.
LO4	To developed student interpersonal skills.
LO5	To encourages students to develop a balanced, diverse approach to solving real-societal problems, both on their own and in a team

CO	Course Outcomes	
CO1	Gives the student a skill such as problem solving, and helps to develop additional skills integral to their Future , such as critical thinking and time management.	PO1
CO2	Enhance their knowledge through practicals and experience.	PO1, PO2
CO3	Be developed interpersonal skills and decision-making skills.	PO4, PO6
CO4	Give a platform to demonstrate his/her abilities.	PO4, PO5, PO6
CO5	Be able to identify the strength and weakness, which will help them to enhance and improve their ability.	PO3, PO8

Methods of Evaluation		
Internal Evaluation	Dissertation Submission	50 Marks
External Evaluation	Viva Voce Examination	50 Marks

Methods of Assessment	
Recall (K1)	Simple definitions, MCQ, Recall steps, Concept definitions
Understad/ Comprehnd (K2)	MCQ, True/False, Short essays, Concept explanations, short summary or overview
Application (K3)	Suggest idea/concept with examples, suggest formulae, solve problems, Observe, Explain
Analyze (K4)	Problem-solving questions, finish a procedure in many steps, Differentiate between various ideas, Map knowledge
Evaluate(K5)	Longer essay/ Evaluation essay, Critique or justify with pros and cons
Create (K6)	Check knowledge in specific or offbeat situations, Discussion, Debating or Presentations

CO/PO/PSO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO1	3	3	3	3	2	3	2	3	3	3
CO2	2	3	3	3	3	3	3	3	3	3
CO3	3	2	3	1	2	3	3	3	3	3
CO4	3	3	3	3	2	3	3	2	3	3
CO5	3	3	3	3	2	3	2	3	3	3
Weightage of course contributed to each PSO	14	14	15	13	11	15	13	14	15	15

ELECTIVE – VI : DIFFERENTIAL GEOMETRY

Subject Code	L	T	P	S	Credits	Inst. Hours	Marks		
							CIA	External	Total
26PEMA41	**5**	**0**	0	IV	**3**	**5**	**50**	**50**	**100**

Learning Objectives	
LO1	Understand the geometry of space curves and their properties.
LO2	Study intrinsic properties of surfaces and metrics.
LO3	Analyze geodesics and curvature concepts.
LO4	Explore non-intrinsic properties such as curvature and developable surfaces.
LO5	Apply differential geometry concepts to solve geometric problems.

Prerequisites:

Unit	Contents	No. of Hours
I	**Space curves:** Definition of a space curve – Arc length – tangent – normal and binormal – curvature and torsion – contact between curves and surfaces- tangent surface- involutes and evolutes- Intrinsic equations – Fundamental Existence Theorem for space curves- Helies. Chapter I : Sections 1 to 9.	**15**
II	**Intrinsic properties of a surface:** Definition of a surface – curves on a surface – Surface of revolution – Helicoids – Metric- Direction coefficients – families of curves- Isometric correspondence- Intrinsic properties. Chapter II: Sections 1 to 9.	**15**
III	**Geodesics:** Geodesics – Canonical geodesic equations – Normal property of geodesics- Existence Theorems – Geodesic parallels – Geodesics curvature- Gauss- Bonnet Theorem – Gaussian curvature- surface of constant curvature. Chapter II: Sections 10 to 18.	**15**
IV	**Non Intrinsic properties of a surface:**The second fundamental form- Principal curvature – Lines of curvature – Developable - Developable associated with space curves and with curves on surface - Minimal surfaces – Ruled surfaces. Chapter III: Sections 1 to 8.	**15**
V	**Differential Geometry of Surfaces :**Compact surfaces whose points are umblics- Hilbert's lemma – Compact surface of constant curvature – Complete surface and their characterization – Hilbert's Theorem – Conjugate points on geodesics. Chapter IV : Sections 1 to 8	**15**
TOTAL		**75**

CO	**Course Outcomes**
CO1	Explain space curves, Curves between surfaces, metrics on a surface, fundamental for of a surface and Geodesics.
CO2	Evaluate these concepts with related examples.

CO3	Compose problems on geodesics.
CO4	Recognize applicability of developable.
CO5	Construct and analyze the problems on curvature and minimal surfaces
Textbooks	
1	T.J.Willmore, *An Introduction to Differential Geometry,* Oxford University Press,(17th Impression) New Delhi 2002. (Indian Print).
Reference Books	
1	Struik, D.T. *Lectures on Classical Differential Geometry,* Addison – Wesley, Mass. 1950.
2	Kobayashi. S. and Nomizu. K. *Foundations of Differential Geometry,*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.

CO/PO/PSO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PSO 1	PSO 2	PSO 3
CO1	**3**	**1**	**3**	**2**	**3**	**3**	**3**	**2**	**1**
CO2	**2**	**1**	**3**	**1**	**3**	**3**	**3**	**2**	**1**
CO3	**3**	**2**	**3**	**1**	**3**	**3**	**3**	**2**	**1**
CO4	**1**	**2**	**3**	**2**	**3**	**3**	**3**	**2**	**1**
CO5	**3**	**1**	**2**	**3**	**3**	**3**	**3**	**2**	**1**
Weightage of course contributed to each PSO	**12**	**7**	**14**	**9**	**15**	**15**	**15**	**10**	**5**

ELECTIVE COURSE: MATHEMATICAL PYTHON – PRACTICAL

Subject Code	L	T	P	S	Credits	Inst. Hours	Marks		
							CIA	External	Total
26PEMAP1	0	0	5	IV	3	5	**50**	**50**	**100**

Learning Objectives

LO1	Apply Python programming to solve mathematical problems.
LO2	Develop algorithms for searching, sorting, and numerical computations.
LO3	Analyze data using arrays and basic statistical measures.
LO4	Implement graph-related problems using adjacency matrices.
LO5	Visualize data using plots and charts.

Prerequisites:

Contents

1. Find minimum/maximum in a list / guess an integer in given range
2. Distance between two points
3. Find GCD
4. Sum an array of numbers
5. Linear search
6. Binary search.
7. Find the numbers which are divisible by n in a given range
8. Print first n Fibonacci numbers
9. Selection sort
10. Insertion sort
11. Merge sort
12. Count word frequencies
13. Generate adjacency matrix of any graph on n vertices
14. Find degree of vertices from given adjacency matrix of the graph
15. Find odd number in given array/ Replace odd numbers with given integer in the given array
16. Compute multiplication of two 3x3 matrices
17. Compute mean and standard deviation of given array
18. Create a Bar plot/Pie chart for comparing three features.

CO	Course Outcomes
CO1	Write programs using advanced concepts of Python.
CO2	Write, Test and Debug Python Programs.
CO3	Implement Conditionals and Loops for Python Programs.
CO4	Use functions and represent Compound data using Lists, Tuples and Dictionaries.
CO5	Read, write and manipulate data from & to files in Python.

CO/PO/PSO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PSO 1	PSO 2	PSO 3
CO1	**3**	**2**	**3**	**3**	**2**	**3**	**3**	**3**	**3**
CO2	**3**	**2**	**3**	**3**	**2**	**3**	**3**	**3**	**3**
CO3	**3**	**2**	**3**	**3**	**3**	**3**	**3**	**3**	**3**
CO4	**3**	**2**	**3**	**3**	**3**	**3**	**3**	**3**	**3**

CO5	2	2	2	3	3	3	3	3	3
Weightage of course contributed to each PSO	**14**	**10**	**14**	**15**	**13**	**15**	**15**	**15**	**15**

Textbooks	
1	Allen B.Dowley,*Think Python: How to Think Like a Computer Scientist*, 2nd Edition
Reference Books	
1	Wes McKinney, *Python for Data Analysis: Data Wrangling with Pandas, NumPy, and Ipython*, O'Reilly, 2nd Edition, 2018.
2	Jake VanderPlas, *Python Data Science Hand Book: Essential Tools for working with Data*, O'Reilly, 2017.
3	Wesley J. Chun, *Core Python Programming*, Prentice Hall, 2006.
4	N.Safina Devi and C.Devamanoharan, *Algorithmic Problem Solving and Python- A Beginner's Guide*, Francidev Publications, 2023.

ELECTIVE COURSE - VI: ALGEBRAIC TOPOLOGY

Subject Code	L	T	P	S	Credits	Inst. Hours	Marks		
							CIA	External	Total
26PEMA42	**5**	**0**	0	IV	**3**	**5**	**50**	**50**	**100**

Learning Objectives	
LO1	Understand fundamental group and homotopy concepts.
LO2	Analyze topological spaces using algebraic methods.
LO3	Study covering spaces and lifting theorems.
LO4	Apply algebraic topology to solve geometric problems.
LO5	Understand connections between topology and group theory.

Prerequisites:

Unit	Contents	No. of Hours
I	**Homotopy of paths**: fundamental group of a topological space, homotopy of maps of topological spaces, contractible and simply connected spaces. Chapter 9: Sec: 51, 52.	**15**
II	**The Fundamental group of the circle**: Path lifting lemma, Retractions and fixed points, Brouwer's fixed- point theorem for the disc, The fundamental Theorem of Algebra. Chapter 9. Sec: 54 – 56	**15**
III	**Covering spaces:** Equivalence of covering spaces, The general lifting lemma, The universal covering space. Chapter 9 : Sec: 53, Chapter 13: Sec: 79, 80	**15**
IV	**Separation theorems in the plane:** Null homotopy lemma, The Jordan separation theorem, A general separation theorem, Homotopy Extension lemma, Borsuk lemma, Invariance of domain. Chapter 10: Sec: 61, 62	**15**
V	**Applications to Group theory:** Covering spaces of a graph, The fundamental group of a graph. Chapter 14: Sec 83, 84.	**15**
	TOTAL	**75**

CO	Course Outcomes
CO1	Give an account of the concepts homotopy, homology and co-homology, their basic properties and relationships
CO2	Prove topological results by using algebraic methods
CO3	Use the theory to solve elementary topological problems
CO4	Compute algebro-topological invariants in specific examples
CO5	Explain the fundamental concepts of algebraic topology and their role in modern mathematics and applied contexts.

Textbooks

➢	James R. Munkres, *Topology*, Prentice Hall of India, New Delhi,2002 (2nd Edition).
Reference Books	
1.	M.K.Agoston, Algebraic topology- A First Course, Marcel Dekker, 1962
2.	Satya Deo, Algebraic Topology, Hindustan Book Agency, New Delhi, 2003.
3.	M.Greenberg and Harper, Algebraic Topology-A First course, Benjamin/Cummings, 1981.
4.	C.F. Maunder, Algebraic topology, Van Nastrand, New York, 1970

CO/PO/PSO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PSO 1	PSO 2	PSO 3
CO1	**3**	**1**	**3**	**2**	**3**	**3**	**3**	**2**	**1**
CO2	**2**	**1**	**3**	**1**	**3**	**3**	**3**	**2**	**1**
CO3	**3**	**2**	**3**	**1**	**3**	**3**	**3**	**2**	**1**
CO4	**1**	**2**	**3**	**2**	**3**	**3**	**3**	**2**	**1**
CO5	**3**	**1**	**2**	**3**	**3**	**3**	**3**	**2**	**1**
Weightage of course contributed to each PSO	**12**	**7**	**14**	**9**	**15**	**15**	**15**	**10**	**5**

SKILL ENHANCEMENT COURSE-III:
INTRODUCTION TO MACHINE LEARNING AND APPLICATIONS

Subject Code	L	T	P	S	Credits	Inst. Hours	Marks		
							CIA	External	Total
26PSMA41	**3**	0	0	IV	**2**	**3**	**50**	**50**	**100**

Learning Objectives	
LO1	Understand basic concepts and importance of machine learning.
LO2	Analyze the relationship between big data and machine learning.
LO3	Study different types of machine learning techniques.
LO4	Compare supervised, unsupervised, and reinforcement learning methods.
LO5	Understand neural networks and real-world applications.

Prerequisites:

Unit	Contents	No. of Hours
I	**Understanding Machine Learning** -What Is Machine Learning?	**09**
II	**Defining Big Data**- Big Data in Context with Machine Learning - Leveraging the Power of Machine Learning	**09**
III	**Descriptive analytics** - Predictive analytics - The Roles of Statistics and Data Mining with MachineLearning	**09**
IV	**Approaches to Machine Learning** - Supervised learning -Unsupervised learning - Reinforcement learning	**09**
V	**Neural Networks** - Applying machine Learning - Understanding machine Learning Techniques	**09**
	TOTAL	**45**

CO	Course Outcomes
CO1	Explain the basic concepts and applications of MachineLearning
CO2	Explain the big data and Leveraging the Power of Machine Learning
CO3	Discuss the applications of Machine Learning
CO4	Compare and contrast different supervised machine learning Algorithms
CO5	Explain the neural networks and applications of machine learning.

Text books

➢ 1. Judith Hurwitz and Daniel Kirsch, Machine Learning For Dummies, IBM Limited Edition, Wiley, 2018.

➢	Ethem Alpaydın "Introduction to Machine Learning Second Edition", The MIT Press Cambridge, Massachusetts, London, England

CO/PO/PSO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PSO 1	PSO 2	PSO 3
CO1	**3**	**1**	**3**	**2**	**3**	**3**	**3**	**2**	**2**
CO2	**2**	**1**	**3**	**1**	**3**	**3**	**3**	**1**	**1**
CO3	**3**	**2**	**3**	**1**	**3**	**3**	**3**	**2**	**1**
CO4	**1**	**2**	**3**	**2**	**3**	**3**	**3**	**1**	**2**
CO5	**3**	**1**	**2**	**3**	**3**	**3**	**3**	**2**	**1**
Weightage of course contributed to each PSO	**12**	**7**	**14**	**9**	**15**	**15**	**15**	**8**	**7**

SKILL ENHANCEMENT COURSE-III:
FINANCIAL MATHEMATICS

Subject Code	L	T	P	S	Credits	Inst. Hours	Marks		
							CIA	External	Total
26PSMA42	**3**	0	0	IV	**2**	**3**	**50**	**50**	**100**

Learning Objectives	
LO1	Understand probability concepts used in finance.
LO2	Analyze Brownian motion and geometric Brownian motion.
LO3	Evaluate interest rates and present value of investments.
LO4	Apply arbitrage principles in pricing financial contracts.
LO5	Understand and apply the Arbitrage Theorem.

Prerequisites:

Unit	Contents	No. of Hours
I	Probability and Normal Random Variables	**09**
II	Brownian Motion and Geometric Brownian Motion	**09**
III	Interest Rate and Present Value Analysis	**09**
IV	Pricing Contracts via Arbitrage	**09**
V	The Arbitrage Theorem	**09**
TOTAL		**45**

CO	Course Outcomes
CO1	Understanding probability theory
CO2	Analyze the Geometric Brownian Motion
CO3	Knowledge of Interest Rate and making fair present value analysis
CO4	Examine pricing contracts by understanding and using Arbitrage
CO5	Understanding Arbitragetheorem with various examples

Text books

➢	Sheldon M. Ross, An Introduction to Mathematical Finance : Options and Other Topics, Second Edition, Cambridge University Press, First published 2002.

Reference Books

1	Karatzas and S.E.Shreve, Methods of Mathematical Finance, Springer, 1998.

CO/PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	Mean Score
CO1	3	3	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3	3	3
CO4	3	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3	3	3
Weightage of course contributed to each PSO	15	15	15	15	15	15	15	15	15

SKILL ENHANCEMENT COURSE-III:
PROGRAMMIMG IN C++ - PRACTICALS

Subject Code	L	T	P	S	Credits	Inst. Hours	Marks		
							Internal	External	Total
26PSMAP1	**0**	0	**3**	IV	2	**3**	**50**	**50**	**100**

Learning Objectives

LO1	Develop problem-solving skills using C++ programming.
LO2	Implement mathematical computations through programs.
LO3	Apply object-oriented programming concepts.
LO4	Write, test, and debug efficient C++ programs.
LO5	Use functions, classes, and file handling effectively.

Prerequisites:

Contents

List of Practical's:

1. Programs to evaluate sin x, cos x, e^{-x} to 0.0001% accuracy.
2. Program to calculate the variance and standard deviation of a set of numbers.
3. Program to find Product of matrices, inverse of a matrix using functions. Macro that obtains largest of three numbers.
4. Define a class of students and prepare a statement containing name, total marks of Ranks (using functions).
5. Program to check whether a number/ string is a palindrome without using the corresponding standard function.
6. Write a program to conversion between polar and rectangle co-ordinates
7. Define a class string and exhibit the use of string manipulations.
8. Write a program to finding area of 2 different shapes
9. Create a class FLOAT that contains one float data. Overload all the four arithmetic.
10. Write a C++ program implement a class 'Complex' of complex numbers. The class could be include member functions to add and subtract two complex numbers.
11. Write a C ++ program to implement a class for complex numbers with add and multiply as member functions. Overload ++ operator to increment a complex number.
12. Write a program in C++ to demonstrate friend function.

CO	Course Outcomes

CO1	Write programs using advanced concepts of C++
CO2	Write, Test and Debug C++ Programs.
CO3	Implement Conditionals and Loops for C++ Programs.
CO4	Use functions and represent Compound data using Lists, Tuples and Dictionaries.
CO5	Read, write and manipulate data from & to files in C++.

Text books	
➢	E.Balagurusamy, Object Oriented Programming with C++ , 4th Edition, The McGraw- Hill Company, New Delhi, 2008.
Reference Books	
1	V.Ravichandran, Programming with C++, Second Edition Tata McGraw- Hill, New Delhi, 2006.

CO/PO/PSO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**Mean Score**
CO1	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**
CO2	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**
CO3	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**
CO4	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**
CO5	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**
Weightage of course contributed to each PSO	**15**	**15**	**15**	**15**	**15**	**15**	**15**	**15**	**15**

EXTENSION ACTIVITY /POLLUTION AWARENESS/LITERACY/ VOLUNTARY SERVICES

Subject Code	L	T	P	S	Credits	Inst. Hours	Marks		
							CIA	External	Total
26P3EA41	**0**	0	0	IV	**1**	**-**	**50**	**50**	**100**

Learning Objectives	
LO1	Extension activities concentrates on putting across in an understandable manner new ideas and improved technologies of practical utility to the rural, tribal and urban privileged and underprivileged people.
LO2	Enables students to use the newly acquired knowledge and skills to improve their general standard of living.
LO3	It is a social science that attempts to adopt various strategies of change in the behaviour patterns of people through technological and scientific innovations for the improvement of their standard of living.
LO4	The idea behind the extension work is the coming together for the task of social upliftment.
LO5	Students typically develop leadership and teamwork skills and become more attuned to working amongst populations of varying ethnicity or socio economic status.

CO	**Course Outcomes**	
CO1	Is a learning-teaching methods connect meaningful community service to academic curricula	PO1, PO8
CO2	Service-learning blends community service goals and formal and informal (standard/academic and experiential/non-standard) educational goals in a manner that benefits participants and recipients.	PO1, PO2
CO3	Extension activities and learning is a set of techniques and tools that can strengthen community relationships and connections.	PO5, PO3
CO4	Extension contributes to national development programmers.	PO4, PO6
CO5	It enhances leadership and team work qualities among the students	PO6, PO4

Internal Evaluation	Continuous Performance Assessment and Viva Voce	50 Marks
External Evaluation	Extension Activity Report	50 Marks
	Total	100 Marks

Recall (K1)	Simple definitions, MCQ, Recall steps, Concept definitions
Understand/ Comprehend (K2)	MCQ, True/False, Short essays, Concept explanations, short summary or overview
Application (K3)	Suggest idea/concept with examples, suggest formulae, solve problems, Observe, Explain
Analyze (K4)	Problem-solving questions, finish a procedure in many steps, Differentiate between various ideas, Map knowledge
Evaluate (K5)	Longer essay/ Evaluation essay, Critique or justify with pros and cons
Create (K6)	Check knowledge in specific or offbeat situations, Discussion, Debating or Presentations

CO/PO/PSO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**
CO 1	**3**	**3**	**3**	**3**	**2**	**2**	**2**	**3**	**2**	**3**
CO 2	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**
CO 3	**3**	**2**	**3**	**3**	**2**	**2**	**3**	**3**	**3**	**3**
CO 4	**3**	**3**	**3**	**3**	**3**	**2**	**3**	**3**	**3**	**3**
CO 5	**3**	**3**	**3**	**3**	**3**	**2**	**2**	**3**	**2**	**3**
Weightage of course contributed to each PSO	**15**	**14**	**15**	**15**	**13**	**14**	**13**	**15**	**13**	**15**