M.Sc. MATHEMATICS

(Effective from the academic year 2024 - 2025)

Vision of the Department:

To develop the leadership quality to handle all types of crises in their learning cum working environment, using logical, analytical, and critical thinking skills, holding the ethical values to become an enlightened citizen.

Mission:

To make the students capable of applying mathematical knowledge and computation skills to model, formulate real-life problems, and achieve solutions to serve the nation ethically with socio-economic responsibilities.

Eligibility for admission to M.Sc. Mathematics:

A candidate who has passed the B.Sc. Degree Examination in Branch I Mathematics or B.Sc. Applied Science of Thiruvalluvar University or an examination of some other University accepted by the Syndicate as equivalent thereto shall be eligible for admission to M.Sc. Degree Programme in Mathematics.

Objectives:

- To develop a deep and comprehensive understanding of advanced mathematical concepts, theories, and methods.
- To inculcate advanced critical thinking and logical reasoning abilities.
- To cultivate the ability to conduct mathematical research, including problem formulation, methodology, analysis, and interpretation of results.
- To specialize in specific areas of mathematics such as pure and applied mathematics, statistics, and computational mathematics.
- To prepare students for professional careers in academia, industry, government, and other sectors that require high-level mathematical expertise.
- To instill an awareness of the ethical implications of mathematical work and research.

Highlights of the Revamped Curriculum:

- Student-centric, meeting the demands of academics, industry, tech companies & society, incorporating industrial components, hands-on training, skill development modules, industrial project, a project with viva-voce, exposure to entrepreneurial skills, training for competitive examinations, sustaining the quality of the core components and incorporating application-oriented content wherever required.
- The curriculum is designed to strengthen the tech companies-industry-academia interface and provide more job opportunities for the students.
- The Core and Elective subjects emphasize rigorous proof-writing, theoretical understanding, and options to specialize in pure and applied mathematics with research aptitude.
- State-of-the-art techniques from the streams of inter-disciplinary nature are incorporated as Electives. Training in Mathematical software and programming languages such as MATLAB, R, LaTeX, JAVA, and Python are designed to render skills to make students employable and entrepreneurial.
- Skill Enhancement and Professional Competency Skill courses impart problem-solving skills to the students and help them to face competitive examinations.
- The Internship and Industrial Activity during the first-year vacation is intended to give hands-on training to students that will help them gain valuable work experience and connects classroom knowledge to real-world experience, narrow down and focus on the career path enabling them to become market-ready and choose a career.
- Human rights course allows individuals to be responsible citizens which remains a requisite to the possibility of a just society.
- MOOC course is prescribed to reinforce self-learning and to instill the value of life-long learning in students.
- The project with the viva voce component in the fourth semester is key to honing the research aptitude that enables the students to apply their conceptual knowledge to practical situations.

Value additions in the Revamped Curriculum:

Semester	Newly introduced Components	Outcome / Benefits
I, II, III, IV	**Core Courses in Mathematics**	Students from Mathematics Major in Under graduation get a stronger footing in the subject, by mastering the discipline.
I, II, III, IV	**Elective papers -** An open choice of topics categorized under Generic and Discipline Centric	● Strengthening the domain knowledge. ● Introducing the stakeholders to the state-of-the-art techniques from the streams of interdisciplinary nature. ● Topics related to technology are introduced to facilitate advanced learning in the respective domains. ● Improve the technical know-how of solving problems and make them Industry-ready graduates.
II, III, IV	**Skill Enhancement papers / Professional competency skills** (Discipline centric / Generic / Entrepreneurial)	● Skilled human resources. ● Students are equipped with essential problem-solving skills to face competitive examinations and make them employable.
Semester III (Vacation activity)	Internship / Industrial Training	● Practical training at the Industry/ Educational institutions, enables the students to gain professional experience and become responsible citizens.
Semester IV	Project with Viva - voce	● Self-learning, critical thinking, problem-solving and research acumen is enhanced. ● Application of the concept to real situation is conceived resulting in tangible outcome.

Skills acquired from the Courses	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill.

TANSCHE - BASED PROGRAMME STRUCTURE FOR M.Sc. MATHEMATICS

(For the candidates admitted from the academic year 2024-2025)

Sem	Part	Category	Course Code	Title	Hours/ Week	Exam		Credits	Marks
						Th	Pr		
I	A	Core I	PCMAA24	Algebraic Structures	6	3	-	5	40+60
		Core II	PCMAB24	Real Analysis – I	6	3	-	5	40+60
		Core III	PCMAC24	Ordinary Differential Equations	6	3	-	4	40+60
		Elective I (Discipline Centric)	PEMAA24	Elective: Advanced Graph Theory	5	3	-	3	40+60
			PEMAB24	Elective: Number Theory and Cryptography					
		Elective II (Generic)	PEMAC24/ PEMAD24	Elective: Programming with Java Elective Practical: Java	3 + 2	3	3	2+1	40+60
			PEMAE24/ PEMAF24	Elective: Programming with R Elective Practical: R					
	B			Human Rights	1	-	-	-	-
				Value Education	1	-	-	-	-
				Total	**30**			**20**	**500**
II	A	Core IV	PCMAD24	Advanced Algebra	6	3	-	5	40+60
		Core V	PCMAE24	Real Analysis - II	6	3	-	5	40+60
		Core VI	PCMAF24	Partial Differential Equations	6	3	-	4	40+60
		Elective III (Discipline Centric)	PEMAG24	Elective: Mathematical Statistics	4	3	-	3	40+60
			PEMAH24	Elective: Fuzzy Sets and their Applications					
		Elective IV (Generic)	PEMAI24	Elective: Differential Geometry	4	3	-	3	40+60
			PEMAJ24	Elective: Wavelets					
	B	Skill Enhancement Course [SEC I]	PSMAI24	SEC: Quantitative Aptitude for Competitive Examinations-I	2	-	-	2	100
			PNHRA24	Human Rights	1	2	-	2	40+60
				Value Education	1	-	-	-	-
			POMA24	Online Course	-	-	-	1	-
				Total	**30**			**25**	**700**

Sem	Part	Category	Course Code	Title	Hours/ Week	Exam		Credits	Marks
						Th	Pr		
III	A	Core VII	PCMAG24	Complex Analysis	6	3	-	5	40+60
		Core VIII	PCMAH24	Mechanics	6	3	-	5	40+60
		Core IX	PCMAI24	Topology	6	3		5	40+60
		Core X [Industry Module]	PCMAJ24	Probability Theory	6	3	-	4	40+60
		Elective V	PEMAK24	Elective: Resource Management Techniques	3	3	-	3	40+60
			PEMAL24	Elective: Fluid Dynamics					
	B	Skill Enhancement Course [SEC II]	PSMA224	SEC: Quantitative Aptitude for Competitive Examinations-II	2	-	-	2	100
			PIMA24	Internship	-	-	-	2	
				Value Education	1	-	-	-	-
				Total	**30**			**26**	**600**
IV	A	Core XI	PCMAK24	Functional Analysis	6	3	-	5	40+60
		Core XII	PCMAL24	Numerical Analysis	6	3	-	5	40+60
		Project	PCMAM24	Research Methodology and Ethics Project with Viva Voce	5 + 5	-	-	3+4	40+60
		Elective VI	PEMAM24	Elective: LaTeX and MATLAB	4	3	-	3	40+60
			PEMAN24	Elective: Mathematical Python (Among the two choices, anyone can be chosen by the student - 20% Theory and 80% Practical)					
	B C	Professional Competency Skill Enhancement Course	PSMA324	Skill Enhancement in Algebra and Real Analysis	3	2	-	2	40+60
				Value Education	1	-	-	-	-
				Extension Activity****	-	-	-	1	-
				Total	**30**			**23**	**500**
				Grand Total	**120**			**94 +2***	**2300**

- * Any one course of the following to be completed during III semester (15 hours teaching and 15 hours activities):
  i) Teaching and Research Aptitude
  ii) Artificial Intelligence Tools
  iii) Entrepreneur Skill
  iv) Photography

** Minimum of 4-week Massive Open Online Course (MOOC) to be completed through Swayam platform.

*** Internship/Industrial training to be carried out during summer vacation at the end of I year for 30 days.

**** 30 hrs. of Extension Activity to be completed by the end of I semester.

Methods of Evaluation						
S. No.	**Category**	**Assessment Tool**	**Maximum Marks**	**Exam Theory**	**Weightage**	
1	Core Courses/Generic & Discipline Specific Electives	I Continuous Assessment (ICA)	50	1 ½ hrs.	35	40
		II Continuous Assessment (IICA)	50	1 ½ hrs.		
		Innovative Component (IC)	5	-	5	
		End Semester Examination	100	3 hrs.		60
2	Professional Competency Skill Enhancement Course	I Continuous Assessment (ICA)	30	1 hr. (MCQ)	35	40
		II Continuous Assessment (IICA)	30	1 hr. (MCQ)		
		Innovative Component (IC)	5	-	5	
		End Semester Examination	60	2 hrs. (MCQ)		60
3	HR	Continuous Assessment (IICA)	25	1 hr.		40
		Innovative Component (IC)	25	-		
		End Semester Examination	60	2 hrs.		60

Methods of Evaluation							
S. No.	**Category**	**Assessment Tool**	**Maximum Marks**	**Exam Theory**	**Exam Practical**	**Weightage**	
4.	Elective II (Generic)	I Continuous Assessment (ICA)	50	1 ½ hrs.	-	35	40
		II Continuous Assessment (IICA)	50	1 ½ hrs.	-		
		Innovative Component (IC)	5	-	-	5	
		Elective Practical: Continuous Assessment (CA)	25	-	1 ½ hrs.	25	

		Observation	10	-	-	10	
		Perfection	5	-	-	5	
		End Semester Examination	100	3 hrs.	-	60	
		Elective Practical: End Semester Practical Examination	45	-	3 hrs.	45	60
		Record	10			10	
		Viva Voce	5			5	

Methods of Evaluation						
S. No.	**Category**	**Assessment Tool**	**Maximum Marks**	**Exam Practical**	**Weightage**	
5.	Elective VI	I Continuous Assessment (ICA)	30	1 ½ hrs.	25	40
		II Continuous Assessment (IICA)	30	1 ½ hrs.		
		Observation	10	-	10	
		Perfection	5	-	5	
		End Semester Practical Examination	45	3 hrs.		60
		Record	10	-		
		Viva Voce	5	-		

S. No.	**Category**	**Assessment Tool**	**Maximum Marks**	**Exam Theory**	**Weightage**	
6.	Project	**Research Methodology and Ethics:** I Continuous Assessment (ICA)	50	1 ½ hrs.	35	40
		II Continuous Assessment (IICA)	50	1 ½ hrs.		
		Innovative Component (IC)	5	-	5	
		Project and Viva: Project	40 (Internal Examiner = 20 External Examiner = 20)	-		60
		Viva Voce	20 (Content = 10 Presentation = 5 Answering Questions = 5)	-		

Activity-based Assessment for Skill Enhancement Courses (SEC I & II):

Activity 1 for Unit I: (Nature of Activity) – 20 marks

Activity 2 for Unit II: (Nature of Activity) – 20 marks

Activity 3 for Unit III: (Nature of Activity) – 20 marks

Activity 4 for Unit IV: (Nature of Activity) – 20 marks

Activity 5 for Unit V: (Nature of Activity) – 20 marks

Nature of Activity: Field visit/Industrial visit/Project (individual or group)/Exhibits/Model making/Hands-on training/Lab practice/Product making/Extempore/Block and Tackle/Debate/Report writing/Case study/Interpretation of data or results/Transcription/Quiz (LMS)/Problem-solving/ Designing/Role-play/Start-up proposal/Research proposal/Poster presentation/Oral presentation (live or video recorded)/Survey (Field or Online)/Group discussion/Problem formulation/Interviews/Concept mapping/Mind mapping /Promoting public awareness etc.

(Record of Assessment will be maintained by the course instructors and verified by the Head of the department.)

Cognitive Levels of Assessment	
Recall (K1)	Simple definitions, MCQ, Recall steps, Concept definitions, and Statement of the theorems.
Understand/ Comprehend (K2)	MCQ, True/False, Short essays, Concept explanations, short summary or Overview.
Application (K3)	Suggest ideas/concepts with examples, suggest formulae, Solve problems, Observe, Explain.
Analyze (K4)	Problem-solving questions, finish a procedure in many steps, Differentiate between various ideas, testing and analyzing the statement of the theorems, and Map knowledge.
Evaluate (K5)	Longer essay/Evaluation essay, justifying and testing the statement of the theorems.
Create (K6)	Check knowledge in specific or offbeat situations, Discussion, Debating, or Presentations, and Test/Validate/Justify the statement of the theorems.

PROGRAMME OUTCOMES (PO)

On completion of the PG Programme, students will be able to:

PO1: Attain an in-depth knowledge in the respective domains augmented through self-learning.

PO2: Assimilate and apply principles and concepts towards skill development and employability.

PO3: Apply critical and scientific approaches to address problems and find solutions.

PO4: Develop research skills through multi/inter/trans-disciplinary perspectives.

PO5: Integrate issues of social relevance in the field of study.

PO6: Persist in life-long learning for personal and societal progress.

PROGRAMME SPECIFIC OUTCOMES (PSO)

On completion of the PG Programme in Mathematics, students will be able to:

PSO1: Attain in-depth knowledge of Pure Mathematics through theorems and Applied Mathematics using real-life examples and simulation results.

PSO2: Develop a deep interest in Advanced Mathematics and have the capability to understand the outcomes in various branches of Mathematics.

PSO3: Apply the programming concepts of JAVA, MATLAB, and R language to model, formulate, and solve real-life problems.

PSO4: Acquire profound knowledge in Mathematics to develop generic skills to qualify for the fellowship examinations approved by UGC like CSIR-NET, JRF, GATE, and SET.

PSO5: Inculcate research-level thinking in pure and applied mathematics and apply theoretical knowledge to write the dissertation using the Mathematical software LaTeX.

PSO6: Develop teaching, research, and technical skills in Mathematics for employment in different sectors and enhance self-learning & life-long learning to compete globally and meet social needs.

PSO/PO	PO1	PO2	PO3	PO4	PO5	PO6
PSO1	H	H	H	H	M	H
PSO2	H	M	H	H	M	H
PSO3	H	H	H	H	H	H
PSO4	H	H	H	H	L	M
PSO5	H	H	H	H	M	H
PSO6	H	H	H	H	L	H

(HIGH (H) - 3, MODERATE (M) - 2, LOW (L) - 1)

<table>
<tr><td>Title of the Course</td><td colspan="7">ALGEBRAIC STRUCTURES</td></tr>
<tr><td>Paper No.</td><td colspan="7">Core I</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Core</td><td>Year</td><td>I</td><td>Credits</td><td>5</td><td>Course Code</td><td>PCMAA24</td></tr>
<tr><td>Semester</td><td>I</td></tr>
<tr><td>Instructional Hours per week</td><td>Lecture</td><td>Tutorial</td><td colspan="3">Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td></td><td>5</td><td>1</td><td colspan="3">-</td><td colspan="2">6</td></tr>
<tr><td>Pre-requisites</td><td colspan="7">UG-level Modern Algebra</td></tr>
<tr><td>Objectives of the Course</td><td colspan="7">• To introduce the concepts of counting principles and Sylow’s subgroups.
• To gain knowledge on direct products and finite abelian groups.
• To impart various concepts in matrix theory.
• To familiarize with the characteristic polynomial and linear transformation.
• To explain the various problems in a Symmetric matrix and Hermitian matrix.</td></tr>
<tr><td>Course Outline</td><td colspan="7">UNIT I (18 hours) (K1, K2, K3, K4, K5 & K6)
Group Theory
1.1 Counting Principle
1.2 Class equation for finite groups and its applications
1.3 Cauchy’s theorem
1.4 First part of Sylow’s Theorem
1.5 Second part of Sylow’s Theorem
1.6 Third part of Sylow’s Theorem
Chapter 2: Sections 2.11 and 2.12 (for theorem 2.12.1 include first proof only, include Lemma 2.12.3 & 2.12.4, omit Lemma 2.12.1, 2.12.2 & 2.12.5)</td></tr>
<tr><td></td><td colspan="7">UNIT II (18 hours) (K1, K2, K3, K4, K5 & K6)
Group Theory, Fields and Modules
2.1 External direct product
2.2 Internal direct product
2.3 Finite Abelian groups
2.4 Finite Abelian groups (contd.)
2.5 Module, Direct sum, Sub module, Cyclic
2.6 Fundamental theorem on finitely generated R- modules
Chapter 2: Sections 2.13 and 2.14, Chapter 4: Section 4.5</td></tr>
<tr><td></td><td colspan="7">UNIT III (18 hours) (K1, K2, K3, K4, K5 & K6)
Linear Transformations
3.1 Introduction
3.2 Similar
3.3 Canonical form
3.4 Triangular form
3.5 Nilpotent transformation
3.6 Invariant and Cyclic
Chapter 6: Sections 6.4 and 6.5</td></tr>
</table>

	UNIT IV (18 hours) (K1, K2, K3, K4, K5 & K6) **Linear Transformations (Contd.)** 4.1 Introduction 4.2 Jordan Canonical form 4.3 Jordan Block 4.4 Rational canonical form, Cyclic sub-modules 4.5 Companion matrix 4.6 Elementary Divisors and Characteristic Polynomial **Chapter 6: Sections 6.6 and 6.7**
	UNIT V (18 hours) (K1, K2, K3, K4, K5 & K6) **Types of Linear Transformations** 5.1 Trace 5.2 Transpose 5.3 Hermitian 5.4 Unitary 5.5 Normal transformations 5.6 Real Quadratic form **Chapter 6: Sections 6.8, 6.10 and 6.11**
Extended Professional Component (isa part of the internal component only, not to be included in theexternal examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC and others to be solved. (To be discussed during the Tutorial hours)
Text Book	I.N. Herstein, Topics in Algebra, 2nd 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; also published by Hindustan Publishing Company, New Delhi, 1980.
Web Resources	1. http://mathforum.org 2. http://ocw.mit.edu/ocwweb/Mathematics 3. http://www.opensource.org 4. www.algebra.com

CO	Course Outcomes
On completion of this course, students will be able to;	
CO1	Recall the basic counting principle, define class equations to solve problems, explain Sylow's theorems, and apply the theorem to find the number of Sylow subgroups.
CO2	Define direct products, examine the properties of finite abelian groups, and define modules.
CO3	Define similar Transformations, define invariant subspace, explore the properties of the triangular matrix, find the index of Nilpotent to decompose space into invariant subspaces, find invariants of a linear transformation, explore the properties of nilpotent transformation relating nilpotent with invariants.
CO4	Define Jordan, canonical form, Jordan blocks, define rational canonical form, define companion matrix of polynomial, find the elementary devices of transformation, and apply the concepts to find the characteristic polynomial of linear transformation.
CO5	Define trace, define transpose of a matrix, explain the properties of trace and transpose, find a trace, find the transpose of a matrix, prove Jacobson lemma using the triangular form, define a symmetric matrix, skew-symmetric matrix, adjoint, to define Hermitian, unitary, normal transformations and to verify whether the transformation is Hermitian, unitary and normal.

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	H	M	H	H	M	H
CO2	H	H	H	H	L	M
CO3	H	H	H	H	M	M
CO4	H	H	H	H	L	M
CO5	H	H	H	H	L	M

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	H	M	H	M	L	M
CO2	H	H	H	M	L	M
CO3	H	H	H	M	L	M
CO4	H	H	H	M	L	M
CO5	H	H	H	M	L	M

<table>
<tr><td>Title of the Course</td><td colspan="7">REAL ANALYSIS – I</td></tr>
<tr><td>Paper No.</td><td colspan="7">Core II</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Core</td><td>Year</td><td>I</td><td>Credits</td><td>5</td><td>Course Code</td><td>PCMAB24</td></tr>
<tr><td>Semester</td><td>I</td><td colspan="4"></td></tr>
<tr><td>Instructional Hours per week</td><td>Lecture</td><td>Tutorial</td><td colspan="3">Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td></td><td>5</td><td>1</td><td colspan="3">-</td><td colspan="2">6</td></tr>
<tr><td>Pre-requisites</td><td colspan="7">UG – Level Real Analysis</td></tr>
<tr><td>Objectives of the Course</td><td colspan="7">• To impact the concepts of bounded variation and rectifiable curves.
• To work exclusively with Riemann Stieltjes integral and its respective properties.
• To introduce various concepts in step function and Lebesgue integrable functions.
• To familiarize the double sequences, double series, and infinite products alongside the power series method.
• To enrich the analysis of uniform convergence using basic theorems.</td></tr>
<tr><td>Course Outline</td><td colspan="7">UNIT I (18 hours) (K1, K2, K3, K4, K5 & K6)
Functions of bounded Variation and Infinite Series
1.1 Introduction, Properties of monotonic functions, Functions of bounded variation
1.2 Total variation, Additive property of total variation, Total variation on [a, x] as a function of x
1.3 Functions of bounded variation expressed as the difference of increasing functions
1.4 Continuous functions of bounded variation
1.5 Absolute and conditional convergence, Dirichlet's test and Abel's test, Rearrangements of series
1.6 Riemann's theorem on conditionally convergent series
Chapter 6: Sections 6.1 – 6.8, Chapter 8: Sections 8.8, 8.15, 8.17 and 8.18</td></tr>
<tr><td></td><td colspan="7">UNIT II (18 hours) (K1, K2, K3, K4, K5 & K6)
The Riemann - Stieltjes Integral
2.1 Introduction, Notation, The definition of the Riemann - Stieltjes integral, Linear Properties
2.2 Integration by parts, Change of variable in a Riemann - Stieltjes integral
2.3 Reduction to a Riemann Integral, Step functions as integrators
2.4 Reduction of a Riemann - Stieltjes integral to a finite sum, Euler’s summation formula
2.5 Monotonically increasing integrators, Upper and lower integrals, Additive and linearity properties of upper, and lower integrals
2.6 Riemann's condition, Comparison theorems</td></tr>
</table>

	Chapter 7: Sections 7.1 – 7.14
	UNIT III (18 hours) (K1, K2, K3, K4, K5 & K6) **The Riemann-Stieltjes Integral (Contd.)** 3.1 Integrators of bounded variation, Sufficient conditions for existence of Riemann - Stieltjes integrals, Necessary conditions for existence of Riemann - Stieltjes integrals 3.2 Mean Value Theorems for Riemann - Stieltjes integrals, The Integrals as a function of Interval 3.3 Second fundamental theorem of integral calculus, Change of variable in a Riemann Integral 3.4 Second Mean Value Theorem for Riemann integrals, Riemann - Stieltjes integrals depending on a parameter 3.5 Differentiation under the integral sign, Interchanging the order of integration 3.6 Lebesgue's criterion for the existence of Riemann integrals **Chapter 7: Sections 7.15 – 7.26**
	UNIT IV (18 hours) (K1, K2, K3, K4, K5 & K6) **Infinite Series, infinite Products, and Power series** 4.1 Double sequences, Double series 4.2 Rearrangement theorem for double series, A sufficient condition for equality of iterated series 4.3 Multiplication of series, Cesaro summability, Infinite products 4.4 Power series, Multiplication of power series, The Taylor's series generated by a function 4.5 Bernstein's theorem 4.6 Abel's limit theorem, Tauber's theorem **Chapter 8: Sections 8.20 – 8.26,** **Chapter 9: Sections 9.14, 9.15, 9.19, 9.20, 9.22 and 9.23**
	UNIT V (18 hours) (K1, K2, K3, K4, K5 & K6) **Sequences of Functions** 5.1 Pointwise convergence of sequences of functions, Examples of sequences of real-valued functions 5.2 Definition of uniform convergence, Uniform convergence and continuity, The Cauchy condition for uniform convergence 5.3 Uniform convergence of infinite series of functions, Uniform convergence, and Riemann - Stieltjes integration 5.4 Non-uniformly convergent sequences that can be integrated term by term, Uniform convergence, and differentiation 5.5 Sufficient conditions for uniform convergence of a series 5.6 Mean convergence **Chapter 9: Sections 9.1 - 9.6, 9.8 - 9.11, and 9.13**

Extended Professional Component (isa part of the internal component only, not to be included in theexternal examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC and others to be solved. (To be discussed during the Tutorial hours)

Text Book	Tom M. Apostol, Mathematical Analysis, 2nd Edition, Addison-Wesley Publishing Company Inc. New York, 1974.
Reference Books	1. Bartle R.G., Real Analysis, John Wiley and Sons Inc., 1976. 2. Rudin W., Principles of Mathematical Analysis, 3rd Edition. McGraw Hill Company, New York, 1976. 3. Malik S.C. and Savita Arora, Mathematical Analysis, Wiley Eastern Limited, New Delhi, 1991. 4. Sanjay Arora and Bansi Lal, Introduction to Real Analysis, Satya Prakashan, New Delhi, 1991. 5. Gelbaum B.R. and J. Olmsted, Counter Examples in Analysis, Holden day, San Francisco, 1964. 6. A.L. Gupta and N.R. Gupta, Principles of Real Analysis, Pearson Education, (Indian print) 2003.
Web Resources	1. http://mathforum.org 2. http://ocw.mit.edu/ocwweb/Mathematics 3. http://www.opensource.org 4. www.mathpages.com

CO	**Course Outcomes**
On completion of this course, students will be able to;	
CO1	Analyze and evaluate functions of bounded variation and rectifiable curves.
CO2	Describe the concept of Riemann-Stieltjes integral and its properties.
CO3	Demonstrate the concept of a step function, upper function, Lebesgue function, and their integrals.
CO4	Construct various mathematical proofs using the properties of infinite products and establish various powers series methods.
CO5	Formulate the concept and properties of sequences of functions and Cauchy's condition for uniform convergence.

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	H	H	L	H	M	H
CO2	H	H	L	H	M	H
CO3	H	H	L	H	M	H
CO4	H	H	L	H	M	H
CO5	H	H	L	H	M	H

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	H	H	H	M	L	M
CO2	H	H	H	M	L	M
CO3	H	H	H	M	L	M
CO4	H	H	H	M	L	M
CO5	H	H	H	M	L	M

<table>
<tr><td>Title of the Course</td><td colspan="7">ORDINARY DIFFERENTIAL EQUATIONS</td></tr>
<tr><td>Paper No.</td><td colspan="7">Core III</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Core</td><td>Year</td><td>I</td><td>Credits</td><td>4</td><td>Course Code</td><td>PCMAC24</td></tr>
<tr><td>Semester</td><td>I</td></tr>
<tr><td>Instructional Hours per week</td><td>Lecture</td><td>Tutorial</td><td colspan="3">Lab Practice</td><td>Total</td></tr>
<tr><td></td><td>5</td><td>1</td><td colspan="3">-</td><td>6</td></tr>
<tr><td>Pre-requisites</td><td colspan="7">UG – Level Differential Equations</td></tr>
<tr><td>Objectives of the Course</td><td colspan="7">• To introduce analytic skills in solving homogenous types of differential equations.
• To develop a strong background in dynamical systems of problems.
• To impart various concepts in the initial value problems and Legendre equations.
• To identify the characteristics of regular singular points in second-order differential equations.
• To explain the problems in fundamental concepts of existence and uniqueness theories.</td></tr>
<tr><td>Course Outline</td><td colspan="7">UNIT I (18 hours) (K1, K2, K3, K4, K5 & K6)

Linear equations with constant coefficients
1.1 Introduction, Basic Definitions
1.2 Second-order Homogeneous equations
1.3 Initial value problems
1.4 Linear dependence and independence
1.5 Wronskian and a formula for Wronskian
1.6 Non-homogeneous equation of order two
Chapter 2: Sections 1 – 6</td></tr>
<tr><td></td><td colspan="7">UNIT II (18 hours) (K1, K2, K3, K4, K5 & K6)

Linear equations with constant coefficients (Contd.)

2.1 Introduction, Example
2.2 Homogeneous and non-homogeneous equation of order n
2.3 Initial value problems
2.4 Annihilator method to solve non-homogeneous equation
2.5 Annihilator method to solve non-homogeneous equation (contd.)
2.6 Algebra of constant coefficient operators
Chapter 2: Sections 7 – 12</td></tr>
<tr><td></td><td colspan="7">UNIT III (18 hours) (K1, K2, K3, K4, K5 & K6)

Linear equation with variable coefficients

3.1 Initial value problems, Existence, and uniqueness theorems
3.2 Solutions to solve a non-homogeneous equation
3.3 Wronskian and linear dependence
3.4 Reduction of the order of a homogeneous equation
3.5 Homogeneous equation with analytic coefficients
3.6 The Legendre equation
Chapter 3: Sections 1 – 8</td></tr>
</table>

	UNIT IV (18 hours) (K1, K2, K3, K4, K5 & K6) **Linear equation with regular singular point** 4.1 Introduction 4.2 Euler equation 4.3 Second-order equations with regular singular points 4.4 Second-order equations with regular singular points (contd.) 4.5 Exceptional cases 4.6 Bessel Function **Chapter 4: Sections 1 – 4 and 6 – 8**
	UNIT V (18 hours) (K1, K2, K3, K4, K5 & K6) **Existence and uniqueness of solutions to first-order equations** 5.1 Introduction, Definition, Example 5.2 Equation with variable separated 5.3 Exact equation 5.4 Method of successive approximations 5.5 The Lipschitz condition 5.6 Convergence of the successive approximations and the existence theorem **Chapter 5: Sections 1 – 6**
Extended Professional Component (isa part of the internal component only, not to be included in theexternal examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC and others to be solved. (To be discussed during the Tutorial hours)
Text Book	E.A. Coddington, A., Introduction to ordinary differential equations (3rd Printing) Prentice-Hall of India Ltd., New Delhi, 1987.
Reference Books	1. Williams E. Boyce and Richard C. DI Prima, Elementary differential equations and boundary value problems, John Wiley and Sons, New York, 1967. 2. George F Simmons, Differential equations with applications and historical notes, Tata McGraw Hill, New Delhi, 1974. 3. N.N. Lebedev, Special functions and their applications, Prentice Hall of India, New Delhi, 1965. 4. W.T. Reid. Ordinary Differential Equations, John Wiley and Sons, New York, 1971. 5. M. D. Raisinghania, Advanced Differential Equations, S. Chand & Company Ltd. New Delhi, 2001. 6. B. Rai, D. P. Choudary, and H.I. Freedman, A Course in Ordinary Differential Equations, Narosa Publishing House, New Delhi, 2002.
Web Resources	1. http://mathforum.org 2. http://ocw.mit.edu/ocwweb/Mathematics 3. http://www.opensource.org 4. www.mathpages.com

CO	Course Outcomes
On completion of this course, students will be able to;	
CO1	Obtain solutions of the Homogeneous equation with constant coefficient and Homogeneous equation with analytic coefficient.
CO2	Recognize the physical phenomena modeled by differential equations and dynamical systems.
CO3	Analyze solutions of non-homogenous methods and initial value problems.
CO4	Comprehend the Bessel functions, Legendre equation, Legendre polynomials, and Regular singular points.
CO5	Understand the ordinary differential equations of various type, their solutions, and fundamental concepts about their existence.

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	H	M	L	H	H	M
CO2	H	H	L	M	H	M
CO3	H	H	M	H	M	L
CO4	H	M	L	H	M	H
CO5	H	M	L	H	H	L

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	H	H	H	M	L	M
CO2	H	H	H	M	L	M
CO3	H	H	H	M	L	M
CO4	H	H	H	M	L	M
CO5	H	H	H	M	L	M

<table>
<tr><td>Title of the Course</td><td colspan="7">ELECTIVE: ADVANCED GRAPH THEORY</td></tr>
<tr><td>Paper No.</td><td colspan="7">Elective I A</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Elective</td><td>Year</td><td>I</td><td rowspan="2">Credits</td><td rowspan="2">3</td><td rowspan="2">Course Code</td><td rowspan="2">PEMAA24</td></tr>
<tr><td>Semester</td><td>I</td></tr>
<tr><td rowspan="2">Instructional Hours per week</td><td>Lecture</td><td>Tutorial</td><td colspan="3">Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td>5</td><td>-</td><td colspan="3">-</td><td colspan="2">5</td></tr>
<tr><td>Pre-requisites</td><td colspan="7">UG-level Graph theory</td></tr>
<tr><td>Objectives of the Course</td><td colspan="7">• To impart knowledge on subgraphs, cycles, paths, and connections in graphs.
• To familiarize the concepts of cut vertices, cut edges, and bonds in trees.
• To assess the Hamiltonian and Eulerian graphs.
• To gain knowledge on matchings and coverings in bipartite graphs.
• To learn the concepts of colouring and planar graphs</td></tr>
<tr><td>Course Outline</td><td colspan="7">UNIT I (15 hours) (K1, K2, K3, K4, K5 & K6)
Graphs and Subgraphs
1.1 Graphs and Simple Graphs
1.2 Graph Isomorphism
1.3 Incidence and adjacency Matrices
1.4 Subgraphs, Vertex degrees
1.5 Paths and Connection
1.6 Cycles
Chapter 1: Sections 1.1 – 1.7</td></tr>
<tr><td></td><td colspan="7">UNIT II (15 hours) (K1, K2, K3, K4, K5 & K6)
Trees and Connectivity
2.1 Trees
2.2 Cut Edges and Bonds
2.3 Cut Vertices
2.4 Cayley's Formula
2.5 Connectivity
2.6 Blocks
Chapter 2: Sections 2.1 - 2.5, Chapter 3: Sections 3.1- 3.2</td></tr>
<tr><td></td><td colspan="7">UNIT III (15 hours) (K1, K2, K3, K4, K5 & K6)
Euler Tours and Hamilton Cycles
3.1 Euler Tours
3.2 Theorems on Euler Tours
3.3 Hamilton Cycles
3.4 Theorems on Hamilton Cycles
3.5 The Chinese Postman Problem
3.6 The Travelling Salesman Problem</td></tr>
</table>

	Chapter 4: Sections 4.1 - 4.4
	UNIT IV (15 hours) (K1, K2, K3, K4, K5 & K6) **Matchings, Independent Sets and Cliques** 4.1 Matchings 4.2 Theorems on Matchings 4.3 Coverings in bipartite graphs 4.4 Perfect matching 4.5 Independent Sets 4.6 Cliques **Chapter 5: Sections 5.1 - 5.4, Chapter 7: Section 7.1**
	UNIT V (15 hours) (K1, K2, K3, K4, K5 & K6) **Vertex Colouring and Planar graphs** 5.1 Chromatic Number- Brook's theorem 5.2 Chromatic Polynomials 5.3 Plane and planar graphs 5.4 Dual graphs 5.5 Euler's formula 5.6 The Five-Colour theorem **Chapter 8: Sections 8.1, 8.2 and 8.4, Chapter 9: Sections 9.1 - 9.3 and 9.6**
Text Book	J. A. Bondy and U.S.R. Murty, Graph theory and Applications, Macmillan 5th Edition, 1982.
Reference Books	1. Douglas B. West, Introduction to Graph Theory, 2nd Edition – Urbana, 2006. 2. Harary, Graph Theory, 1st Edition – Narosa Publishing House, 1988. 3. S. Arumugam and S. Ramachandran, Invitation to Graph Theory – SciTech Publications Pvt. Ltd., 2001.
Web Resources	1. http://mathforum.org 2. http://ocw.mit.edu/ocwweb/Mathematics 3. http://www.opensource.org 4. www.algebra.com

CO	Course Outcomes
On completion of this course, students will be able to;	
CO1	Identify subgraphs, Cycles, paths, and connections in graphs.
CO2	Analyze the cut vertices, cut edges, and bonds in trees.
CO3	Distinguish between the Hamiltonian and Eulerian graphs.
CO4	Explain the concepts of matchings and coverings in bipartite graphs.
CO5	Understand the concepts of colouring and planar graphs.

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	H	H	H	H	L	M
CO2	H	H	H	H	M	H
CO3	H	H	H	H	L	M
CO4	H	H	H	H	M	H
CO5	H	H	H	H	M	M

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	H	H	L	M	M	H
CO2	H	H	L	M	M	H
CO3	H	H	L	M	M	H
CO4	H	H	M	M	M	H
CO5	H	H	M	M	M	H

<table>
<tr><td>Title of the Course</td><td colspan="7">ELECTIVE: NUMBER THEORY AND CRYPTOGRAPHY</td></tr>
<tr><td>Paper No.</td><td colspan="7">Elective I B</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Elective</td><td>Year</td><td>I</td><td>Credits</td><td>3</td><td>Course Code</td><td>PEMAB24</td></tr>
<tr><td>Semester</td><td>I</td><td colspan="4"></td></tr>
<tr><td rowspan="2">Instructional Hours per week</td><td>Lecture</td><td>Tutorial</td><td colspan="3">Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td>5</td><td>-</td><td colspan="3">-</td><td colspan="2">5</td></tr>
<tr><td>Pre-requisites</td><td colspan="7">-</td></tr>
<tr><td>Objectives of the Course</td><td colspan="7">• To impart knowledge on the elementary topics in number theory.
• To examine the finite fields and quadratic residues.
• To generate the cryptography using cryptosystem and enciphering matrices.
• To learn the concepts of public key cryptography, RSA, and discrete log.
• To analyze the process of public key and primality, and pseudo primes in number theory.</td></tr>
<tr><td>Course Outline</td><td colspan="7">UNIT I (15 hours) (K1, K2, K3, K4, K5 & K6)
Some Topics in Elementary Number Theory
1.1 Introduction
1.2 Number Theory: Basic definitions
1.3 Time estimates for doing Arithmetic
1.4 Divisibility and Euclidean Algorithm
1.5 Congruences
1.6 Some applications to factorizing
Chapter 1</td></tr>
<tr><td></td><td colspan="7">UNIT II (15 hours) (K1, K2, K3, K4, K5 & K6)
Finite Fields Quadratic Residues
2.1 Fields: Definition
2.2 Properties of finite fields
2.3 Finite fields
2.4 Examples of finite fields
2.5 Quadratic Residues
2.6 Reciprocity
Chapter 2</td></tr>
<tr><td></td><td colspan="7">UNIT III (15 hours) (K1, K2, K3, K4, K5 & K6)
Cryptography
3.1 Cryptography: Introduction
3.2 Cryptosystem
3.3 Some Simple Cryptosystems
3.4 Matrices, Basics
3.5 Enciphering</td></tr>
</table>

	3.6 Enciphering Matrices **Chapter 3**
	UNIT IV (15 hours) (K1, K2, K3, K4, K5 & K6) **Public Key** 4.1 Introduction 4.2 Basic Definitions, Public Key 4.3 The idea of public key cryptography 4.4 RSA 4.5 Discrete log 4.6 Examples of RSA and discrete log **Chapter 4: Sections 4.1 - 4.3**
	UNIT V (15 hours) (K1, K2, K3, K4, K5 & K6) **Public Key and Primality** 5.1 Protocols: Introduction 5.2 Knapsack zero, knowledge protocols 5.3 Obvious transfer 5.4 Theorem, propositions 5.5 Pseudo primes (Except strong pseudo primes) 5.6 Examples of Pseudo primes **Chapter 4: Sections 4.4 and 4.5, Chapter 5: Section 5.1**
Text Book	Neal Koblitz, Number Theory and Cryptography, 2nd Edition, Springer Verlag, New Delhi, 1994.
Reference Books	1. Graham R., L. Kmuth, D.E., and Patachink O., Concrete Mathematics, 2nd Edition, Pearson Education, Asia, 2002. 2. Brensoud D. Wagon S., A Course in Computational Number Theory, Key collage Publishing, 2000.
Web Resources	1. https://books.google.com/books/about/A_Course_in_Number_Theory_and_Cryptograp.html?id=4eMlBQAAQBAJ 2. https://seriouscomputerist.atariverse.com/media/pdf/book/Concrete%20Mathematics.pdf 3. https://nptel.ac.in 4. www.coursera.org 5. https://swayam.gov.in

CO	Course Outcomes
On completion of this course, students will be able to;	
CO1	Know about the elementary topics in number theory.
CO2	Analyze the finite fields and quadratic residues.
CO3	Formulate the cryptography using cryptosystem and enciphering matrices.
CO4	Explore the ideas of public key cryptography, RSA, and discrete log.
CO5	Analyze the methods of the public key, primality, and pseudo primes in number theory.

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	H	H	H	H	L	M
CO2	H	M	H	H	L	M
CO3	H	H	H	H	M	M
CO4	H	H	H	H	M	M
CO5	H	H	H	H	M	M

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	H	H	H	M	L	M
CO2	H	H	H	M	L	M
CO3	H	H	H	M	L	M
CO4	H	H	H	M	L	M
CO5	H	H	H	M	L	M

<table>
<tr><td>Title of the Course</td><td colspan="7">ELECTIVE: PROGRAMMING WITH JAVA</td></tr>
<tr><td>Paper No.</td><td colspan="7">Elective II A</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Elective</td><td>Year</td><td>I</td><td>Credits</td><td>2</td><td>Course Code</td><td>PEMAC24</td></tr>
<tr><td>Semester</td><td>I</td><td colspan="3"></td></tr>
<tr><td>Instructional Hours per week</td><td>Lecture</td><td>Tutorial</td><td colspan="3">Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td></td><td>3</td><td>-</td><td colspan="3">-</td><td colspan="2">3</td></tr>
<tr><td>Pre-requisites</td><td colspan="7">UG-level C and C++</td></tr>
<tr><td>Objectives of the Course</td><td colspan="7">• To understand the benefits and applications of OOP.
• To gain knowledge about operators and their types.
• To analyze the decision-making statements.
• To familiarize the concepts of classes and methods in the Java programming language.
• To investigate arrays in the Java programming language.</td></tr>
<tr><td>Course Outline</td><td colspan="7">UNIT I (9 hours) (K1, K2, K3, K4, K5 & K6)
Fundamentals of Object-Oriented Programming
1.1 Basic Concepts of Object-Oriented Programming, Benefits of OOP
1.2 Applications of OOP, Features of Java
1.3 Java Differs from C and C++, Java environment
1.4 Java program structure
1.5 Tokens, Statements
1.6 Java programming style
Chapter 1: Sections 1.3 – 1.5, Chapter 2: Sections 2.2, 2.3 and 2.9, Chapter 3: Sections 3.5 – 3.7 and 3.12</td></tr>
<tr><td></td><td colspan="7">UNIT II (9 hours) (K1, K2, K3, K4, K5 & K6)
Constants, Variables and Data Types, Operators and Expressions
2.1 Constants, Variables, Data types, Declaration of variables
2.2 Giving values to variables, Scope of variables, Symbolic constants
2.3 Type casting, Getting values of variables, Standard default values
2.4 Operators: Arithmetic, relational, logical, assignment, increment and decrement, conditional bitwise, and special, Arithmetic expressions
2.5 Evaluation of expressions, Operator precedence, and associativity
2.6 Mathematical functions
Chapter 4: Sections 4.2 – 4.11, Chapter 5: Sections 5.2 – 5.11, 5.14, and 5.15</td></tr>
<tr><td></td><td colspan="7">UNIT III (9 hours) (K1, K2, K3, K4, K5 & K6)
Decision Making, Branching, Looping
3.1 Decision-making statements: if, simple if, if … else
3.2 Nesting of if … else, else if ladder
3.3 Switch statements and conditional operator
3.4 Loop statements: while, do, for loops
3.5 Jumps in loops
3.6 Labeled loops
Chapter 6: Sections 6.2 – 6.8, Chapter 7: Sections 7.2 – 7.6</td></tr>
</table>

	UNIT IV (9 hours) (K1, K2, K3, K4, K5 & K6) **Classes, Objects, and Methods** 4.1 Defining a class, Fields declaration, and Methods declaration 4.2 Creating objects, Accessing class members, Constructors 4.3 Methods overloading, Static members, Nesting of methods 4.4 Inheritance, overriding methods 4.5 Final variables, methods, and classes, Finalizer methods 4.6 Abstract methods and classes, Methods with varargs, Visibility control **Chapter 8: Sections 8.2 – 8.18**
	UNIT V (9 hours) (K1, K2, K3, K4, K5 & K6) **Arrays, Strings, Vectors and Interfaces** 5.1 One and two-dimensional arrays 5.2 Strings, Vectors 5.3 Wrapper classes, Enumerated types 5.4 Annotations, Defining Interfaces 5.5 Extending interfaces, Implementing interfaces 5.6 Accessing interface variables **Chapter 9: Sections 9.2 – 9.9, Chapter 10: Sections 10.2 – 10.5**
Text Book	E. Balagurusamy, Programming with Java, Tata McGraw Hill Publication, 5th Edition, 2014.
Reference Books	1. K. Arnold and J. Gosling, The Java Programming Language, Ed. 2, Publication 2000. 2. Cays Horstmann and Gary Cornell, Core Java Volume II, Publications 2001. 3. Phil Hanna, JSP 2.0: The Complete Reference, TMH, Edition 2, Publications 2003.
Web Resources	1. https://www.acs.ase.ro/Media/Default/documents/java/ClaudiuVinte/books/ArnoldGoslingHolmes06.pdf 2. https://ptgmedia.pearsoncmg.com/images/9780137081608/samplepages/013708160X.pdf 3. https://nitikesh.yolasite.com/resources/JSP%20complete%20reference.pdf 4. https://mu.ac.in/wp-content/uploads/2022/09/Core-JAVA.pdf 5. https://nptel.ac.in/ 6. https://swayam.gov.in/nc_details/NPTEL 7. https://www.coursera.org/

CO	Course Outcomes
On completion of this course, students will be able to;	
CO1	Understand the benefits and applications of OOP and distinguish C++ and JAVA.
CO2	Gain knowledge about operators and their types.
CO3	Define decision-making statements and solve problems based on them.
CO4	Develop the program by manipulating classes and methods in the Java programming language.
CO5	Explore the Java programming by using arrays.

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	M	H	H	L	M	H
CO2	M	H	H	L	M	H
CO3	M	H	H	L	M	H
CO4	M	M	H	L	M	H
CO5	H	H	H	L	M	H

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	H	H	H	M	L	M
CO2	H	H	H	M	L	M
CO3	H	H	H	M	L	M
CO4	H	H	H	M	L	M
CO5	H	H	H	M	L	M

<table>
<tr><td>Title of the Course</td><td colspan="7">ELECTIVE PRACTICAL: JAVA</td></tr>
<tr><td>Paper No.</td><td colspan="7">Elective II A</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Elective Practical</td><td>Year</td><td>I</td><td>Credit</td><td>1</td><td>Course Code</td><td>PEMAD24</td></tr>
<tr><td>Semester</td><td>I</td></tr>
<tr><td rowspan="2">Instructional Hours per week</td><td>Lecture</td><td>Tutorial</td><td colspan="3">Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td>-</td><td>-</td><td colspan="3">2</td><td colspan="2">2</td></tr>
<tr><td>Pre-requisites</td><td colspan="7">UG-level C and C++ Program</td></tr>
<tr><td>Objectives of the Course</td><td colspan="7">• To employ programs with classes.
• To explore programs that perform operations using arrays.
• To evolve the program by decision-making statements.
• To instantiate the basic programming concepts.
• To design & program stand-alone Java applications.</td></tr>
<tr><td>Course Outline</td><td colspan="7">PROGRAMS
1. Solution of linear equations
2. Number and sum of integers between two given integers that are divisible by a number
3. Multiplication table
4. Verifying whether a given number is a palindrome
5. Generation of Fibonacci sequence
6. Sorting an array
7. Merging two sorted arrays
8. Product of two matrices
9. Transpose of a matrix
10. Replacing a substring with another</td></tr>
<tr><td>Text Book</td><td colspan="7">E. Balagurusamy, Programming with Java, Tata McGraw Hill Publication, 5th Edition, 2014.</td></tr>
<tr><td>Reference Books</td><td colspan="7">1. K. Arnold and J. Gosling, The Java Programming Language, Ed. 2, Publication, 2000.
2. Cays Horstmann and Gary Cornell, Core Java Volume II, Publications, 2001.
3. Phil Hanna, JSP 2.0: The Complete Reference, TMH, Edition 2, Publications, 2003.</td></tr>
<tr><td>Web Resources</td><td colspan="7">1. https://www.acs.ase.ro/Media/Default/documents/java/ClaudiuVinte/books/ArnoldGoslingHolmes06.pdf
2. https://ptgmedia.pearsoncmg.com/images/9780137081608/samplepages/013708160X.pdf
3. https://nitikesh.yolasite.com/resources/JSP%20complete%20reference.pdf</td></tr>
</table>

	4. https://nptel.ac.in/ 5. https://swayam.gov.in/nc_details/NPTEL 6. https://www.coursera.org/

CO	Course Outcomes
On completion of this course, students will be able to;	
CO1	Implement programs with classes.
CO2	Write programs that perform operations using arrays.
CO3	Develop the program by decision-making statements and solve problems based on it.
CO4	Illustrate basic programming concepts such as program flow and syntax of a high-level general-purpose language.
CO5	Take a problem, figure out the algorithm to solve it, and write the code.

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	M	H	H	L	M	H
CO2	M	H	H	L	M	H
CO3	M	H	H	L	M	H
CO4	M	M	H	L	M	H
CO5	H	H	H	L	M	H

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	H	H	H	M	L	M
CO2	H	H	H	M	L	M
CO3	H	H	H	M	L	M
CO4	H	H	H	M	L	M
CO5	H	H	H	M	L	M

<table>
<tr><td>Title of the Course</td><td colspan="7">ELECTIVE: PROGRAMMING WITH R</td></tr>
<tr><td>Paper No.</td><td colspan="7">Elective II B</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Elective</td><td>Year</td><td>I</td><td rowspan="2">Credits</td><td rowspan="2">2</td><td rowspan="2">Course Code</td><td rowspan="2">PEMAE24</td></tr>
<tr><td>Semester</td><td>I</td></tr>
<tr><td rowspan="2">Instructional Hours per week</td><td>Lecture</td><td>Tutorial</td><td colspan="3">Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td>3</td><td>-</td><td colspan="3">-</td><td colspan="2">3</td></tr>
<tr><td>Pre-requisites</td><td colspan="7">-</td></tr>
<tr><td>Objectives of the Course</td><td colspan="7">• To master the use of an interactive R environment with built-in documentation.
• To use R for descriptive statistics and write multivariate models in R.
• To understand the looping statements.
• To develop a strong background in technical computing in various suitable applications.
• To create the knowledge in R with matrix theory.</td></tr>
<tr><td>Course Outline</td><td colspan="7">UNIT I (9 hours) (K1, K2, K3, K4, K5 & K6)
Introduction to the R language
1.1 Starting and quitting in R
1.2 Basic features in R
1.3 Built-in functions
1.4 Logical vectors
1.5 Rational operators
1.6 Rational operators (contd.)
Chapter 2: Sections 2.1 - 2.4</td></tr>
<tr><td></td><td colspan="7">UNIT II (9 hours) (K1, K2, K3, K4, K5 & K6)
Programming Statistical Graph
2.1 Changing Directories, redirecting R output, Lists
2.2 Data frames
2.3 Plotting bar charts, and dot charts
2.4 Plotting Pie Charts
2.5 Plotting Histograms
2.6 Plotting Box plot
Chapter 3: Section 3.1</td></tr>
<tr><td></td><td colspan="7">UNIT III (9 hours) (K1, K2, K3, K4, K5 & K6)
Programming with R
3.1 Plotting scatter plot
3.2 For loop
3.3 If statement
3.4 While loop
3.5 While loop (contd.)
3.6 Newton’s method for finding the root</td></tr>
</table>

	Chapter 4: Section 4.1
	UNIT IV (9 hours) (K1, K2, K3, K4, K5 & K6) **Simulation in R** 4.1 Monte Carlo simulation 4.2 Generation of pseudo-random numbers 4.3 Bernoulli random variables 4.4 Binomial random variables 4.5 Poisson random variables 4.6 Poisson random variables (contd.) **Chapter 5: Sections 5.1 and 5.2**
	UNIT V (9 hours) (K1, K2, K3, K4, K5 & K6) **Computational Linear Algebra in R** 5.1 Vectors and matrices in R 5.2 Constructing matrix objects 5.3 Accessing matrix elements 5.4 Row and column names 5.5 Matrix properties, Matrix multiplication, and inversion 5.6 Eigen values and Eigen vectors **Chapter 6: Section 6.1**
Text Book	W. John Braun, Duncan J. Murdoch, A first course in statistical programming with R, Cambridge University Press, 2007.
Reference Books	1. Gardener, M. Beginning R: The statistical programming language, John Wiley & Sons 2012. 2. Martin, T. The Undergraduate Guide to R. A beginner's introduction to R programming Language, 2009. 3. Chambers, J. Software for data analysis: programming with R. Springer Science & Business Media, 2008.
Web Resources	1. http://assets.cambridge.org/97805218/72652/frontmatter/9780521872652_frontmatter.pdf 2. http://students.aiu.edu/submissions/profiles/resources/onlineBook/A7E7d8_Beginning%20R%20statistics.pdf 3. https://www.cs.upc.edu/~robert/teaching/estadistica/rprogramming.pdf 4. https://www.cs.upc.edu/~robert/teaching/estadistica/TheRBook.pdf 5. https://nptel.ac.in/ 6. https://swayam.gov.in/nc_details/NPTEL 7. https://www.coursera.org/ 8. https://spoken-tutorial.org/

CO	Course Outcomes
On completion of this course, students will be able to;	
CO1	Familiarize the basics of R software and the built-in function of R.
CO2	Identify the characteristics of datasets and plot the datasets in R using graphical methods.
CO3	Develop programs using for loop, if statement, and break statement.
CO4	Implement the learning techniques and computing environment suitable for the applications under consideration.
CO5	Compute vectors and matrices, matrix inverse, eigen values, and eigen vectors.

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	M	H	H	L	M	H
CO2	M	H	H	L	M	H
CO3	M	H	H	L	M	H
CO4	M	M	H	L	M	H
CO5	M	H	H	L	M	H

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	M	H	H	M	L	H
CO2	M	H	H	M	L	H
CO3	M	H	H	M	L	H
CO4	M	H	H	M	L	H
CO5	M	H	H	M	L	H

<table>
<tr><td>Title of the Course</td><td colspan="7">ELECTIVE PRACTICAL: R</td></tr>
<tr><td>Paper No.</td><td colspan="7">Elective II B</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Elective Practical</td><td>Year</td><td>I</td><td>Credit</td><td>1</td><td>Course Code</td><td>PEMAF24</td></tr>
<tr><td>Semester</td><td>I</td></tr>
<tr><td rowspan="2">Instructional Hours per week</td><td>Lecture</td><td>Tutorial</td><td colspan="3">Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td>-</td><td>-</td><td colspan="3">2</td><td colspan="2">2</td></tr>
<tr><td>Pre-requisites</td><td colspan="7">-</td></tr>
<tr><td>Objectives of the Course</td><td colspan="7">• To learn the programs with the respective classes.
• To master the use of performance in arrays.
• To understand the decision-making in looping statements.
• To create a strong background in the general purpose of language.
• To develop knowledge in writing algorithms and code for problem-solving.</td></tr>
<tr><td>Course Outline</td><td colspan="7">PROGRAMS:
1. Write an R Program for “Hello Geeks”
2. Creating data frame from given 4 vectors
3. Write an R Program to Add Two Vectors
4. Find the Sum, Mean, and Product of the Vector in R Programming
5. Create an R Program to Take Input from the User
6. Create an R Program to Find the Minimum and Maximum
7. R Program to Sort a Vector
8. Multiply a matrix by its transpose while ignoring missing values in R
9. Convert matrix to list in R
10. 2D and 3D plotting’s</td></tr>
<tr><td>Text Book</td><td colspan="7">W. John Braun, Duncan J. Murdoch, A first course in statistical programming with R, Cambridge University Press, 2007.</td></tr>
<tr><td>Reference Books</td><td colspan="7">1. Gardener, M. Beginning R: The statistical programming language, John Wiley & Sons 2012.
2. Martin, T. The Undergraduate Guide to R. A beginner’s introduction to R programming Language, 2009.
3. Chambers, J. Software for data analysis: programming with R. Springer Science & Business Media, 2008.</td></tr>
<tr><td>Web Resources</td><td colspan="7">1. https://www.geeksforgeeks.org/r-programming-examples/
2. https://nptel.ac.in/
3. https://swayam.gov.in/nc_details/NPTEL
4. https://www.coursera.org/</td></tr>
</table>

CO	Course Outcomes
On completion of this course, students will be able to;	
CO1	Implement programs with classes.
CO2	Write programs that perform operations using arrays.
CO3	Develop the program by decision-making statements and solve problems based on it.
CO4	Illustrate basic programming concepts such as program flow and syntax of a high-level general-purpose language.
CO5	Take a problem, figure out the algorithm to solve it, and write the code.

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	M	H	H	L	M	H
CO2	M	H	H	L	M	H
CO3	M	H	H	L	M	H
CO4	M	M	H	L	M	H
CO5	H	H	H	L	M	H

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	M	H	H	M	L	H
CO2	M	H	H	M	L	H
CO3	M	H	H	M	L	H
CO4	M	H	H	M	L	H
CO5	M	H	H	M	L	H

<table>
<tr><td>Title of the Course</td><td colspan="7">ADVANCED ALGEBRA</td></tr>
<tr><td>Paper No.</td><td colspan="7">Core IV</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Core</td><td>Year</td><td>I</td><td>Credits</td><td>5</td><td>Course Code</td><td>PCMAD24</td></tr>
<tr><td>Semester</td><td>II</td></tr>
<tr><td>Instructional Hours per week</td><td>Lecture</td><td>Tutorial</td><td colspan="3">Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td></td><td>5</td><td>1</td><td colspan="3">-</td><td colspan="2">6</td></tr>
<tr><td>Pre-requisites</td><td colspan="7">UG-level Linear Algebra</td></tr>
<tr><td>Objectives of the Course</td><td colspan="7">• To write theorems applying algebraic ways of thinking.
• To gain knowledge in remainder and factor theorem.
• Assess the concepts of Galois Theory.
• To explain the finite fields and their properties.
• To impart knowledge on fundamental concepts, including the Frobenius theorem, Lagrange’s theorem, Lagrange’s identity, and the Left Division algorithm.</td></tr>
<tr><td>Course Outline</td><td colspan="7">UNIT I (18 hours) (K1, K2, K3, K4, K5 & K6)
Fields
1.1 Introduction
1.2 Extension fields
1.3 Finite extension
1.4 Algebraic over the field
1.5 Algebraic extensions
1.6 Transcendence e
Chapter 5: Sections 5.1 and 5.2</td></tr>
<tr><td></td><td colspan="7">UNIT II (18 hours) (K1, K2, K3, K4, K5 & K6)
Fields (Contd.)
2.1 Introduction
2.2 Remainder theorem
2.3 Factor theorem
2.4 Splitting field
2.5 Derivative of a polynomial
2.6 Simple extension
Chapter 5: Sections 5.3 and 5.5</td></tr>
<tr><td></td><td colspan="7">UNIT III (18 hours) (K1, K2, K3, K4, K5 & K6)
Galois Group and Galois Theory
3.1 Galois group
3.2 Subfield
3.3 Group of Automorphism
3.4 Elementary symmetric functions
3.5 Normal Extensions
3.6 Fundamental theorem on Galois theory
Chapter 5: Section: 5.6</td></tr>
</table>

	UNIT IV (18 hours) (K1, K2, K3, K4, K5 & K6) **Finite fields** 4.1 Introduction 4.2 Finite field 4.3 Properties of finite fields 4.4 The existence of solutions of certain equations in a finite field 4.5 Division ring 4.6 Wedderburn's theorem on finite division rings **Chapter 7: Sections 7.1 and 7.2 (Theorem 7.2.1 only)**
	UNIT V (18 hours) (K1, K2, K3, K4, K5 & K6) **Finite fields (Contd.)** 5.1 Solvability by radicals 5.2 Frobenius theorem 5.3 Adjoint, Norm 5.4 Lagrange's Identity 5.5 Left Division Algorithm 5.6 Lagrange's theorem **Chapter 5: Section 5.7, Chapter 7: Sections 7.3 and 7.4**
Extended Professional Component (isa part of the internal component only, not to be included in theexternal examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC and others to be solved. (To be discussed during the Tutorial hours)
Text Book	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 Hindustan Publishing Company, New Delhi, 2009.
Web Resources	1. http://mathforum.org 2. http://ocw.mit.edu/ocwweb/Mathematics 3. http://www.opensource.org 4. www.algebra.com

CO	Course Outcomes
On completion of this course, students will be able to;	
CO1	Prove theorems applying algebraic ways of thinking.
CO2	Connect Remainder and Factor theorem.
CO3	Compose clear and accurate proofs using the concepts of Galois Theory.
CO4	Bring out insight into the finite fields and their properties.
CO5	Understand the fundamental concepts including the Frobenius theorem, Lagrange's theorem, Lagrange's identity, and the Left Division algorithm.

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	H	H	H	H	M	L
CO2	H	H	H	H	L	M
CO3	H	H	H	H	M	M
CO4	H	H	H	H	L	M
CO5	H	H	H	H	L	M

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	H	H	H	M	L	M
CO2	H	H	H	M	L	M
CO3	H	H	H	M	L	M
CO4	H	H	H	M	L	M
CO5	H	H	H	M	L	M

<table>
<tr><td>Title of the Course</td><td colspan="7">REAL ANALYSIS - II</td></tr>
<tr><td>Paper No.</td><td colspan="7">Core V</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Core</td><td>Year</td><td>I</td><td>Credits</td><td>5</td><td>Course Code</td><td>PCMAE24</td></tr>
<tr><td>Semester</td><td>II</td></tr>
<tr><td>Instructional Hours per week</td><td>Lecture</td><td>Tutorial</td><td colspan="3">Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td></td><td>5</td><td>1</td><td colspan="3">-</td><td colspan="2">6</td></tr>
<tr><td>Pre-requisites</td><td colspan="7">UG-level Real Analysis</td></tr>
<tr><td>Objectives of the Course</td><td colspan="7">• To introduce the concepts of Lebesgue Measure, Measurable sets, and functions.
• To explain the integration of non-negative functions, General integral, Riemann, and Lebesgue integrals.
• To impart knowledge on basic concepts of Fourier series and Fourier integrals concerning the orthogonal system.
• To acquire knowledge in multivariable differential calculus.
• To familiarize the concepts of Inverse function theorem, Implicit function theorem, and Extremum problems.</td></tr>
<tr><td>Course Outline</td><td colspan="7">UNIT I (18 hours) (K1, K2, K3, K4, K5 & K6)
Measure on the Real line
1.1 Lebesgue Outer Measure
1.2 Measurable sets
1.3 Regularity
1.4 Measurable Functions
1.5 Borel and Lebesgue Measurability
1.6 Borel and Lebesgue Measurability (contd.)
Chapter 2: Sections 2.1- 2.5</td></tr>
<tr><td></td><td colspan="7">UNIT II (18 hours) (K1, K2, K3, K4, K5 & K6)
Integration of Functions of a Real Variable
2.1 Integration of non-negative functions
2.2 Integration of non-negative functions (Contd.)
2.3 The General Integral
2.4 The General Integral (Contd.)
2.5 Riemann and Lebesgue Integrals
2.6 Riemann and Lebesgue Integrals (Contd.)
Chapter 3: Sections 3.1, 3.2 and 3.4</td></tr>
<tr><td></td><td colspan="7">UNIT III (18 hours) (K1, K2, K3, K4, K5 & K6)
Fourier Series and Fourier Integrals
3.1 Introduction, Orthogonal systems of functions, The theorem on best approximation
3.2 The Fourier series of a function relative to an orthonormal system, Properties of the Fourier Coefficients
3.3 The Riesz-Fischer Theorem, The convergence and representation problems for trigonometric series, The Riemann Lebesgue Lemma
3.4 The Dirichlet Integrals, An integral representation for the partial sums of a Fourier series, Riemann's localization theorem</td></tr>
</table>

	3.5 Sufficient conditions for convergence of a Fourier series at a particular point, Cesaro summability of Fourier series 3.6 Consequences of Fejer's theorem, The Weierstrass approximation theorem **Chapter 11: Sections 11.1 – 11.15**
	UNIT IV (18 hours) (K1, K2, K3, K4, K5 & K6) **Multivariable Differential Calculus** 4.1 Introduction, The Directional derivative, Directional derivatives, and continuity 4.2 The total derivative, the total derivative expressed in terms of partial derivatives 4.3 The matrix of linear function, The Jacobian matrix, The chain rule, Matrix form of the chain rule 4.4 The Mean-Value theorem for differentiable functions, A sufficient condition for differentiability 4.5 A sufficient condition for equality of mixed partial derivatives 4.6 Taylor's formula for functions of R^n to R^1 **Chapter 12: Sections 12.1 – 12.14 (Omit 12.6)**
	UNIT V (18 hours) (K1, K2, K3, K4, K5 & K6) **Implicit Functions and Extremum Problems** 5.1 Introduction 5.2 Functions with non-zero Jacobian determinant 5.3 The Inverse Function Theorem 5.4 The Implicit Function Theorem 5.5 Extrema of real-valued functions of one variable, Extrema of real-valued functions of severable variables 5.6 Extremum problems with side conditions **Chapter 13: Sections 13.1 – 13.7**
Extended Professional Component (isa part of the internal component only, not to be included in theexternal examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC and others to be solved. (To be discussed during the Tutorial hours)
Text Books	1. G. de Barra, Measure Theory and Integration, Wiley Eastern Ltd., New Delhi, 1981. (for Units I and II) 2. Tom M. Apostol, Mathematical Analysis, 2nd Edition, Addison-Wesley Publishing Company Inc. New York, 1974. (for Units III, IV, and V)
Reference Books	1. Burkill, J.C., The Lebesgue Integral, Cambridge University Press, 1951. 2. Munroe M.E., Measure and Integration. Addison-Wesley, Mass, 1971.

	3. Roydon H.L., Real Analysis, Macmillan Pub. Company, New York, 1988. 4. Rudin W., Principles of Mathematical Analysis, McGraw Hill Company, New York, 1979. 5. Malik S.C. and Savita Arora, Mathematical Analysis, Wiley Eastern Limited. New Delhi, 1991. 6. Sanjay Arora and Bansi Lal, Introduction to Real Analysis, Satya Prakashan, New Delhi, 1991.
Web Resources	1. http://mathforum.org 2. http://ocw.mit.edu/ocwweb/Mathematics

CO	**Course Outcomes**
On completion of this course, students will be able to;	
CO1	Understand the concepts of Lebesgue Measure, Measurable sets, and functions. .
CO2	Analyze the integration of non-negative functions, General integral, Riemann, and Lebesgue integrals.
CO3	Describe the Fourier series and Fourier integrals concerning the orthogonal system.
CO4	Validate the concepts of multivariable differential calculus.
CO5	Justify the proof of Inverse function theorem, Implicit function theorem, and Extremum problems.

CO/PSO	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1	H	H	L	H	M	H
CO2	H	H	L	H	M	H
CO3	H	H	L	H	M	H
CO4	H	H	L	H	M	H
CO5	H	H	L	H	M	H

CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	H	H	H	M	L	M
CO2	H	H	H	M	L	M
CO3	H	H	H	M	L	M
CO4	H	H	H	M	L	M
CO5	H	H	H	M	L	M

<table>
<tr><td>Title of the Course</td><td colspan="7">PARTIAL DIFFERENTIAL EQUATIONS</td></tr>
<tr><td>Paper No.</td><td colspan="7">Core VI</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Core</td><td>Year</td><td>I</td><td>Credits</td><td>4</td><td>Course Code</td><td>PCMAF24</td></tr>
<tr><td>Semester</td><td>II</td></tr>
<tr><td>Instructional Hours per week</td><td>Lecture</td><td>Tutorial</td><td colspan="3">Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td></td><td>5</td><td>1</td><td colspan="3">-</td><td colspan="2">6</td></tr>
<tr><td>Pre-requisites</td><td colspan="7">UG-level Differential Equations</td></tr>
<tr><td>Objectives of the Course</td><td colspan="7">• To learn the concepts of second-order equations and find general solutions
• To assess the wave equations in different polar coordinates.
• To calculate the Solution of the vibrating string, and heat conduction problems, to identify and solve Laplace and beam equations.
• To impart knowledge on maximum and minimum principles and solve Dirichlet, and Neumann problems for various boundary conditions.
• To familiarize the phenomena of Green’s function and solve Dirichlet, and Laplace problems, to apply Helmholtz operation, and to solve higher dimensional problems.</td></tr>
<tr><td>Course Outline</td><td colspan="7">UNIT I (18 hours) (K1, K2, K3, K4, K5 & K6)
Mathematical Models and Classification of Second-Order Equation
1.1 Classical equations, vibrating string
1.2 Vibrating membrane
1.3 Waves in an elastic medium
1.4 Conduction of heat in solids, Gravitational potential
1.5 Second-order equations in two independent variables, canonical forms
1.6 Equations with constant coefficients, general solution
Chapter 2: Sections 2.1 - 2.6, Chapter 3: Sections 3.1 - 3.4</td></tr>
<tr><td></td><td colspan="7">UNIT II (18 hours) (K1, K2, K3, K4, K5 & K6)
Cauchy Problem
2.1 The Cauchy problem
2.2 Homogeneous wave equation, Initial Boundary value problem
2.3 Non-homogeneous boundary conditions
2.4 Finite string with fixed ends, non-homogeneous wave equation
2.5 Riemann method, Goursat problem
2.6 Spherical wave equation, cylindrical wave equation
Chapter 4: Sections 4.1 - 4.11</td></tr>
<tr><td></td><td colspan="7">UNIT III (18 hours) (K1, K2, K3, K4, K5 & K6)
Method of separation of variables
3.1 Separation of variable
3.2 Vibrating string problem</td></tr>
</table>

	3.3 Existence and uniqueness of the solution of vibrating string problem 3.4 Heat conduction problem 3.5 Existence and uniqueness of solution of heat conduction problem 3.6 Laplace and beam equations **Chapter 6: Sections 6.1 - 6.6**
	UNIT IV (18 hours) (K1, K2, K3, K4, K5 & K6) **Boundary Value Problems** 4.1 Boundary value problems 4.2 Maximum and Minimum Principles 4.3 Uniqueness and continuity theorem 4.4 Dirichlet Problem for a circle, a circular annulus, a rectangle 4.5 Dirichlet problem involving Poisson equation 4.6 Neumann problem for a circle and a rectangle **Chapter 8: Sections 8.1 - 8.9**
	UNIT V (18 hours) (K1, K2, K3, K4, K5 & K6) **Green's Function** 5.1 The Delta functions 5.2 Green's function, Method of Green's function 5.3 Dirichlet Problem for the Laplace and Helmholtz operators 5.4 Method of Images and Eigen functions 5.5 Higher dimensional problem 5.6 Neumann Problem **Chapter 10: Sections 10.1 - 10.9**
Extended Professional Component (isa part of the internal component only, not to be included in theexternal examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC and others to be solved. (To be discussed during the Tutorial hours)
Text Book	TynMyint-U and Lokenath Debnath, Partial Differential Equations for Scientists and Engineers (Third Edition), North Hollan, 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.

Web Resources	1. http://mathforum.org 2. http://ocw.mit.edu/ocwweb/Mathematics 3. http://www.opensource.org 4. www.mathpages.com.

CO	Course Outcomes
On completion of this course, students will be able to;	
CO1	Understand and classify second-order equations and find general solutions.
CO2	Analyze and solve wave equations in different polar coordinates.
CO3	Solve the vibrating string and heat conduction problems, to identify and solve Laplace and beam equations.
CO4	Apply maximum and minimum principles and solve Dirichlet and Neumann problems for boundary conditions.
CO5	Identify Green's function and solve Dirichlet, Laplace problems, and apply Helmholtz operation to solve Higher dimensional problems.

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	H	M	H	L	H	M
CO2	H	H	H	M	H	M
CO3	H	H	M	H	M	L
CO4	H	M	H	H	M	H
CO5	H	M	H	H	H	L

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	H	H	L	M	M	H
CO2	H	H	L	M	M	H
CO3	H	H	L	M	M	H
CO4	H	H	L	M	M	H
CO5	H	H	L	M	M	H

<table>
<tr><td>Title of the Course</td><td colspan="7">ELECTIVE: MATHEMATICAL STATISTICS</td></tr>
<tr><td>Paper No.</td><td colspan="7">Elective III A</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Elective</td><td>Year</td><td>I</td><td>Credits</td><td>3</td><td>Course Code</td><td>PEMAG24</td></tr>
<tr><td>Semester</td><td>II</td><td colspan="4"></td></tr>
<tr><td rowspan="2">Instructional Hours per week</td><td>Lecture</td><td>Tutorial</td><td colspan="3">Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td>3</td><td>1</td><td colspan="3">-</td><td colspan="2">4</td></tr>
<tr><td>Pre-requisites</td><td colspan="7">UG-level Mathematical Statistics</td></tr>
<tr><td>Objectives of the Course</td><td colspan="7">• To familiarize Statistics, and its scope in various areas and to analyze the notion and distribution of statistic.
• To learn various methods of small and large samples in significance tests.
• To learn the Preliminary notions and Theory of Estimation.
• To apply problem-solving techniques to solve real-world events and acquire knowledge about hypothesis testing
• To gain knowledge on the Design of Experiments.</td></tr>
<tr><td>Course Outline</td><td colspan="7">UNIT I (12 hours) (K1, K2, K3, K4, K5 & K6)
Sample moments and their functions
1.1 Introduction
1.2 The notion of a sample
1.3 The notion of a statistic
1.4 The distribution of the arithmetic means of independent normally distributed random variables
1.5 The chi-square distribution
1.6 The distribution of the statistic ($\bar{X}$,S)
Chapter 9: Sections 9.1 - 9.5</td></tr>
<tr><td></td><td colspan="7">UNIT II (12 hours) (K1, K2, K3, K4, K5 & K6)
The Test of Significance
2.1 Introduction
2.2 The concept of a statistical test
2.3 Parametric tests for small samples
2.4 Examples based on small samples
2.5 Parametric tests for large samples
2.6 Examples based on large samples
Chapter 12: Sections 12.1 - 12.3</td></tr>
<tr><td></td><td colspan="7">UNIT III (12 hours) (K1, K2, K3, K4, K5 & K6)
Theory of Estimation
3.1 Preliminary notions
3.2 Consistent estimate
3.3 Unbiased estimate
3.4 The Sufficiency of an Estimate</td></tr>
</table>

	3.5 The Efficiency of an Estimate 3.6 Asymptotically most efficient estimate **Chapter 13: Sections 13.1 - 13.6**
	UNIT IV (12 hours) (K1, K2, K3, K4, K5 & K6) **Theory of Hypotheses testing** 4.1 Introduction 4.2 Preliminary remarks 4.3 The Power function 4.4 The OC function 4.5 Most Powerful Tests 4.6 Uniformly most powerful test **Chapter 16: Sections 16.1 - 16.4**
	UNIT V (12 hours) (K1, K2, K3, K4, K5 & K6) **Design of Experiments** 5.1 Aim of the Design of Experiments 5.2 Basic Principles of Experimental Design 5.3 Some Basic Designs of Experiment 5.4 Analysis of variance 5.5 Comparison of RBD and LSD 5.6 Examples based on analysis of variance **Chapter 10: Sections 10.1 - 10.11**
Extended Professional Component (isa part of the internal component only, not to be included in theexternal examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC and others to be solved. (To be discussed during the Tutorial hours)
Text Books	1. Marek Fisz, Probability Theory and Mathematical Statistics, 3rd edition, John Wiley and Sons Inc, 1963. (Unit I to IV) 2. Veerarajan T, Probability, Statistics and Random Processes, 2nd Edition, Tata McGraw-Hill, 2006. (Unit V)
Reference Books	1. Suddhenda Biswas and G. L. Sriwastav, Mathematical Statistics, Narosa Publishing House, 2011. 2. Alexander M. Mood, Franklin A. Graybill, and Duane C. Bose, Introduction to Theory of Statistics, 3rd Edition, Tata McGraw Hill, 1974. 3. P. Kandasamy, K. Thilagavathy and K. Gunavathy, Probability, Statistics and Queuing Theory, 2nd Edition, Sultan Chand and Sons, 2005.
Web Resources	1. https://www.scribd.com/document/294762054/Probability-Theory-and-Mathematical 2. https://r.search.yahoo.com/_ylt=AwrKAnSkarVk9P8.IiPnHgx.;_ylu=Y29sbwMEcG9zAzEEdnRpZAMEc2VjA3Ny/RV=2/RE=1689639716/RO=10/RU=https%3a%2f%2fdrive.google.com%2ffile%2fd%2

	f0B3ouU3Ur4aahVy13TzBfYjdUN3c%2fedit%3fusp%3dsharing/RK=2/RS=cZtZhaJAGtGLVB_.TFsHTeJhluc- 3. http://mathforum.org 4. http://ocw.mit.edu/ocwweb/Mathematics 5. http://www.opensource.org 6. https://nptel.ac.in 7. https://www.probability.net 8. www.coursera.org 9. https://swayam.gov.in

CO	Course Outcomes
On completion of this course, students will be able to;	
CO1	Understand the sample moments and their functions and analyze chi-square, Student-t, and Fishers-Z distributions.
CO2	Demonstrate knowledge of the properties of parametric testing procedures.
CO3	Construct tests and estimators, and derive their properties. Estimate population parameters from data sets and use the sampling distributions to compute confidence intervals for these population parameters.
CO4	Assess the basic components of hypothesis testing and perform hypothesis tests on population means.
CO5	Understand the basic terms used in the design of experiments and use appropriate experimental designs to analyze the experimental data.

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	H	H	H	H	H	H
CO2	H	H	H	H	H	H
CO3	H	H	L	H	M	L
CO4	H	H	L	H	H	M
CO5	H	H	H	H	H	H

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	H	H	H	H	M	H
CO2	H	H	H	H	M	H
CO3	H	H	H	H	M	H
CO4	H	H	H	H	M	H
CO5	H	H	H	H	M	H

<table>
<tr><td>Title of the Course</td><td colspan="7">ELECTIVE: FUZZY SETS AND THEIR APPLICATIONS</td></tr>
<tr><td>Paper No.</td><td colspan="7">Elective III B</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Elective</td><td>Year</td><td>I</td><td>Credits</td><td>3</td><td>Course Code</td><td>PEMAH24</td></tr>
<tr><td>Semester</td><td>II</td></tr>
<tr><td rowspan="2">Instructional Hours per week</td><td>Lecture</td><td>Tutorial</td><td colspan="3">Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td>4</td><td>-</td><td colspan="3">-</td><td colspan="2">4</td></tr>
<tr><td>Pre-requisites</td><td colspan="7">-</td></tr>
<tr><td>Objectives of the Course</td><td colspan="7">• To understand the difference between a crisp set and a fuzzy set.
• To be familiar with the standard fuzzy set operations.
• To construct the fuzzy number
• To study the fuzzy relation and its operations.
• To explore the methods of decision-making in a fuzzy environment.</td></tr>
<tr><td>Course Outline</td><td colspan="7">UNIT I (12 hours) (K1, K2, K3, K4, K5 & K6)
Crisp Sets and Fuzzy Sets
1.1 Crisp Sets: An Overview
1.2 Fuzzy Sets: Basic Types
1.3 Fuzzy Sets: Basic Concepts
1.4 Additional properties of alpha cuts
1.5 Representations of fuzzy sets
1.6 Extension Principle for fuzzy sets
Chapter 1: Sections 1.2-1.4, Chapter 2: Sections 2.1-2.3</td></tr>
<tr><td></td><td colspan="7">UNIT II (12 hours) (K1, K2, K3, K4, K5 & K6)
Operations on Fuzzy Sets
2.1 Types of operations
2.2 Fuzzy Complements
2.3 Fuzzy Intersection: t-Norms
2.4 Fuzzy Union: t-Conorms
2.5 Combinations of operations
2.6 Aggregation Operations
Chapter 3: Sections 3.1-3.6</td></tr>
<tr><td></td><td colspan="7">UNIT III (12 hours) (K1, K2, K3, K4, K5 & K6)
Fuzzy Arithmetic
3.1 Fuzzy numbers
3.2 Linguistic variables
3.3 Arithmetic operations on intervals
3.4 Arithmetic operations on fuzzy numbers
3.5 Lattice of fuzzy numbers</td></tr>
</table>

	3.6 Fuzzy equations **Chapter 4: Sections 4.1-4.6**
	UNIT IV (12 hours) (K1, K2, K3, K4, K5 & K6) **Fuzzy Relations** 4.1 Crisp versus Fuzzy Relations 4.2 Projections and Cylindric Extensions 4.3 Binary fuzzy relations 4.4 Binary relations on a single set 4.5 Fuzzy equivalence relations 4.6 Fuzzy compatibility relations, Fuzzy ordering relations **Chapter 5: Sections 5.1 - 5.7**
	UNIT V (12 hours) (K1, K2, K3, K4, K5 & K6) **Fuzzy Decision Making** 5.1 Individual Decision Making 5.2 Multiperson Decision Making 5.3 Multi criteria Decision Making 5.4 Multistage Decision Making 5.5 Fuzzy Ranking Methods 5.6 Fuzzy linear programming **Chapter 15: Sections 15.2-15.7**
Text Book	George J. Klir and Bo Yuan, Fuzzy sets and fuzzy logic - Theory and Applications, Prentice Hall of India Private Limited, New Delhi, 2005.
Reference Books	1. Kwang H. Lee, First Course on Fuzzy Theory and Applications, Springer, 2005. 2. Sudhir K. Pundir and Rimple Pundir, Fuzzy Sets and their Applications, Pragati Prakashan Educational Publisher, First Edition, 2006. 3. S. Nanda and N. R. Das, Fuzzy Mathematical Concepts, Narosa Publishing House, 2010.
Web Resources	1. http://www.pzs.dstu.dp.ua/logic/bibl/yuan.pdf 2. https://cours.etsmtl.ca/sys843/REFS/Books/ZimmermannFuzzySetTheory2001.pdf 3. https://nptel.ac.in 4. www.coursera.org 5. https://swayam.gov.in

CO	Course Outcomes
On completion of this course, students will be able to;	
CO1	Distinguish between crisp and fuzzy sets through bi-valued and infinite-valued logic.
CO2	Know about the most widely used standard fuzzy set operations.
CO3	Formulate the fuzzy number, a special case of a convex, normalized fuzzy set of the real line.
CO4	Explore the fuzzy relation and its operations which is the generalization of crisp relation.
CO5	Analyze the methods of decision-making in a fuzzy environment and their applications in LPP.

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	H	H	H	H	L	M
CO2	H	M	H	H	L	M
CO3	H	H	H	H	M	M
CO4	H	H	H	H	M	M
CO5	H	H	H	H	M	M

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	H	H	H	M	L	M
CO2	H	H	H	M	L	M
CO3	H	H	H	M	L	M
CO4	H	H	H	M	L	M
CO5	H	H	H	M	L	M

<table>
<tr><td>Title of the Course</td><td colspan="7">ELECTIVE: DIFFERENTIAL GEOMETRY</td></tr>
<tr><td>Paper No.</td><td colspan="7">Elective IV A</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Elective</td><td>Year</td><td>I</td><td>Credits</td><td>3</td><td>Course Code</td><td>PEMAI24</td></tr>
<tr><td>Semester</td><td>II</td></tr>
<tr><td>Instructional Hours per week</td><td>Lecture</td><td>Tutorial</td><td colspan="3">Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td></td><td>3</td><td>1</td><td colspan="3">-</td><td colspan="2">4</td></tr>
<tr><td>Pre-requisites</td><td colspan="7">-</td></tr>
<tr><td>Objectives of the Course</td><td colspan="7">• To learn the concepts of the line integrals, deal with differential forms, and calculate arc length, and curvature of surfaces.
• To gain knowledge on involutes, evolutes, and fundamental existence theorem for space curves.
• To familiarize the concepts of Surfaces and the family of curves.
• To impart knowledge on Geodesics and Gaussian curvature.
• To assess the principal curvatures, lines of curvatures, and Developables.</td></tr>
<tr><td>Course Outline</td><td colspan="7">UNIT I (12 hours) (K1, K2, K3, K4, K5 & K6)
Space Curves
1.1 Introductory remarks about space curves
1.2 Definitions, Arc length
1.3 Tangent, normal and binormal
1.4 Curvature and torsion of a curve given as the intersection of two surfaces
1.5 Contact between curves and surfaces
1.6 Contact between curves and surfaces (contd.)
Chapter 1: Sections 1-6</td></tr>
<tr><td></td><td colspan="7">UNIT II (12 hours) (K1, K2, K3, K4, K5 & K6)
Space Curves (Contd.)
2.1 Space Curves Tangent surface
2.2 Involutes
2.3 Evolutes
2.4 Intrinsic equations
2.5 Fundamentals existence theorem for space curves
2.6 Helices
Chapter 1: Sections 7-9</td></tr>
<tr><td></td><td colspan="7">UNIT III (12 hours) (K1, K2, K3, K4, K5 & K6)
Surfaces and Families of Curves
3.1 Surfaces and Families of Curves, Definition of a surface
3.2 Curves on a surface
3.3 Surfaces of Revolution
3.4 Helicoids
3.5 Metric on a surface
3.6 Direction coefficients on a surface</td></tr>
</table>

	Chapter 2: Sections 1-9
	UNIT IV (12 hours) (K1, K2, K3, K4, K5 & K6) **Geodesics** 4.1 Geodesics 4.2 Canonical geodesic equations 4.3 Normal property of geodesic Intrinsic properties 4.4 Existence theorems 4.5 Geodesic curvature 4.6 Gauss-Bonnet theorem, Gaussian curvature **Chapter 2: Sections 10 – 17**
	UNIT V (12 hours) (K1, K2, K3, K4, K5 & K6) **Developables** 5.1 Second fundamental form 5.2 Principle curvatures 5.3 Lines of curvatures 5.4 Developable associated with space curves 5.5 Developable associated with curves on surfaces 5.6 Minimal Surface **Chapter 3: Sections 1-7**
Extended Professional Component (isa part of the internal component only, not to be included in theexternal examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC and others to be solved. (To be discussed during the Tutorial hours)
Text Book	T.J Wilmore, An Introduction to Differential Geometry, 2nd Edition, Oxford at the Clarendon Press, First Reprint – 2000.
Reference Books	1. D. Somasundaram, Differential Geometry, second reprint, Narosa Publishing House, 2008. 2. M. L. Khanna, Differential Geometry, 6th Edition, Jai Prakash Nath and Co., Garh Road, Meerut City, 1998. 3. T.J Wilmore, An Introduction to Differential Geometry, 2nd Edition, Oxford at the Clarendon Press, First Reprint, 2000. 4. Dirk J Struik, Lectures on Classical Differential Geometry, 2nd Edition, Dover Publications, Inc, New York, 1961.
Web Resources	1. https://math.libretexts.org/Bookshelves/Calculus/Calculus_(OpenStax)/13%3A_Vector-Valued_Functions/13.03%3A_Arc_Length_and_Curvature 2. https://books.google.gm/books?id=dbIAAQAAQBAJ&lpg=PR4&pg=PP1#v=onepage&q&f=false

	3. https://mis.alagappauniversity.ac.in/siteAdmin/dde-admin/uploads/3/PG_M.Sc._Mathematics_31131%20DIFFERENTIAL%20GEOMETRY.pdf

CO	Course Outcomes
On completion of this course, students will be able to;	
CO1	Understand the line integrals, deal with differential forms, and calculate arc length, and curvature of surfaces.
CO2	Analyze involutes, evolutes, and fundamental existence theorem for space curves.
CO3	Identify the Surfaces and family of curves.
CO4	Explain the concepts of Geodesics and Gaussian curvature.
CO5	Compute the Principal curvatures, lines of curvatures, and Developables.

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	H	H	M	H	M	H
CO2	H	H	M	H	M	H
CO3	H	H	M	H	M	H
CO4	H	H	L	H	M	H
CO5	H	H	M	H	M	H

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	H	H	L	M	M	H
CO2	H	H	L	M	M	H
CO3	H	H	L	M	M	H
CO4	H	H	L	M	M	H
CO5	H	H	L	M	M	H

<table>
<tr><td>Title of the Course</td><td colspan="7">ELECTIVE: WAVELETS</td></tr>
<tr><td>Paper No.</td><td colspan="7">Elective IV B</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Elective</td><td>Year</td><td>I</td><td>Credits</td><td>3</td><td>Course Code</td><td>PEMAJ24</td></tr>
<tr><td>Semester</td><td>II</td></tr>
<tr><td>Instructional Hours per week</td><td>Lecture</td><td>Tutorial</td><td colspan="3">Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td></td><td>4</td><td>-</td><td colspan="3">-</td><td colspan="2">4</td></tr>
<tr><td>Pre-requisites</td><td colspan="7">-</td></tr>
<tr><td>Objectives of the Course</td><td colspan="7">• To know the terminology used in the wavelet literature and familiarize the concept of integral wavelet transforms and Time-frequency analysis.
• To discuss the concepts of Fourier series and Wavelet series.
• To establish the theory necessary to understand and use wavelets and related constructions.
• To acquire knowledge on scaling functions and direct-sum decompositions of wavelets and duals.
• To explain interpolating spline wavelets and computation of cardinal spline wavelets.</td></tr>
<tr><td>Course Outline</td><td colspan="7">UNIT I (12 hours) (K1, K2, K3, K4, K5 & K6)
An Overview
1.1 Fourier to Wavelets
1.2 Integral Wavelets Transform and Time-frequency analysis, Inversion formulas and duals
1.3 Classification of Wavelets, Multi-resolution analysis, Spines and Wavelets
1.4 Fourier Analysis: Fourier and Inverse Fourier Transformation, Continuous-time convolution
1.5 The Delta functions
1.6 Fourier Transformation of square-integrable functions.
Chapter 1: Sections 1.1 - 1.6, Chapter 2: Sections 2.1 - 2.3</td></tr>
<tr><td></td><td colspan="7">UNIT II (12 hours) (K1, K2, K3, K4, K5 & K6)
Fourier Series and Wavelet Series
2.1 Fourier Series, Basic Convergence Theory, Poisson Summation Formula
2.2 The Gabor Transforms
2.3 Short-time Fourier Transforms and the Uncertainty Principle
2.4 The integral Wavelet Transform
2.5 Dyadic Wavelets
2.6 Inversion, Frames, and Wavelet Series
Chapter 2: Sections 2.4 - 2.5, Chapter 3: Sections 3.1 - 3.6</td></tr>
<tr><td></td><td colspan="7">UNIT III (12 hours) (K1, K2, K3, K4, K5 & K6)
Cardinal Spline Analysis
3.1 Cardinal Spline spaces, B-splines, and their basic properties
3.2 The time scale relation and an interpolating graphical display algorithm
3.3 B – Net representations and computation of cardinal splines</td></tr>
</table>

	3.4 Constructions of cardinal splines 3.5 Constructions of spline application formulas 3.6 Construction of spline interpolation formulas **Chapter 4: Sections 4.1 - 4.6**
	UNIT IV (12 hours) (K1, K2, K3, K4, K5 & K6) **Scaling Functions and Direction Sum Decompositions of Wavelets** 4.1 Introduction 4.2 Basic definitions with examples 4.3 Multi-resolution analysis 4.4 Scaling functions with finite two-scale relation 4.5 Direct-sum Decompositions of Wavelets 4.6 Direct-sum Decomposition of the Duals. **Chapter 5: Sections 5.1 - 5.4**
	UNIT V (12 hours) (K1, K2, K3, K4, K5 & K6) **Cardinal Splines Wavelets** 5.1 Introduction 5.2 Interpolating Splines wavelets 5.3 Compactly supported spline 5.4 Wavelets 5.5 Computation of Cardinal spline wavelets 5.6 Euler – Frebenious polynomials **Chapter 5: Sections 5.5 - 5.6, Chapter 6: Sections 6.1 - 6.4**
Text Book	Charles K. Chui, An Introduction to Wavelets. Academic Press, 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.
Web Resources	1. https://archive.nptel.ac.in/courses/108/101/108101093/ 2. https://onlinecourses.nptel.ac.in/noc23_ee32/preview

CO	Course Outcomes
On completion of this course, students will be able to;	
CO1	Understand the concept of Fourier to Wavelets.
CO2	Evaluate Fourier series and Wavelet series.
CO3	Utilize wavelets and related constructions.
CO4	Examine scaling functions and direct-sum decompositions of wavelets and duals.
CO5	Analyze interpolating splines wavelets and computation of cardinal spline wavelets.

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	H	H	H	H	M	L
CO2	H	H	H	H	L	M
CO3	H	H	H	H	M	M
CO4	H	H	H	H	L	M
CO5	H	H	H	H	L	M

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	H	H	H	M	L	M
CO2	H	H	H	M	L	M
CO3	H	H	H	M	L	M
CO4	H	H	H	M	L	M
CO5	H	H	H	M	L	M

<table>
<tr><td>Title of the Course</td><td colspan="7">SEC: QUANTITATIVE APTITUDE FOR COMPETITIVE EXAMINATIONS – I</td></tr>
<tr><td>Paper No.</td><td colspan="7">Skill Enhancement Course (SEC I)</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">SEC</td><td>Year</td><td>I</td><td rowspan="2">Credits</td><td rowspan="2">2</td><td rowspan="2">Course Code</td><td rowspan="2">PSMAI24</td></tr>
<tr><td>Semester</td><td>II</td></tr>
<tr><td rowspan="2">Instructional Hours per week</td><td>Lecture</td><td>Tutorial</td><td colspan="3">Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td>1</td><td>1</td><td colspan="3">-</td><td colspan="2">2</td></tr>
<tr><td>Pre-requisites</td><td colspan="7">-</td></tr>
<tr><td>Objectives of the Course</td><td colspan="7">• To enhance problem-solving abilities and improve the basic mathematical skills in the Number System.
• To familiarize the formulae and solve problems on profit and loss, Interest, Time, and Work.
• To help students prepare for competitive examinations and acquire satisfactory competency in verbal reasoning.
• To acquire knowledge of clerical ability
• To learn confidence and efficiency in the test of spotting errors and test of sentence improvements.</td></tr>
<tr><td>Course Outline</td><td colspan="7">UNIT I (6 hours) (K1, K2, K3, K4, K5 & K6)
General Aptitude
Number System - HCF and LCM – Simplification - Fractions and Decimals - Powers and roots - Average – Percentage - Ratio and Proportion.
Section 2</td></tr>
<tr><td></td><td colspan="7">UNIT II (6 hours) (K1, K2, K3, K4, K5 & K6)
General Aptitude (Contd.)
Profit and Loss - Simple Interest - Compound Interest - Time and Work - Time and Distance - Clocks – Calendar - Area and Volume.
Section 2</td></tr>
<tr><td></td><td colspan="7">UNIT III (6 hours) (K1, K2, K3, K4, K5 & K6)
Verbal Ability Test
Series Completion - Odd man out/ Classification, Coding/ Decoding - Direction questions - Questions on age.
Section 2B</td></tr>
<tr><td></td><td colspan="7">UNIT IV (6 hours) (K1, K2, K3, K4, K5 & K6)
Test of Clerical Ability
Questions based on Tables - Word Arrangement, Category/Classification.
Section 5</td></tr>
<tr><td></td><td colspan="7">UNIT V (6 hours) (K1, K2, K3, K4, K5 & K6)
Test of English Language
Test of spotting the errors - Test of sentence improvements - Test of Synonyms and Antonyms.
Section 4</td></tr>
</table>

Extended Professional Component (isa part of the internal component only, not to be included in theexternal examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC and others to be solved. (To be discussed during the Tutorial hours)

Text Book	Showick Thorpe, The Pearson Guide to the Bank Clerical Recruitment Examination, Second Edition, Publisher: Pearson, 2010.
Reference Books	1. R. S Agarwal, Quantitative Aptitude for Competitive Examinations, S. Chand Publications, 2017. 2. Khattar, Quantitative Aptitude for Competitive Exams 3ed, Pearson Publications, 2015. 3. B.S. Sijwalii, InduSijwali, A New Approach to REASONING Verbal & Non-Verbal, Arihant, Publications, 2014.
Web Resources	1. https://www.indiabix.com 2. https://www.indiabix.com/aptitude/questions-and-answers 3. https://myupsc.com/wp-content/uploads/2020/11/Quantitative-Aptitude-for-Competitive-Examinations-by-Dinesh-Khattar-z-lib.org_.pdf 4. http://mathforum.org 5. http://ocw.mit.edu/ocwweb/Mathematics 6. http://www.opensource.org 7. www.coursera.org 8. https://swayam.gov.in

CO	Course Outcomes
On completion of this course, students will be able to;	
CO1	Understand the concepts of Number System and aptitude problems.
CO2	Recollect the formulae and solve problems on profit and loss, Interest, Time, and Work.
CO3	Demonstrate a basic understanding of data interpretation and exhibit eloquence in verbal reasoning.
CO4	Identify and respond effectively to questions on clerical ability.
CO5	Recognize the type of questions and answer them confidently with efficiency in grammar.

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	H	H	M	H	M	H
CO2	H	H	M	H	M	H
CO3	H	H	L	H	M	H
CO4	H	H	M	H	M	H
CO5	H	H	M	H	M	H

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	H	H	H	M	L	M
CO2	H	H	H	M	L	M
CO3	H	H	H	M	L	M
CO4	H	H	H	M	L	M
CO5	H	H	H	M	L	M

<table>
<tr><td>Title of the Course</td><td colspan="7">COMPLEX ANALYSIS</td></tr>
<tr><td>Paper No.</td><td colspan="7">Core VII</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Core</td><td>Year</td><td>II</td><td rowspan="2">Credits</td><td rowspan="2">5</td><td rowspan="2">Course Code</td><td rowspan="2">PCMAG24</td></tr>
<tr><td>Semester</td><td>III</td></tr>
<tr><td rowspan="2">Instructional Hours per week</td><td>Lecture</td><td>Tutorial</td><td colspan="3">Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td>5</td><td>1</td><td colspan="3">-</td><td colspan="2">6</td></tr>
<tr><td>Pre-requisites</td><td colspan="7">UG – Level Complex Analysis</td></tr>
<tr><td>Objectives of the Course</td><td colspan="7">• To analyze and evaluate local properties of analytical functions.
• To learn the concept of the general form of Cauchy’s theorem
• To impart knowledge on definite integral and harmonic functions.
• To familiarize with the concepts of the Taylor and Laurent series.
• To characterize the infinite products, canonical products, and Jensen’s formula.</td></tr>
<tr><td>Course Outline</td><td colspan="7">UNIT I (18 hours) (K1, K2, K3, K4, K5 & K6)
Cauchy’s Integral Formula
1.1 The Index of a point with respect to a closed curve
1.2 The Integral formula
1.3 Higher derivatives
1.4 Local Properties of Analytical Functions, Removable Singularities
1.5 Taylors’s Theorem
1.6 Zeros and poles, The local Mapping, The Maximum Principle
Chapter 4: Section 2: 2.1 - 2.3, Chapter 4: Section 3: 3.1 - 3.4</td></tr>
<tr><td></td><td colspan="7">UNIT II (18 hours) (K1, K2, K3, K4, K5 & K6)
The General Form of Cauchy’s Theorem
2.1 Definitions, Chains, and Cycles
2.2 Simple Continuity
2.3 Homology, The General statement of Cauchy’s Theorem, Proof of Cauchy’s theorem
2.4 Locally exact differentials, Multiply connected regions
2.5 Residue theorem
2.6 The Argument principle
Chapter 4: Section 4: 4.1 - 4.7, Chapter 4: Section 5: 5.1 and 5.2</td></tr>
<tr><td></td><td colspan="7">UNIT III (18 hours) (K1, K2, K3, K4, K5 & K6)
Evaluation of Definite Integrals and Harmonic Functions
3.1 Definition and properties of definite integrals
3.2 Evaluation of definite integrals
3.3 Definition of Harmonic Function
3.4 Basic properties of Harmonic function
3.5 Mean value property
3.6 Poisson formula
Chapter 4: Section 5: 5.3, Chapter 4: Sections 6: 6.1 - 6.3</td></tr>
</table>

	UNIT IV (18 hours) (K1, K2, K3, K4, K5 & K6) **Harmonic Functions and Power Series Expansions** 4.1 Schwarz's theorem 4.2 The reflection principle 4.3 Weierstrass's theorem 4.4 Taylor series 4.5 Laurent series 4.6 Problems with Taylor's series and Laurent's series **Chapter 4: Sections 6.4 and 6.5, Chapter 5: Sections 1.1 - 1.3**
	UNIT V (18 hours) (K1, K2, K3, K4, K5 & K6) **Partial Fractions and Entire Functions** 5.1 Partial fractions 5.2 Infinite products 5.3 Canonical products 5.4 Gamma Function 5.5 Jensen's formula 5.6 Hadamard's Theorem **Chapter 5: Sections 2.1 - 2.4, Chapter 5: Sections 3.1 and 3.2**
Extended Professional Component (isa part of the internal component only, not to be included in theexternal examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC and others to be solved. (To be discussed during the Tutorial hours)
Text Book	Lars V. Ahlfors, Complex Analysis, 3rd Edition, McGraw-Hill International Editions, Tokyo, 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, 1978. 3. E. Hille, Analytic function Theory (2 vols.), Gonm & Co., 1959. 4. M. Heins, Complex function Theory, Academic Press, New York,1968.
Web Resources	1. http://mathforum.org 2. http://ocw.mit.edu/ocwweb/Mathematics 3. http://www.opensource.org 4. http://en.wikipedia.org

CO	Course Outcomes
On completion of this course, students will be able to;	
CO1	Analyze and evaluate local properties of analytical functions, Taylor's theorem, and the Maximum Principle.
CO2	Demonstrate the concept of the general form of Cauchy's theorem.
CO3	Describe the concept of definite integral and harmonic functions.
CO4	Develop the Taylor and Laurent series.
CO5	Explain the infinite products, canonical products, and Jensen's formula.

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	H	M	L	H	M	M
CO2	H	M	L	H	H	M
CO3	H	M	L	H	M	M
CO4	H	M	L	H	M	L
CO5	H	M	L	H	H	L

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	H	H	H	M	L	M
CO2	H	H	H	M	L	M
CO3	H	H	H	M	L	M
CO4	H	H	H	M	L	M
CO5	H	H	H	M	L	M

<table>
<tr><td>Title of the Course</td><td colspan="7">MECHANICS</td></tr>
<tr><td>Paper No.</td><td colspan="7">Core VIII</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Core</td><td>Year</td><td>II</td><td>Credits</td><td>5</td><td>Course Code</td><td>PCMAH24</td></tr>
<tr><td>Semester</td><td>III</td></tr>
<tr><td rowspan="2">Instructional Hours per week</td><td>Lecture</td><td>Tutorial</td><td colspan="3">Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td>5</td><td>1</td><td colspan="3">-</td><td colspan="2">6</td></tr>
<tr><td>Pre-requisites</td><td colspan="7">UG-level Statics and Dynamics</td></tr>
<tr><td>Objectives of the Course</td><td colspan="7">• To understand mechanical systems under generalized coordinate systems.
• To apply the techniques of mechanics in virtual work, Energy, and Momentum to discuss the Lagrange equation.
• To update the analytic skills in Hamilton’s equations.
• To acquire the knowledge of Hamilton-Jacobi equations and Separability.
• To evaluate problems based on Canonical transformations.</td></tr>
<tr><td>Course Outline</td><td colspan="7">UNIT I (18 hours) (K1, K2, K3, K4, K5 & K6)
Mechanical System
1.1 Introduction: Preliminaries
1.2 The Mechanical System, Theorem
1.3 Generalized Coordinates
1.4 Types of Constraints
1.5 Virtual work, Virtual Displacement
1.6 Energy and Momentum
Chapter 1: Sections 1.1 - 1.5</td></tr>
<tr><td></td><td colspan="7">UNIT II (18 hours) (K1, K2, K3, K4, K5 & K6)
Lagrange’s Equations
2.1 Derivation of Lagrange’s equations
2.2 Forms of the equations of motion
2.3 Examples based on forms of the equations of motion
2.4 Integrals of Motion
2.5 Liouville’s system
2.6 Examples based on integrals of motion
Chapter 2: Sections 2.1- 2.3</td></tr>
<tr><td></td><td colspan="7">UNIT III (18 hours) (K1, K2, K3, K4, K5 & K6)
Hamilton’s Equations
3.1 Hamilton’s Principle
3.2 Brachistochrone problem, Geodesic problem
3.3 Hamilton’s principle, Multiplier Rule
3.4 Hamilton’s Equations
3.5 Other variational principles
3.6 Examples</td></tr>
</table>

	Chapter 4: Sections 4.1 – 4.3
	UNIT IV (18 hours) (K1, K2, K3, K4, K5 & K6) **Hamilton - Jacobi Theory** 4.1 Introduction 4.2 Hamilton's principle function 4.3 Hamilton – Jacobi Equation 4.4 Conservative systems and Ignorable coordinates 4.5 Separability 4.6 Kepler problem on separability **Chapter 5: Sections 5.1-5.3**
	UNIT V (18 hours) (K1, K2, K3, K4, K5 & K6) **Canonical Transformations** 5.1 Differential Forms and Generating Functions 5.2 Special Transformations 5.3 Problems based on canonical transformations 5.4 Lagrange Brackets 5.5 Poisson Brackets 5.6 Bilinear covariant **Chapter 6: Sections 6.1 - 6.3**
Extended Professional Component (isa part of the internal component only, not to be included in theexternal examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC and others to be solved. (To be discussed during the Tutorial hours)
Text Book	D.T. Greenwood, Classical Dynamics, Prentice Hall of India, New Delhi, 1985.
Reference Books	1. Goldstein, Classical Mechanics, Narosa Publishing House, New Delhi, 17th Reprint, 1998. 2. N.C. Ran and P.S. Joag, Classical Mechanics, Tata Mc-Graw Hill Publishing Company Limited, New Delhi, 2004. 3. J. L. Synge and P. S. C. Joag, Classical Mechanics, Tata Mc-Graw Hill, New Delhi, 1991. 4. P. G. Bergmann, Introduction to Theory of Relativity, Prentice Hall of India, Eddington, New Delhi, 1969.
Web Resources	1. http://mathforum.org, http://ocw.mit.edu/ocwweb/Mathematics, 2. http://www.opensource.org, www.mathpages.com 3. https://books.google.com.na/books?id=x7rj83I98yMC&printsec=frontcover#v=onepage&q&f=false 4. https://efaidnbmnnnibpcajpcglclefindmkaj/http://www.stet.edu.in/SSR_Report/Study%20Material/PDF/MATHS/PG/II%20Year/1.pdf 5. http://poincare.matf.bg.ac.rs/~zarkom/Book_Mechanics_Goldstein_Classical_Mechanics_optimized.pdf

CO	Course Outcomes
On completion of this course, students will be able to;	
CO1	Explain the basic concepts of mechanical systems under generalized coordinate systems.
CO2	Identify the Lagrange's equations and its application.
CO3	Derive the Hamilton’s Equations.
CO4	Analyze Hamilton’s Principle and Hamilton-Jacobi Equation and Separability
CO5	Apply Lagrange and Poisson brackets to evaluate the problems.

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	H	M	H	L	H	M
CO2	H	H	H	M	H	M
CO3	H	H	M	H	M	L
CO4	H	M	H	H	M	H
CO5	H	M	H	H	H	L

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	H	H	H	M	L	H
CO2	H	H	H	M	L	H
CO3	H	H	H	M	L	H
CO4	H	H	H	M	L	H
CO5	H	H	H	M	L	H

<table>
<tr><td>Title of the Course</td><td colspan="7">TOPOLOGY</td></tr>
<tr><td>Paper No.</td><td colspan="7">Core IX</td></tr>
<tr><td>Category</td><td>Core</td><td>Year</td><td>II</td><td>Credits</td><td>5</td><td>Course Code</td><td>PCMAI24</td></tr>
<tr><td></td><td></td><td>Semester</td><td>III</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Instructional Hours per week</td><td>Lecture</td><td>Tutorial</td><td colspan="3">Lab Practice</td><td>Total</td></tr>
<tr><td></td><td>5</td><td>1</td><td colspan="3">-</td><td>6</td></tr>
<tr><td>Pre-requisites</td><td colspan="7">UG – Level Real Analysis</td></tr>
<tr><td>Objectives of the Course</td><td colspan="7">• To define and illustrate the concept of topological spaces.
• To impart knowledge on the concepts of continuous functions and their properties in topological spaces.
• To learn the topology generated by the given basis, connectedness, and path connectedness of the product of an arbitrary family of spaces.
• To be familiar with the concept of compactness.
• To explore countability and separation axioms.</td></tr>
<tr><td>Course Outline</td><td colspan="7">UNIT I (18 hours) (K1, K2, K3, K4, K5 & K6)
Topological Spaces
1.1 Topological spaces
1.2 Basis for a topology
1.3 The ordered topology, The product topology on X x Y
1.4 The subspace topology
1.5 Closed sets
1.6 Limit points
Chapter 2: Sections 12 – 17</td></tr>
<tr><td></td><td colspan="7">UNIT II (18 hours) (K1, K2, K3, K4, K5 & K6)
Metric Space Topology and Connectedness
2.1 Continuous functions
2.2 Continuous functions (contd.)
2.3 The product topology
2.4 The product topology (contd.)
2.5 The metric topology
2.6 The metric topology (contd.)
Chapter 2: Sections 18 - 21</td></tr>
<tr><td></td><td colspan="7">UNIT III (18 hours) (K1, K2, K3, K4, K5 & K6)
Connectedness
3.1 Connected spaces
3.2 Connected subspaces of the real line
3.3 Components
3.4 Components (contd.)
3.5 Local connectedness</td></tr>
</table>

	3.6 Local connectedness (contd.) **Chapter 3: Sections 23 – 25**
	UNIT IV (18 hours) (K1, K2, K3, K4, K5 & K6) **Compactness** 4.1 Compact spaces 4.2 Compact subspaces of the real Line 4.3 Limit point Compactness 4.4 Limit point Compactness (contd.) 4.5 Local Compactness 4.6 Local Compactness (contd.) **Chapter 3: Sections 26 – 29**
	UNIT V (18 hours) (K1, K2, K3, K4, K5 & K6) **Countability and Separation Axiom** 5.1 The Countability Axioms 5.2 The Separation Axioms 5.3 Normal spaces 5.4 The Urysohn Lemma 5.5 The Urysohn Metrization Theorem 5.6 The Tietze Extension Theorem **Chapter 4: Sections 30 - 35**

Extended Professional Component (isa part of the internal component only, not to be included in theexternal examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC and others to be solved. (To be discussed during the Tutorial hours)

Text Books	1. James R. Munkres, Topology, 2nd Edition, Pearson Education Pvt. Ltd., Delhi-2002. (Third Indian Reprint) 2. James Munkres, Topology, 2nd Edition, Pearson New International Edition, Pearson Education Limited, USA, 2014.
Reference Books	1. J. Dugundji, Topology, Prentice Hall of India, New Delhi, 1975. 2. George F. Simmons, Introduction to Topology and Modern Analysis, McGraw Hill Book Co., 1963. 3. J.L. Kelly, General Topology, Van Nostrand, Reinhold Co., New York, 1969. 4. L. Steen and J. Subhash, Counter Examples in Topology, Holt, Rinehart and Winston, New York, 1970. 5. S. Willard, General Topology, Addison - Wesley, Mass., 1970
Web Resources	1. http://mathforum.org 2. http://ocw.mit.edu/ocwweb/Mathematics 3. http://www.opensource.org 4. http://en.wikipedia.org

CO	Course Outcomes
On completion of this course, students will be able to;	
CO1	Define and illustrate the concept of topological spaces and the basic definitions of open sets, neighborhood, interior, exterior, closure, and their axioms for defining topological space.
CO2	Understand the concepts of continuous functions and their properties in topological spaces.
CO3	Analyze connected spaces, components and local connectedness.
CO4	Distinguish limit point compactness and local compactness.
CO5	Explain countability and separation axioms and validate the statements of Urysohn lemma, Urysohn metrization theorem.

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	H	H	L	H	M	M
CO2	H	H	L	H	M	M
CO3	H	H	L	H	M	M
CO4	H	H	L	H	M	M
CO5	H	H	L	H	M	M

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	H	H	H	M	L	M
CO2	H	H	H	M	L	M
CO3	H	H	H	M	L	M
CO4	H	H	H	M	L	M
CO5	H	H	H	M	L	M

<table>
<tr><td>Title of the Course</td><td colspan="7">PROBABILITY THEORY</td></tr>
<tr><td>Paper No.</td><td colspan="7">Core X</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Core</td><td>Year</td><td>II</td><td rowspan="2">Credits</td><td rowspan="2">4</td><td rowspan="2">Course Code</td><td rowspan="2">PCMAJ24</td></tr>
<tr><td>Semester</td><td>III</td></tr>
<tr><td>Instructional Hours per week</td><td>Lecture</td><td>Tutorial</td><td colspan="3">Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td></td><td>5</td><td>1</td><td colspan="3">-</td><td colspan="2">6</td></tr>
<tr><td>Pre-requisites</td><td colspan="7">-</td></tr>
<tr><td>Objectives of the Course</td><td colspan="7">• To introduce the axiomatic approach to probability theory.
• To familiarize with the concepts of Expectation, Moments, and Chebyshev Inequality.
• To discuss the characteristic functions and their properties.
• To acquire knowledge of Probability distributions.
• To focus on the limit theorems on probability.</td></tr>
<tr><td>Course Outline</td><td colspan="7">UNIT I (18 hours) (K1, K2, K3, K4, K5 & K6)
Random Events and Random Variables
1.1 Random events, Probability axioms
1.2 Combinatorial formulae, conditional probability
1.3 Bayes Theorem, Independent events
1.4 Random Variables, Distribution Function, Joint Distribution, Marginal Distribution, Conditional Distribution
1.5 Independent random variables
1.6 Functions of random variables
Chapter 1: Sections 1.1-1.7, Chapter 2: Sections 2.1-2.9</td></tr>
<tr><td></td><td colspan="7">UNIT II (18 hours) (K1, K2, K3, K4, K5 & K6)
Parameters of the Distribution
2.1 Expectation, Moments
2.2 The Chebyshev Inequality
2.3 Absolute moments
2.4 Order parameters
2.5 Moments of random vectors
2.6 Regression of the first and second types
Chapter 3: Sections 3.1-3.8</td></tr>
<tr><td></td><td colspan="7">UNIT III (18 hours) (K1, K2, K3, K4, K5 & K6)
Characteristic functions
3.1 Properties of characteristic functions, Characteristic functions, and moments
3.2 Semi - invariants
3.3 Characteristic function of the sum of the independent random variables
3.4 Determination of distribution function by the Characteristic function</td></tr>
</table>

	3.5 Characteristic function of multidimensional random vectors 3.6 Probability-generating functions **Chapter 4: Sections 4.1-4.7**
	UNIT IV (18 hours) (K1, K2, K3, K4, K5 & K6) **Probability distributions** 4.1 One point, two point 4.2 Binomial, Polya, Hypergeometric distributions 4.3 Poisson (discrete) distributions 4.4 Uniform Distribution 4.5 Normal, gamma, Beta distribution 4.6 Cauchy and Laplace (continuous) distributions **Chapter 5: Sections 5.1 – 5.10**
	UNIT V (18 hours) (K1, K2, K3, K4, K5 & K6) **Limit Theorems** 5.1 Stochastic convergence, Bernoulli law of large numbers 5.2 Convergence of sequence of distribution functions 5.3 Levy-Cramer Theorems, De Moivre - Laplace Theorem 5.4 Poisson, Chebyshev 5.5 Khintchine Weak law of large numbers, Lindberg Theorem 5.6 Lapunov Theorem, Borel-Cantelli Lemma, Kolmogorov Inequality and Kolmogorov Strong Law of large numbers **Chapter 6: Sections 6.1-6.4, 6.6-6.9, 6.11 and 6.12**
Extended Professional Component (isa part of the internal component only, not to be included in theexternal examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC and others to be solved. (To be discussed during the Tutorial hours)
Text Book	Marek Fisz, Probability Theory and Mathematical Statistics, John Wiley and Sons, New York, 1963.
Reference Books	1. R.B. Ash, Real Analysis and Probability, Academic Press, New York, 1972. 2. K.L. Chung, A course in Probability, Academic Press, New York, 1974. 3. R. Durrett, Probability: Theory and Examples, (2nd Edition) Duxbury Press, New York, 1996. 4. V.K. Rohatgi, An Introduction to Probability Theory and Mathematical Statistics, Wiley Eastern Ltd., New Delhi, 1988 (3rd Print). 5. S.I. Resnick, A Probability Path, Birhauser, Berlin,1999. 6. B.R. Bhat, Modern Probability Theory (3rd Edition), New Age International (P) Ltd., New Delhi, 1999.

Web Resources	1. https://www.scribd.com/document/294762054/Probability-Theory-and-Mathematical 2. https://www.probability.net 3. www.coursera.org 4. https://swayam.gov.in 5. http://mathforum.org 6. http://ocw.mit.edu/ocwweb/Mathematics, 7. http://www.opensource.org

CO	**Course Outcomes**
On completion of this course, students will be able to;	
CO1	Understand Random Events, random variables, to describe Probability, Apply Bayes, to define Distribution Function, Find the Joint Distribution function, the Marginal Distribution and Conditional Distribution function, to solve functions on random variables.
CO2	Estimate Expectation, Moments, and Chebyshev Inequality, to solve Regression of the first and second types.
CO3	Define Characteristic functions, distribution functions, to find probability-generating functions and to solve problems by applying characteristic functions.
CO4	Apply One point, Two-point, Binomial distributions, to solve problems of Hypergeometric and Poisson distributions, Define Uniform, normal, gamma, and Beta distributions, to solve problems on Cauchy and Laplace distributions.
CO5	Analyze stochastic convergence, and Bernoulli law of large numbers, to elaborate Convergence of sequence of distribution functions, Prove Levy-Cramer Theorems and de Moivre-Laplace Theorems, Explain Poisson, Chebyshev, Khintchine Weak law of large numbers, and solve problems on Kolmogorov Inequality and Kolmogorov Strong Law of large numbers.

CO/PSO	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1	H	H	M	H	H	M
CO2	H	H	M	H	H	M
CO3	H	H	M	H	H	L
CO4	H	H	M	H	H	L
CO5	H	H	M	H	H	L

CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	H	H	H	M	L	M
CO2	H	H	H	M	L	M
CO3	H	H	H	M	L	M
CO4	H	H	H	M	L	M
CO5	H	H	H	M	L	M

<table>
<tr><td>Title of the Course</td><td colspan="7">ELECTIVE: RESOURCE MANAGEMENT TECHNIQUES</td></tr>
<tr><td>Paper No.</td><td colspan="7">Elective V A</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Elective</td><td>Year</td><td>II</td><td rowspan="2">Credits</td><td rowspan="2">3</td><td rowspan="2">Course Code</td><td rowspan="2">PEMAK24</td></tr>
<tr><td>Semester</td><td>III</td></tr>
<tr><td rowspan="2">Instructional Hours per week</td><td>Lecture</td><td>Tutorial</td><td colspan="3">Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td>2</td><td>1</td><td colspan="3">-</td><td colspan="2">3</td></tr>
<tr><td>Pre-requisites</td><td colspan="7">UG-level Operations Research</td></tr>
<tr><td>Objectives of the Course</td><td colspan="7">• To impart knowledge on the basic concepts of Operations Research and the Revised Simplex method.
• To familiarize the concepts of Inventory models and Network analysis.
• To learn various methods in Game theory and Replacement Models.
• To gain knowledge on decision theory and Decision trees.
• To familiarize the notions of Dynamic model and Time Series analysis.</td></tr>
<tr><td>Course Outline</td><td colspan="7">UNIT I (9 hours) (K1, K2, K3, K4, K5 & K6)
Advanced Topics in Linear Programming
1.1 LPP formulation
1.2 Solving LPP by Graphical Method
1.3 Generalized simplex tableau in matrix form
1.4 The Revised Simplex Method
1.5 Problems on Revised Simplex Method
1.6 Primal and Dual
Chapter 2: Sections 2.1 - 2.3, Chapter 6: Sections 6.1 - 6.3</td></tr>
<tr><td></td><td colspan="7">UNIT II (9 hours) (K1, K2, K3, K4, K5 & K6)
Inventory Models and Network Models
2.1 Inventory Problem: A Supply Chain Perspective
2.2 Role of demand in the development of Inventory models
2.3 Static Economic-Order-Quantity (EOQ) models
2.4 EOQ with price breaks
2.5 Scope and Definition of Network Models
2.6 Shortest – Route problem
Chapter: Sections 2.1- 2.3</td></tr>
<tr><td></td><td colspan="7">UNIT III (9 hours) (K1, K2, K3, K4, K5 & K6)
Game Theory and Replacement Models
3.1 Game Theory: Two- person Zero-sum games, Saddle point
3.2 Games without Saddle point</td></tr>
</table>

	3.3 Dominance Properties 3.4 Graphical Method 3.5 Individual replacement models with time value of money 3.6 Replacement Models without time value of money **Chapter 14: Sections 14.1 – 14.7, Chapter 19: Sections 19.1 and 19.2**
	UNIT IV (9 hours) (K1, K2, K3, K4, K5 & K6) **Decision Theory and Decision Trees** 4.1 Decision making under risk, Expected value criterion 4.2 Expected value combined with variance criterion 4.3 Decision-making under risk: EMV models 4.4 Decision-making under risk: EOL models 4.5 Decision trees 4.6 Decision-making under Uncertainty **Chapter 13: Sections 13.1-13.7**
	UNIT V (9 hours) (K1, K2, K3, K4, K5 & K6) **Dynamic Programming and Time Series Analysis** 5.1 Recursive Nature of Dynamic Programming Computation 5.2 Forward and Backward Recursion 5.3 Equipment Replacement Model 5.4 Time Series Analysis 5.5 Variation in Time Series 5.6 Trend Analysis **Chapter 16: Sections 16.1 -16.4**
Extended Professional Component (isa part of the internal component only, not to be included in theexternal examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC and others to be solved. (To be discussed during the Tutorial hours)
Text Books	1. Prem Kumar Gupta, Hira D.S., Operations Research, S. Chand & Company Pvt. Limited: New Delhi, Seventh Revised Edition, 2014. 2. Taha, H.A., Operations Research: An Introduction, 10th Edition, Pearson, 2019. 3. Sankara Iyer P., Operations Research, Tata McGraw Hill, 2008.
Reference Books	1. Kanti Swarup, P.K. Gupta and Man Mohan, Introduction to Management Science - Operations Research, Sultan Chand and Sons, 2014. 2. P.R.Vittal, Introduction to Operations Research, Margham Publications, 2008. 3. V. Sundaresan, K.S. Ganapathy Subramanian, and K. Ganesan, Resource Management Techniques, A.R. Publications, 2009. 4. Pannerselvam, R., Operations Research, Prentice Hall of India, 4th Edition, 2008.

	5. J. L. Synge and P. S. C. Joag, Classical Mechanics, Tata Mc-Graw Hill, New Delhi, 1991. 6. P. G. Bergmann, Introduction to Theory of Relativity, Prentice Hall of India, Eddington, New Delhi, 1969.
Web Resources	1. https://www.acsce.edu.in/acsce/wpcontent/uploads/2020/03/MODULE-4-Queueing-Theory.pdf 2. https://www.srividyaengg.ac.in/coursematerial/CSE/104745.pdf

CO	**Course Outcomes**
On completion of this course, students will be able to;	
CO1	Understand the basic concepts of Operations Research and the Revised Simplex method.
CO2	Analyze Inventory models and Network analysis.
CO3	Distinguish various methods adopted by Game theory and Replacement Models.
CO4	Assess problems on Decision theory and Decision trees.
CO5	Evaluate the problems related to the Dynamic model and Time Series analysis.

CO/PSO	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1	H	H	L	M	M	H
CO2	H	H	M	M	M	H
CO3	H	H	M	M	M	H
CO4	H	H	M	M	M	H
CO5	H	M	H	H	H	L

CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	H	H	M	M	M	H
CO2	H	H	M	M	M	H
CO3	H	H	M	M	M	H
CO4	H	H	M	M	M	H
CO5	H	M	H	H	H	L

<table>
<tr><td>Title of the Course</td><td colspan="7">ELECTIVE: FLUID DYNAMICS</td></tr>
<tr><td>Paper No.</td><td colspan="7">Elective V B</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Elective</td><td>Year</td><td>II</td><td>Credits</td><td>3</td><td>Course Code</td><td>PEMAL24</td></tr>
<tr><td>Semester</td><td>III</td><td colspan="4"></td></tr>
<tr><td rowspan="2">Instructional Hours per week</td><td>Lecture</td><td>Tutorial</td><td colspan="3">Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td>2</td><td>1</td><td colspan="3">-</td><td colspan="2">3</td></tr>
<tr><td>Pre-requisites</td><td colspan="7">-</td></tr>
<tr><td>Objectives of the Course</td><td colspan="7">• To acquire knowledge of fluid flow.
• To identify the pressure of fluid in different kinds of Motion.
• To learn Sources, Sinks, and Stoke’s Stream Function.
• To differentiate the complex potential for two-dimensional flow and complex velocity potentials for standard two-dimensional flows.
• To know the relation between cartesian components of stress and the relation between stress and rate of strain.</td></tr>
<tr><td>Course Outline</td><td colspan="7">UNIT I (9 hours) (K1, K2, K3, K4, K5 & K6)
Kinematics of Fluids in Motion
1.1 Real fluids
1.2 Ideal fluids
1.3 Velocity of a Fluid at a Point-Streamlines and Path lines
1.4 Steady flows
1.5 Unsteady flows
1.6 The Velocity Potential
Chapter 2: Sections 2.1 - 2.9</td></tr>
<tr><td></td><td colspan="7">UNIT II (9 hours) (K1, K2, K3, K4, K5 & K6)
Equations of Motion of a Fluid
2.1 Pressure at a Point in a Fluid at Rest
2.2 Pressure at a Point in a Moving Fluid
2.3 Euler’s Equations of Motion
2.4 Euler’s Equations of Motion – Examples
2.5 Bernoulli’s Equation
2.6 Bernoulli’s Equation: Examples
Chapter 3: Sections 3.1 - 3.6</td></tr>
<tr><td></td><td colspan="7">UNIT III (9 hours) (K1, K2, K3, K4, K5 & K6)
Three-Dimensional Flows
3.1 Introduction
3.2 Sources
3.3 Sinks
3.4 Doublets
3.5 Images in a rigid infinite plane</td></tr>
</table>

	3.6 Stokes's Stream Function **Chapter 4: Sections 4.1, 4.2 and 4.5**
	UNIT IV (9 hours) (K1, K2, K3, K4, K5 & K6) **Two-Dimensional Flows (Contd.)** 4.1 Meaning of Two-Dimensional Flow 4.2 Use of Cylindrical Polar Coordinates 4.3 The Complex Potential for Two-Dimensional Flow 4.4 The Complex Potential for Two-Dimensional Flow – Examples 4.5 Complex Velocity Potentials for Standard Two-Dimensional Flows 4.6 Some Worked Examples **Chapter 13: Sections 13.1-13.7**
	UNIT V (9 hours) (K1, K2, K3, K4, K5 & K6) **Stress Components and Viscosity Flow** 5.1 Stress Components in Real Fluid 5.2 Relations between Cartesian Components of Stress 5.3 Translation Motion of Fluid Element 5.4 The Rate of Principal Stresses 5.5 Relation between Stress and Rate of Strain 5.6 The Coefficient of Viscosity Flow **Chapter 8: Sections 8.1 - 8.9**
Extended Professional Component (isa part of the internal component only, not to be included in theexternal examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC and others to be solved. (To be discussed during the Tutorial hours)
Text Book	F. Chorlton, Text book of Fluid Dynamics, CBS Publishers & Distributors Pvt. Ltd, New Delhi, Reprint 2004.
Reference Books	1. A.R. Paterson, A First Course in Fluid Dynamics, Cambridge University Press, New York, 1987. 2. G.K. Batchelor, An Introduction of Fluid Mechanics, Foundation Books, New Delhi, 1993. 3. R. K. Rathy, An Introduction to Fluid Dynamics, IBH Publishing Company, New Delhi, 1976. 4. E. Krause, Fluid Mechanics with problems and solutions, Springer, 2005.
Web Resources	1. https://pdfcoffee.com/fluid-dynamics-by-chorlton-pdf-free.html 2. https://kanchiuniv.ac.in/coursematerials/Fluid%20Dynamics%20MMAF183T40-course%20material.pdf 3. https://handoutset.com/wp-content/uploads/2022/07/A-First-Course-in-Fluid-Dynamics-A.-R.-Paterson.pdf

CO	Course Outcomes
On completion of this course, students will be able to;	
CO1	Understand the concepts of fluid flow.
CO2	Identify the pressure of fluid in different kinds of Motion.
CO3	Analyze the Sources, Sinks, and Stoke's Stream Function.
CO4	Distinguish the complex potential for two-dimensional flow and complex velocity potentials for standard two-dimensional flows.
CO5	Explain the concepts of the Rate of Strain Quadric and Principal Stresses, Stress Analysis in Fluid Motion, the Coefficient of Viscosity and Laminar Flow, and the Navier-Stokes Equations of Motion of a Viscous Fluid.

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	H	H	L	M	H	M
CO2	H	H	L	M	H	M
CO3	H	H	L	M	H	M
CO4	H	M	L	M	H	L
CO5	H	H	L	M	H	M

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	H	H	L	M	M	H
CO2	H	H	L	M	M	H
CO3	H	H	L	M	M	H
CO4	H	H	L	M	M	H
CO5	H	H	L	M	M	H

<table>
<tr><td>Title of the Course</td><td colspan="7">QUANTITATIVE APTITUDE FOR COMPETITIVE EXAMINATIONS – II</td></tr>
<tr><td>Paper No.</td><td colspan="7">Skill Enhancement Course (SEC II)</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">SEC</td><td>Year</td><td>II</td><td rowspan="2">Credits</td><td rowspan="2">2</td><td rowspan="2">Course Code</td><td rowspan="2">PSMA224</td></tr>
<tr><td>Semester</td><td>III</td></tr>
<tr><td rowspan="2">Instructional Hours per week</td><td>Lecture</td><td>Tutorial</td><td colspan="3">Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td>1</td><td>1</td><td colspan="3">-</td><td colspan="2">2</td></tr>
<tr><td>Pre-requisites</td><td colspan="7">-</td></tr>
<tr><td>Objectives of the Course</td><td colspan="7">• To enhance reasoning ability to solve series completion problems.
• To focus on the arithmetic ability to solve problems on trains, boats, streams, area, volume, and surfaces.
• To represent real-world scenarios and to solve stated problems in permutation and combinations, heights, and distance.
• To gain general awareness of clerical ability.
• To impart knowledge of current affairs and computer skills.</td></tr>
<tr><td>Course Outline</td><td colspan="7">UNIT I (6 hours) (K1, K2, K3, K4, K5 & K6)
Reasoning Ability
Series Completion- Arranging figures in series- Classification- Pattern Comparison- Analogies.
Section 3: Part B</td></tr>
<tr><td></td><td colspan="7">UNIT II (6 hours) (K1, K2, K3, K4, K5 & K6)
Arithmetic Ability
Surds and indices- Problem on Trains- Boats and streams- Logarithms- Area- Volume and surfaces.
Section 1</td></tr>
<tr><td></td><td colspan="7">UNIT III (6 hours) (K1, K2, K3, K4, K5 & K6)
Arithmetic Ability (Contd.)
Permutations and Combinations- Probability- Heights and Distance - Odd man out and series.
Section 1</td></tr>
<tr><td></td><td colspan="7">UNIT IV (6 hours) (K1, K2, K3, K4, K5 & K6)
General Awareness
Banks Information- Socio-economic - Government schemes- Agriculture- National- Dateline-Art and Culture - Newspapers in India.
Section 5</td></tr>
</table>

	UNIT V (6 hours) (K1, K2, K3, K4, K5 & K6) **Current Affairs and Computer Skill** Important days- Science and Medicine- International and Current Affairs- Glossary of Computer- Short Keys. **Sections 5 and 6**
Extended Professional Component (isa part of the internal component only, not to be included in theexternal examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC and others to be solved. (To be discussed during the Tutorial hours)
Text Books	1. Showick Thorpe, The Pearson Guide to the Bank Clerical Recruitment Examination, Second Edition, Publisher: Pearson, 2010. (Unit I) 2. IBPS Clerks, Frontline Publication, 2012. (Unit IV & V) 3. R.S.Agarwal, Quantitative Aptitude for Competitive Examinations, Revised Edition, S. Chand Publications, 2017. (Unit II & III)
Reference Books	1. R.S. Agarwal, Quantitative Aptitude for Competitive Examinations, S. Chand Publications, 2017. 2. Khattar, Quantitative Aptitude for Competitive Exams 3ed, Pearson Publications, 2015. 3. B.S. Sijwalii, InduSijwali, A New Approach to REASONING Verbal & Non-Verbal, Arihant Publications, 2014.
Web Resources	1. https://www.indiabix.com 2. https://myupsc.com/wp-content/uploads/2020/11/Quantitative-Aptitude-for-Competitive-Examinations-by-Dinesh-Khattar-z-lib.org_.pdf 3. https://www.studocu.com/in/document/national-institute-of-technology-kurukshetra/applied-statistical-methods/1-rs-aggarwal-quantitative-aptitude-pdfdrivecom/44016064 4. http://mathforum.org 5. http://ocw.mit.edu/ocwweb/Mathematics 6. http://www.opensource.org 7. www.coursera.org

CO	Course Outcomes
On completion of this course, students will be able to;	
CO1	Understand and solve aptitude problems on series completion and pattern comparison.
CO2	Identify and develop the techniques to solve the problems on trains, boats, streams, areas, volume, and surfaces.
CO3	Demonstrate procedural fluency with real number arithmetic operations and use those operations to represent real-world scenarios and to solve stated problems in permutation and combinations, heights, and distance.
CO4	Solve general awareness of clerical ability.
CO5	Ability to face competitive examinations with a clear approach to current affairs and computer knowledge.

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	H	H	L	H	M	H
CO2	H	H	L	H	M	H
CO3	H	H	L	H	M	H
CO4	H	H	L	H	M	H
CO5	H	H	L	H	M	H

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	H	H	H	M	L	M
CO2	H	H	H	M	L	M
CO3	H	H	H	M	L	M
CO4	H	H	H	M	L	M
CO5	H	H	H	M	L	M

<table>
<tr><td>Title of the Course</td><td colspan="7">FUNCTIONAL ANALYSIS</td></tr>
<tr><td>Paper No.</td><td colspan="7">Core XI</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Core</td><td>Year</td><td>II</td><td rowspan="2">Credits</td><td rowspan="2">5</td><td rowspan="2">Course Code</td><td rowspan="2">PCMAK24</td></tr>
<tr><td>Semester</td><td>IV</td></tr>
<tr><td rowspan="2">Instructional Hours per week</td><td>Lecture</td><td>Tutorial</td><td colspan="3">Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td>5</td><td>1</td><td colspan="3">-</td><td colspan="2">6</td></tr>
<tr><td>Pre-requisites</td><td colspan="7">UG – Level Real Analysis</td></tr>
<tr><td>Objectives of the Course</td><td colspan="7">• To impart knowledge on Banach Spaces and Open mapping theorem.
• To introduce Hilbert’s Spaces.
• To adopt various aspects of spectral theory.
• To focus on the general preliminaries on Banach Algebras.
• To represent the structure of commutative Banach Algebras.</td></tr>
<tr><td>Course Outline</td><td colspan="7">UNIT I (18 hours) (K1, K2, K3, K4, K5 & K6)
Banach Spaces
1.1 The definition and some examples
1.2 Continuous linear transformations
1.3 The Hahn-Banach theorem
1.4 The natural imbedding of N in N^{**}
1.5 The open mapping theorem
1.6 The conjugate of an Operator
Chapter 9: Sections 46-51</td></tr>
<tr><td></td><td colspan="7">UNIT II (18 hours) (K1, K2, K3, K4, K5 & K6)
Hilbert Spaces
2.1 The definition and some simple properties
2.2 Orthogonal complements
2.3 Orthonormal sets
2.4 The conjugate space H^*
2.5 The adjoint of an operator, Self-adjoint operators
2.6 Normal and unitary operators, Projections
Chapter10: Sections 52-59</td></tr>
<tr><td></td><td colspan="7">UNIT III (18 hours) (K1, K2, K3, K4, K5 & K6)
Finite-Dimensional Spectral Theory
3.1 Introduction- Preliminaries
3.2 Finite-Dimensional Spectral Theory
3.3 Matrices
3.4 Determinants and the spectrum of an operator
3.5 Determinants and the spectrum of an operator (Contd.)
3.6 The spectral theorem
Chapter 11: Sections 60-62</td></tr>
</table>

	UNIT IV (18 hours) (K1, K2, K3, K4, K5 & K6) **General Preliminaries on Banach Algebras** 4.1 General Preliminaries on Banach Algebras 4.2 The definition and some examples 4.3 Regular and singular elements 4.4 Topological divisors of zero 4.5 The spectrum, The formula for the spectral radius 4.6 The radical and semi-simplicity **Chapter 12: Sections 64-69**
	UNIT V (18 hours) (K1, K2, K3, K4, K5 & K6) **The Structure of Commutative Banach Algebras** 5.1 The Gelfand mapping 5.2 The Gelfand mapping (Contd.) 5.3 Application of the formula $r(x) = \lim \|x^n\|^{1/n}$ 5.4 Involutions in Banach algebras 5.5 The Gelfand-Neumark theorem 5.6 The Gelfand-Neumark theorem (Contd.) **Chapter 13: Sections 70-73**
Extended Professional Component (isa part of the internal component only, not to be included in theexternal examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC and others to be solved. (To be discussed during the Tutorial hours)
Text Book	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, New Delhi,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.
Web Resources	1. http://mathforum.org, 2. http://ocw.mit.edu/ocwweb/Mathematics, 3. http://www.opensource.org, 4. http://en.wikiepedia.org

CO	Course Outcomes
On completion of this course, students will be able to;	
CO1	Understand the Banach Spaces and Transformations on Banach Spaces.
CO2	Create a strong foundation in Hilbert's orthonormal set and conjugate space.
CO3	Analyze various aspects of Spectral theory.
CO4	Know the general preliminaries on Banach Algebras and distinguish the regular and singular elements.
CO5	Develop the Gelfand mapping and involutions in Banach algebras.

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	H	H	L	H	M	H
CO2	H	H	L	H	M	H
CO3	H	H	L	H	M	H
CO4	H	H	L	H	M	H
CO5	H	H	L	H	M	H

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	H	H	H	M	L	M
CO2	H	H	H	M	L	M
CO3	H	H	H	M	L	M
CO4	H	H	H	M	L	M
CO5	H	H	H	M	L	M

<table>
<tr><td>Title of the Course</td><td colspan="7">NUMERICAL ANALYSIS</td></tr>
<tr><td>Paper No.</td><td colspan="7">Core XII</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Core</td><td>Year</td><td>II</td><td rowspan="2">Credits</td><td rowspan="2">5</td><td rowspan="2">Course Code</td><td rowspan="2">PCMAL24</td></tr>
<tr><td>Semester</td><td>IV</td></tr>
<tr><td rowspan="2">Instructional Hours per week</td><td>Lecture</td><td>Tutorial</td><td colspan="3">Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td>5</td><td>1</td><td colspan="3">-</td><td colspan="2">6</td></tr>
<tr><td>Pre-requisites</td><td colspan="7">-</td></tr>
<tr><td>Objectives of the Course</td><td colspan="7">• To determine the solution in Numerical, Algebraic, and transcendental equations.
• To solve the set of algebraic equations by direct and iterative methods.
• To investigate the values of a function for any intermediate value of the independent variable.
• To evaluate interpolation formula with equal and unequal intervals.
• To compute the numerical solution of ordinary differential equations.</td></tr>
<tr><td>Course Outline</td><td colspan="7">UNIT I (18 hours) (K1, K2, K3, K4, K5 & K6)
Solution to Numerical, Algebraic, and Transcendental Equations
1.1 Introduction, Bisection Method
1.2 Method of successive approximation, False position
1.3 Newton’s Iteration Method
1.4 Geometrical Interpretation, Convergence of Newton
1.5 Rate of convergence of Newton Raphson Method
1.6 Newton - Horner’s Method
Chapter 3: Section 3.1 – 3.9</td></tr>
<tr><td></td><td colspan="7">UNIT II (18 hours) (K1, K2, K3, K4, K5 & K6)
Simultaneous Linear Algebraic Equations
2.1 Introduction, Gauss Elimination Method
2.2 Gauss Jordan Method
2.3 Inverse of a matrix using the Gauss Elimination Method
2.4 Method of Factorization or Triangularization, Crout’s Method
2.5 Iterative Methods – Jacobi Method of Iteration
2.6 Gauss Seidel Iteration method
Chapter 4: Sections 4.1- 4.6 and 4.8 – 4.10</td></tr>
<tr><td></td><td colspan="7">UNIT III (18 hours) (K1, K2, K3, K4, K5 & K6)
Finite Differences
3.1 Introduction, Finite differences
3.2 Forward and Backward Differences
3.3 Central differences, differences of polynomial
3.4 Factorial notation or Factorial polynomial, Reciprocal Factorial</td></tr>
</table>

	3.5 Polynomial in Factorial notation, Error propagation in Difference table 3.6 Other difference operators, Summation of series **Chapter 5: Sections 5.1 – 5.12**
	UNIT IV (18 hours) (K1, K2, K3, K4, K5 & K6) **Interpolation with equal and unequal intervals** 4.1 Introduction, Gregory Newton's forward and backward interpolation formula 4.2 Properties of divided differences 4.3 Relation between divided differences and forward differences 4.4 Newton's divided difference formula 4.5 Lagrange's Interpolation formula, Inverse interpolation 4.6 Lagrange's method **Chapter 6: Sections 6.1 – 6.3, Chapter 8: Sections 8.1 – 8.7**
	UNIT-V: (18 hours) (K1, K2, K3, K4, K5 & K6) **Numerical Solution to Ordinary Differential Equations** 5.1 Introduction, power series solution 5.2 Euler's method, Improved and modified Euler's method 5.3 Runge-Kutta Method 5.4 Runge – Kutta methods for higher order and simultaneous first-order equations 5.5 Runge – Kutta method for second order differential equation, predictor-corrector methods 5.6 Milne's method, Adams – Bashforth method **Chapter 11: Sections 11.1, 11.2 and 11.10 – 11.20**
Extended Professional Component (isa part of the internal component only, not to be included in theexternal examination question paper)	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC and others to be solved. (To be discussed during the Tutorial hours)
Text Book	V.N. Vedamurthy, N. Ch. S. N. Iyengar, Numerical Methods, Vikas Publishing House Pvt. Ltd, 2000.
Reference Books	1. R.L. Burden and J. Douglas Faires, Numerical Analysis, Thompson Books, USA, 2005. 2. S.S. Sastry, Introductory Methods of Numerical Analysis, Prentice Hall of India Pvt. Ltd., New Delhi, 2001. 3. M.K. Jain, S.R.K. Iyengar and R.K. Jain, Numerical Methods for Scientific and Engineering Computation, 3rd Edition, Wiley Eastern Ltd, New Delhi 1993.

Web Resources	1. https://powersystemfreebooks.blogspot.com/2019/09/pdf-complete-book-numerical-methods-by.html 2. https://pdf.wecabrio.com/numerical-methods-by-p-kandaswamy.pdf 3. https://efaidnbmnnnibpcajpcglclefindmkaj/https://gdcboysang.ac.in/About/Droid/uploads/Numerical%20Methods.pdf 4. https://nptel.ac.in/ 5. https://swayam.gov.in/nc_details/NPTEL 6. https://www.coursera.org/

CO	**Course Outcomes**
On completion of this course, students will be able to;	
CO1	Find the solution for Numerical, Algebraic, and transcendental equations.
CO2	Solve the set of algebraic equations by direct and iterative methods.
CO3	Identify the values of a function for any intermediate value of the independent variable.
CO4	Acquire the numerical solution of the interpolation formula with equal and unequal intervals.
CO5	Compute the numerical solution of various types of ordinary differential equations.

CO/PSO	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1	H	M	H	H	M	L
CO2	H	M	H	H	M	L
CO3	H	M	H	H	M	L
CO4	H	M	H	H	M	L
CO5	H	M	H	H	M	L

CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	H	H	H	M	L	M
CO2	H	H	H	M	L	M
CO3	H	H	H	M	L	M
CO4	H	H	H	M	L	M
CO5	H	H	H	M	L	M

Title of the Course	**PROJECT with VIVA VOCE**						
Paper No.	**Project**						
Category	**Project**	**Year**	II	**Credits**	4	**Course Code**	PCMAM24
		Semester	IV				
Instructional Hours per week	**Lecture**	**Tutorial**	**Lab Practice**			**Total**	
	-	-	-			5	
	It should be done individually under the guidance of one of the faculty members. The Project should be submitted before 31st March. The students should present their research work during the viva voce examinations.						

Title of the Course	**RESEARCH METHODOLOGY AND ETHICS**						
Paper No.	**Project**						
Category	**Project**	**Year**	II	**Credits**	3	**Course Code**	PCMAM24
		Semester	IV				
Instructional Hours per week	**Lecture**	**Tutorial**	**Lab Practice**			**Total**	
	5	-	-			5	
Pre-requisites	-						
Objectives of the Course	• To provide a clear understanding of the basic concepts of the research methodology. • To know more about publication ethics policy and important guidelines. • To acquire knowledge in open-access publications and identify predatory publications. • To explain the unethical behavior and conflict of interest in research publications. • To familiarize the advanced available software tools like Urkund and Turnitin.						
Course Outline	**UNIT I (15 hours) (K1, K2, K3, K4, K5 & K6)** **Database and Research metrics** Definition: Data collection - Methods of data collection in research Citation database: Web of Science, Scopus, etc. - Research metric impact factor - Citation reports – Metrics: h-index, g-index, i10- index, and altimetric. **Chapters 5 and 6**						
	UNIT II (15 hours) (K1, K2, K3, K4, K5 & K6) **Publication Ethics** Introduction - Publication Ethics - Basic Definition - Importance of						

	Best Practices - Important Standards - Setting Initiatives and Guidelines – COPE and WAME - Conflicts of Interest. **Chapter 7**
	UNIT III (15 hours) (K1, K2, K3, K4, K5 & K6) **Publications in Open-Access Journals** Open-access publications and initiatives - SHERPA/RoMEO - Online Resource to Check Publisher Copyright & Self-Archiving Policies – Software Tool to Identify Predatory Publications Journal Finder/ Journal Suggestion Tools viz. JANE, Elsevier - Journal Finder, Springer Journal Suggester, etc. **Chapter 8**
	UNIT IV (15 hours) (K1, K2, K3, K4, K5 & K6) **Subject-Specific Ethical Issues** Introduction - Concept, Problems that Lead to Unethical Behavior - Types Subject Specific Ethical Issues - FFP and Authorship - Conflicts of Interest and Complaints and Appeals - Examples and Fraud from India and Abroad. **Chapter 9**
	UNIT V (15 hours) (K1, K2, K3, K4, K5 & K6) **Plagiarism Software Tools** Introduction - Software Tools - Uses of Plagiarism Software –Turnitin - Urkund - Other open-source software tools. **Chapter 11**
Text Book	V. K. Verma, Vineet Dheer and Jayakar Singh, Text book on research and publication Ethics, Jaya publication house, New Delhi, 2022.
Reference Books	1. Bernard Beins and Maureen A. McCarthy, Research Methods and Statistics, Cambridge University Press Publications, 2017. 2. C. R. Kothari, Research Methodology: Methods and Techniques, New Delhi: New Age International (P) Ltd., ©2004, 1985. 3. Ian Walker, Research Methods and Statistics, Palgrave Macmillan Publisher, 2010. 4. Sherri L. Jackson, Research Methods and Statistics: A Critical Thinking Approach, Thomson Learning EMEA, Limited, 2008.
Web Resources	1. https://r.search.yahoo.com/_ylt=AwrKAnTbybVkMwADhQLnHgx.;_ylu=Y29sbwMEcG9zAzIEdnRpZAMEc2VjA3Ny/RV=2/RE=1689664091/RO=10/RU=https%3a%2f%2fmfs.mkcl.org%2fimages%2febook%2fFundamental%2520of%2520Research%2520Methodology%2520and%2520Statistics%2520by%2520Yogesh%2520Kumar%2520Singh.pdf/RK=2/RS=34nLQrRAfg3K6OC0qscqOhl3HLM- 2. https://r.search.yahoo.com/_ylt=Awr1Td55z7VkTLMCEAznHgx.;_ylu=Y29sbwMEcG9zAzEEdnRpZAMEc2VjA3Ny/RV=2/RE=16896

	65529/RO=10/RU=https%3a%2f%2fdrive.google.com%2ffile%2fd%2f1XBslFv864x-k2kG-gGxlc35IlDL8_3Z1%2fview%3fusp%3dsharing/RK=2/RS=NIJctXhwacALzFiAfbxuc2xubrA- 3. https://nptel.ac.in/ 4. https://swayam.gov.in/nc_details/NPTEL 5. https://www.coursera.org/

CO	Course Outcomes
On completion of this course, students will be able to;	
CO1	Understand the basic data collection and research metrics in research.
CO2	Know more about the publication ethics policy.
CO3	Utilize the open-access publications for research.
CO4	Classify problems that lead to unethical behavior in research publications.
CO5	Identify the important software tools for plagiarism.

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	H	H	M	H	L	H
CO2	H	H	M	H	L	H
CO3	H	H	M	H	L	H
CO4	H	H	M	H	L	H
CO5	H	H	M	H	L	H

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	H	H	H	M	L	H
CO2	H	H	H	M	L	H
CO3	H	H	H	M	L	H
CO4	H	H	H	M	L	H
CO5	H	H	H	M	L	H

<table>
<tr><td>Title of the Course</td><td colspan="7">ELECTIVE: LATEX and MATLAB</td></tr>
<tr><td>Paper No.</td><td colspan="7">Elective VI A</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Elective</td><td>Year</td><td>II</td><td>Credits</td><td>3</td><td>Course Code</td><td>PEMAM24</td></tr>
<tr><td>Semester</td><td>IV</td><td colspan="4"></td></tr>
<tr><td rowspan="2">Instructional Hours per week</td><td>Lecture</td><td>Tutorial</td><td colspan="3">Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td>2</td><td>-</td><td colspan="3">2</td><td colspan="2">4</td></tr>
<tr><td>Pre-requisites</td><td colspan="7">-</td></tr>
<tr><td>Objectives of the Course</td><td colspan="7">• To implement the Latex program with the tabulations and paragraph alignment.
• To illustrate the research papers in Latex software using mathematical equations, tables, and figures in Latex.
• To develop the program using MATLAB software.
• To explore arrays and basic functions in MATLAB.
• To be familiar with the colon operator and element-by-element operation using MATLAB.</td></tr>
<tr><td>Course Outline</td><td colspan="7">UNIT I (12 hours) (K1, K2, K3, K4, K5 & K6)
Creating text using LATEX
Document with Paragraph alignments - line, page break, spacing – tabular column – Citations - Equations and Array environment- prepare a chapter in a book.</td></tr>
<tr><td></td><td colspan="7">UNIT II (12 hours) (K1, K2, K3, K4, K5 & K6)
Math Mode, Graphics, and Special Parts
Documentation using theorem and paragraph environment -
Mathematical symbols, Fractions, Integration – Front matter- Back matter – Graphics.</td></tr>
<tr><td></td><td colspan="7">UNIT III (12 hours) (K1, K2, K3, K4, K5 & K6)
Starting with MATLAB
MATLAB as a calculator - Operations – Script files.</td></tr>
<tr><td></td><td colspan="7">UNIT IV (12 hours) (K1, K2, K3, K4, K5 & K6)
Creating Arrays
One-dimensional array – operations on one-dimensional arrays – Two-dimensional arrays - operations on two-dimensional arrays.</td></tr>
<tr><td></td><td colspan="7">UNIT V (12 hours) (K1, K2, K3, K4, K5 & K6)
Mathematical operations with Arrays
Colon operator in addressing array – Operations using colon operator – Element-by-element operations using arrays in MATLAB.</td></tr>
<tr><td>Text Books</td><td colspan="7">1. Harvey J. Greenberg, A simplified introduction to LATEX, University of Colorado at Denver, 2010. (Unit I and II)
2. Amos Gilat, MATLAB - An Introduction with Applications, John Wiley and Sons Inc., 2007. (Unit III, IV and V).</td></tr>
</table>

Reference Books	1. Devendra K. Chaturvedi, Modeling and Simulation of Systems using MATLAB and Simulink, CRC press, 2010. 2. Edward A. Bender, An Introduction to Mathematical Modelling, Wiley Press, 1978. 3. Grätzer, G. Math into LATEX: An introduction to LATEX and AMS-LATEX. Springer Science & Business Media, 2013.
Web Resources	1. https://citeseerx.ist.psu.edu/document?repid=rep1&type=pdf&doi=ab4433ddb03085867fca6b70547c33b638bdad42 2. http://www.os.ac.me/MS_kn.pdf 3. https://people.maths.bris.ac.uk/~madjl/course_text.pdf 4. https://spoken-tutorial.in/ 5. https://nptel.ac.in/ 6. https://swayam.gov.in/nc_details/NPTEL 7. https://www.coursera.org/

CO	Course Outcomes
On completion of this course, students will be able to;	
CO1	Implement programs with tabulations and alignment.
CO2	Develop the document using BIBTEX.
CO3	Execute the program using MATLAB as a calculator and solve problems based on it.
CO4	Illustrate basic MATLAB concepts such as creating arrays, and addressing.
CO5	Write a MATLAB program using the colon operator and element-by-element operation.

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	M	H	H	L	M	H
CO2	M	H	H	L	M	H
CO3	M	H	H	L	M	H
CO4	M	M	H	L	M	H
CO5	H	H	H	L	M	H

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	H	H	H	M	L	M
CO2	H	H	H	M	L	M
CO3	H	H	H	M	L	M
CO4	H	H	H	M	L	M
CO5	H	H	H	M	L	M

<table>
<tr><td>Title of the Course</td><td colspan="7">ELECTIVE: MATHEMATICAL PYTHON</td></tr>
<tr><td>Paper No.</td><td colspan="7">Elective VI B</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Elective</td><td>Year</td><td>II</td><td>Credits</td><td>3</td><td>Course Code</td><td>PEMAN24</td></tr>
<tr><td>Semester</td><td>IV</td></tr>
<tr><td rowspan="2">Instructional Hours per week</td><td>Lecture</td><td>Tutorial</td><td colspan="3">Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td>2</td><td>-</td><td colspan="3">2</td><td colspan="2">4</td></tr>
<tr><td>Pre-requisites</td><td colspan="7">UG-level C/C++</td></tr>
<tr><td>Objectives of the Course</td><td colspan="7">• To apply basic Python programs and to solve mathematical problems.
• To develop search algorithms using Python.
• To analyze various sorting techniques.
• To learn and work with Matrix concepts.
• To evaluate Mean and Standard deviation using a Python program. And display the data graphically for comparing various features.</td></tr>
<tr><td>Course Outline</td><td colspan="7">UNIT I (12 hours) (K1, K2, K3, K4, K5 & K6)
Fundamentals of Python Program
Minimum in a list - Maximum in a list - Guess an integer in a given range – Distance between two points - GCD - Sum an array of numbers.</td></tr>
<tr><td></td><td colspan="7">UNIT II (12 hours) (K1, K2, K3, K4, K5 & K6)
Search Algorithm
Linear search - Binary search - Divisible by n in a given range -Fibonacci numbers.</td></tr>
<tr><td></td><td colspan="7">UNIT III (12 hours) (K1, K2, K3, K4, K5 & K6)
Sorting
Selection sort - Insertion sort - Merge sort - Count word frequencies.</td></tr>
<tr><td></td><td colspan="7">UNIT IV (12 hours) (K1, K2, K3, K4, K5 & K6)
Matrix
The adjacency matrix of any graph on n vertices - Degree of vertices from the given adjacency matrix of the graph - Replace odd numbers with a given integer in the given array - Finding an odd number in a given array.</td></tr>
<tr><td></td><td colspan="7">UNIT V (12 hours) (K1, K2, K3, K4, K5 & K6)
Matrix Multiplication and Statistics
Matrix Multiplication (up to 3 × 3) - Mean and standard deviation – Bar Plot - Pie chart for comparing various features.</td></tr>
<tr><td>Text Book</td><td colspan="7">Allen B. Dowley, Think Python: How to Think Like a Computer Scientist, 2nd Edition, 2015.</td></tr>
<tr><td>Reference Books</td><td colspan="7">1. Wes McKinney, Python for Data Analysis: Data Wrangling with Pandas, NumPy, and Python, O'Reilly, 2nd Edition, 2018.
2. Jake VanderPlas, Python Data Science Handbook: Essential Tools for</td></tr>
</table>

	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.
Web Resources	1.www.python.org 2.www.rosettacode.org 3.http://faculty.msmary.edu/heinold/python.html

CO	**Course Outcomes**
On completion of this course, students will be able to;	
CO1	Understand the fundamentals of Python programs.
CO2	Analyze various search algorithms.
CO3	Apply various sorting techniques in the program.
CO4	Work with Matrix concepts.
CO5	Identify Mean and Standard deviation using the Python program and display the data in the form of a graphical representation for comparing various features.

CO/PSO	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1	M	H	H	L	M	H
CO2	M	H	H	L	M	H
CO3	M	H	H	L	M	H
CO4	M	M	H	L	M	H
CO5	H	H	H	L	M	H

CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	H	H	H	M	L	M
CO2	H	H	H	M	L	M
CO3	H	H	H	M	L	M
CO4	H	H	H	M	L	M
CO5	H	H	H	M	L	M

<table>
<tr><td>Title of the Course</td><td colspan="7">SKILL ENHANCEMENT IN ALGEBRA AND REAL ANALYSIS</td></tr>
<tr><td>Paper No.</td><td colspan="7">Professional Competency Skill Enhancement Course</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">SEC</td><td>Year</td><td>II</td><td>Credits</td><td>2</td><td>Course Code</td><td>PSMA324</td></tr>
<tr><td>Semester</td><td>IV</td></tr>
<tr><td>Instructional Hours per week</td><td>Lecture</td><td>Tutorial</td><td colspan="3">Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td></td><td>2</td><td>1</td><td colspan="3">-</td><td colspan="2">3</td></tr>
<tr><td>Pre-requisites</td><td colspan="7">-</td></tr>
<tr><td>Objectives of the Course</td><td colspan="7">• To acquire knowledge of algebraic structure.
• To know the important aspects of groups, subgroups, finite abelian groups, simple groups, and solvable groups.
• To gain the skills to crack problems in linear algebra.
• To impart various benefits and classifications of real number systems.
• To identify the convergence of sequence and series.</td></tr>
<tr><td>Course Outline</td><td colspan="7">UNIT I (9 hours) (K1, K2, K3, K4, K5 & K6)
Groups
Introduction to Groups - Sub Groups – Coset – Abelian Group – Normal Sub Groups – Cyclic Groups - Quotient Groups – Direct Products – Some important Groups – Homomorphism and Isomorphism – The center of a Groups - Permutations – Symmetric Groups S_n – Alternating Groups A_n – Conjugacy Classes and Conjugacy Relations.</td></tr>
<tr><td></td><td colspan="7">UNIT II (9 hours) (K1, K2, K3, K4, K5 & K6)
Groups (Contd.)
Normalizer of Subgroups – Centralizer of an Element or Normalizer of an Element – Commutator Subgroups – Fundamental Theorem of Finite Abelian groups – Number of Non-isomorphic Abelian Groups - Class Equation – Sylow’s theorem – Results on simple Group – Solvable Groups and Jordan - Holder theorem.</td></tr>
<tr><td></td><td colspan="7">UNIT III (9 hours) (K1, K2, K3, K4, K5 & K6)
Linear Algebra
Vector Space - Inner Product Spaces - Orthonormal Bases - Linear transformation - Matrix representations - Canonical forms – Determinants - Caley Hamilton – Application - Hermitian – Unitary and Normal transformation - Quadratic forms.</td></tr>
<tr><td></td><td colspan="7">UNIT IV (9 hours) (K1, K2, K3, K4, K5 & K6)
Real Analysis
Real number system as a complete ordered field - sequences, and series – Convergence - limit supremum and limit infimum- Euclidean space.</td></tr>
</table>

	UNIT V (9 hours) (K1, K2, K3, K4, K5 & K6) **Real Analysis (Contd.)** Continuity – Uniform Continuity – Differentiability - Mean value theorem of derivative - Convergence series - Cauchy condition for uniform convergence.	
Extended Professional Component (isa part of the internal component only, not to be included in theexternal examination question paper)		Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC and others to be solved. (To be discussed during the Tutorial hours)
Text Book	Pawan Sharma, Neha Sharma, Suraj Singh, Mathematical Sciences, UGC CSIR NET/SET (JRF & LS), Arihant Publications (India) Ltd, 2016.	
Reference Books	1. Dr. A. P. Singh, Modern Algebra, Infostudy Publication, 2018. 2. R. Gupta's, Joint CSIR - UGC-NET Mathematical Sciences Previous Year's Solved Paper, 2014. 3. Dr. A. Kumar, CSIR-UGC NET/JRF/SLET Mathematical Sciences (Paper I & II), UPKAR Prakashan Publications, 2010. 4. S.K. Shrivastava & M.K. Malik, CSIR-UGC NET/JRF MATHEMATICAL SCIENCES Previous Years Solved Papers Including Model Papers with Explanation, JBC Press, 2019.	
Web Resources	1. https://nptel.ac.in/ 2. https://swayam.gov.in/nc_details/NPTEL 3. https://www.coursera.org/ 4. https://testbook.com/csir-net/mathematical-science-study-material	

List of courses: I MBA

Sem	Course Code	Title of the Course	Hours	Exam Hours		Credits	Marks
				Th	Pr		
I	PCBAB24	Quantitative Techniques and Research Methods in Business	5	3	-	4	40+60
II	PCBAG24	Applied Operations Research	5	3	-	4	40+60

PROGRAMME OUTCOMES (PO)

PO1: To prepare the students for a successful career with the skills to work with values that meet the diversified needs of industry and society.

PO2: To inculcate ethics and social commitment in the students and to prepare them for personal and professional life so that they add value to the society.

PO3: To ignite the passion for entrepreneurship and leadership by inculcating the necessary qualities and skills.

PO4: To develop self-learning and continuous learning ability in graduates for their benefit and for the society at large.

PO5: To prepare the students towards the issues of social relevance and introduce them to professional ethics and practice.

PROGRAMME SPECIFIC OUTCOMES (PSO)

PSO1: At the end of the course the students shall be able to conceptualize, critically analyse and provide solutions to problems in Business and Management.

PSO2: Students gain the ability to synthesize knowledge with skills in the areas of Business and Management and can provide innovative and entrepreneurial solutions to job-related problems.

PSO3: The students would have gained practical exposure and multidisciplinary knowledge.

PSO4: Students can objectively research on business and management problems by collecting, analyzing, and interpreting the data and professionally recommend feasible solution/s.

PSO5: Students are equipped to apply the principles, tools, and techniques of management in real-life situations.

PSO6: Students can analyse and solve problems and make informed decisions in challenging situations.

PSO7: Students develop self-learning skills, and remain updated on contemporary management practices and can leverage their learning to provide solutions to business problems.

PSO8: Students know inter-disciplinary domains through the diverse areas of specialization of the industry.

PSO9: The students can function effectively as an individual and in a group with the capacity to be a team leader, as an entrepreneur, and administrator.

PSO10: Students will understand the professional, legal, ethical, and environmental responsibilities and will be committed towards them.

<table>
<tr><td>Title of the Course</td><td colspan="7">QUANTITATIVE TECHNIQUES AND RESEARCH METHODS IN BUSINESS</td></tr>
<tr><td>Paper No.</td><td colspan="7">Core II</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Core</td><td>Year</td><td>I</td><td rowspan="2">Credits</td><td rowspan="2">4</td><td rowspan="2">Course Code</td><td rowspan="2">PCBAB24</td></tr>
<tr><td>Semester</td><td>I</td></tr>
<tr><td rowspan="2">Instructional Hours per week</td><td>Lecture</td><td>Tutorial</td><td colspan="3">Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td>4</td><td>1</td><td colspan="3">-</td><td colspan="2">5</td></tr>
<tr><td>Objectives of the Course</td><td colspan="7">To introduce the students to probability theory and discuss how probability calculations may facilitate their decision-making.
To construct a coherent research proposal that includes an abstract, literature review, research questions, ethical considerations, and methodology.
To understand the basic statistical tools for analysis & interpretation of qualitative and quantitative data.
To recognize the principles and characteristics of the multivariate data analysis techniques.
To become familiar with the process of drafting a report that poses a significant problem.</td></tr>
<tr><td>Course Outline</td><td colspan="7">UNIT I (15 hours) (K1, K2, K3, K4, K5 & K6)
Introduction to Probability
1.1 Probability, Rules of Probability
1.2 Probability distribution: Binomial, Poisson, and Normal Distributions, their applications in Business and Industrial problems
1.3 Baye’s Theorem and its Applications
1.4 Decision-making under risk and Uncertainty
1.5 Maximax, Maximin, Regret Hurwitz and Laplace Criteria in Business and Decision Making
1.6 Decision Tree</td></tr>
<tr><td></td><td colspan="7">UNIT II (15 hours) (K1, K2, K3, K4, K5 & K6)
Research Process
2.1 Definition: Research, Research Process
2.2 Research Design: Definition, Types of Research Design, Role of Theory in Research
2.3 Objectives - Hypothesis
2.4 Types of Data, Primary and Secondary Data, Methods of Primary Data Collection; Survey, Observation, Experiments
2.5 Construction of Questionnaire, Questionnaire Schedule, Validity and Reliability of Instruments
2.6 Types of Attitude Measurement Scales, Sampling Techniques; Probability and Nonprobability Techniques, Optimal Sample Size Determination</td></tr>
</table>

	UNIT III (15 hours) (K1, K2, K3, K4, K5 & K6) **Preparation and Analysis of Data** 3.1 Data Preparation: Editing, Coding, Data Entry 3.2 Data Analysis, Testing of Hypothesis Univariate and Bivariate Analysis 3.3 Parametric and Nonparametric Tests and Interpretation of Test Results 3.4 Chi-Square Test, Correlation; Karl Pearson's Vs Correlation Coefficient and Spearman's Rank Correlation 3.5 Regression Analysis 3.6 One-Way and Two-Way Analysis of Variance
	UNIT IV (15 hours) (K1, K2, K3, K4, K5 & K6) **Multivariate Statistical Analysis** 4.1 Exploratory and Confirmatory Factor Analysis 4.2 Discriminant Analysis 4.3 Cluster Analysis 4.4 Multiple Regression 4.5 Multidimensional Scaling, Application in Marketing Problems 4.6 Application of Statistical Software for Data Analysis
	UNIT V (15 hours) (K1, K2, K3, K4, K5 & K6) **Report Writing and Ethics in Business Research** 5.1 Research Reports, Different Types 5.2 Writing Format, Content of Report 5.3 Need for Executive Summary - Chapterization 5.4 Framing The title of the Report 5.5 Different Styles of Referencing – Academic Vs Business Research Reports 5.6 Ethics in Research
Extended Professional Component (is a part of the internal component only, not to be included in the external examination question paper)	Questions related to the above topics, from various competitive examinations UPSC/JAM /TNPSC and others to be solved (To be discussed during the Tutorial hours)
Text Books	1. Kumar, R., Research Methodology: A Step-by-Step Guide for Beginners, Sage, South Asia, 4th Edition, 2014. 2. Srivatsav TN, Shailajarago, Statistics for Management, Tata McGraw Hill, 3rd Edition, 2016.
Reference Books	7. Cooper, D.R., Schindler, P. And Business Research Methods, Tata-McGrew Hill, 12th Edition, 2012. 8. Cooper, D.R., Schindler, P. and Sharma, J.K., Business Research Methods,11th Edition, Tata-McGraw Hill, 12th Edition, 2018.

	9. Johnson, R.A., and Wichern, D.W., Applied Multivariate Statistical Analysis, PHI Learning Pvt. Ltd., 6th Edition, 2012. 10. Anderson, Sweeny, Williams, Camm and Cochran, Statistics for Business and Economics, Cengage Learning, New Delhi, 13th Edition, 2017.
Web Resources	5. https://www.dartmouth.edu/~chance/teaching_aids/books_articles/probability_book/amsbook.mac.pdf 6. https://study.com/academy/topic/probability.html 7. https://onlinecourses.nptel.ac.in/noc18_ma07/preview 8. https://hbr.org/1964/07/decision-trees-for-decision-making

CO	Course Outcomes
On completion of this course, students will be able to;	
CO1	Develop problem-solving techniques needed to accurately calculate probabilities.
CO2	Devise research methods, techniques and strategies in the appropriate manner for managerial decision making and conduct research for the industry.
CO3	Apply and interpret the different types of quantitative and qualitative methods of data analysis.
CO4	Use multivariate techniques appropriately, undertake multivariate hypothesis tests, and draw appropriate conclusions.
CO5	Present orally their research or a summary of another's research in an organized, coherent, and compelling fashion.

CO/PO	PO1	PO2	PO3	PO4	PO5
CO1	H	H	H	H	L
CO2	H	H	H	H	M
CO3	H	H	H	H	L
CO4	H	H	H	H	M
CO5	H	H	H	H	M

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	H	H	L	M	M	H	H	M	L	M
CO2	H	H	M	M	M	H	H	M	M	M
CO3	H	H	M	M	M	H	H	M	L	H
CO4	H	H	L	M	M	H	H	M	M	L
CO5	H	H	M	M	M	H	H	M	M	H

H (High) – 3, M (Moderate) – 2, L (Low) – 1

<table>
<tr><td>Title of the Course</td><td colspan="7">APPLIED OPERATIONS RESEARCH</td></tr>
<tr><td>Paper No.</td><td colspan="7">Core VII</td></tr>
<tr><td rowspan="2">Category</td><td rowspan="2">Core</td><td>Year</td><td>I</td><td rowspan="2">Credits</td><td rowspan="2">4</td><td rowspan="2">Course Code</td><td rowspan="2">PCBAG24</td></tr>
<tr><td>Semester</td><td>II</td></tr>
<tr><td rowspan="2">Instructional Hours per week</td><td>Lecture</td><td>Tutorial</td><td colspan="3">Lab Practice</td><td colspan="2">Total</td></tr>
<tr><td>4</td><td>1</td><td colspan="3">-</td><td colspan="2">5</td></tr>
<tr><td>Objectives of the Course</td><td colspan="7">• To provide the students with introduction on OR and its models to aid in understanding its applicability in the various functional areas of management.
• To understand the concept of linear programming models in determining profit maximization and cost minimization.
• To learn about various methods adopted in Transportation and Assignment models.
• To determine about inventory models, replacement models, job sequencing, networking model and Queuing model.
• To throw light on dynamic model and game models and the application of pure and mixed strategies in competitive environment.</td></tr>
<tr><td>Course Outline</td><td colspan="7">UNIT I (15 hours) (K1, K2, K3, K4, K5 & K6)
Introduction
1.1 Overview of Operations Research
1.2 Origin, Nature of OR
1.3 Scope of OR
1.4 Characteristics of OR
1.5 Models in OR
1.6 Applications of operations research in functional areas of Management</td></tr>
<tr><td></td><td colspan="7">UNIT II (15 hours) (K1, K2, K3, K4, K5 & K6)
Linear Programming Problem
2.1 Linear Programming Problem Model – Formulation
2.2 Maximization and Minimization Problem
2.3 Solution by Graphical Method
2.4 Solution by Simplex Method
2.5 Artificial variable techniques (Big M method only)
2.6 Primal and Dual</td></tr>
<tr><td></td><td colspan="7">UNIT III (15 hours) (K1, K2, K3, K4, K5 & K6)
Transportation and Assignment Models
3.1 Basic Solution: North West Corner Solution and Least Cost Method (LCM)
3.2 Basic Solution: Vogel’s approximation method (VAM)
3.3 Check for Optimality: Solution by MODI method
3.4 MODI method-Degeneracy</td></tr>
</table>

	3.5 Assignment Model: Solution by Hungarian Method-Imbalance matrix 3.6 Travelling Salesman Problem
	UNIT IV (15 hours) (K1, K2, K3, K4, K5 & K6) **Project Scheduling and Resource Management** a. Deterministic inventory models, Purchasing, and Manufacturing models b. Probabilistic inventory models, Replacement models c. Sequencing models, Brief introduction to Queuing Models d. Networking: Programme Evaluation and Review Technique e. Networking: Critical Path Method f. Resource Allocation and Resource Scheduling
	UNIT V (15 hours) (K1, K2, K3, K4, K5 & K6) **Game Theory and Optimization Techniques** 5.1 Game Theory: Two-person Zero-sum games, Saddle point 5.2 Mixed Strategies for games without saddle points 5.3 Dominance Method 5.4 Graphical and LP solutions 5.5 Goal programming, Integer programming 5.6 Dynamic Programming
Extended Professional Component (is a part of the internal component only, not to be included in the external examination question paper)	Questions related to the above topics, from various competitive examinations UPSC/JAM /TNPSC and others to be solved (To be discussed during the Tutorial hours)
Text Books	1. Anderson, D.R., Sweeney, D.J., Williams, T.A. and Martin, K., An Introduction to Management Science: Quantitative Approach to Decision Making, 14th Edition Paperback – 1, Cengage Learning India Pvt. Ltd., 2019. 2. Gupta, P.K., and Comboj, Introduction to Operations Research, S. Chand, 2014. 3. Hiller, F., Liebermann, Nag and Basu, Introduction to Operations Research, 11th Edition Paperback, Tata McGraw-Hill Publishing Co. Ltd., 2021. 4. Khanna, R.B., Quantitative Techniques for Managerial Decision Making, 3rd Edition – Paperback, New Age International Publishers, 2018. 5. Taha, H.A., Operations Research: An Introduction, 10th Edition, Pearson, 2019. 6. Vohra,N.D., Quantitative Techniques in Management, 5th Edition, Tata McGraw Hill Education Pvt. Ltd., 2017.

Reference Books	1. Kanti Swarup, P.K. Gupta and Man Mohan, Introduction to Management Science, Operations Research, Sultan Chand and Sons, 2014. 2. P.R. Vittal, Introduction to Operations Research, Margham Publications, 2008. 3. V. Sundaresan, K.S. Ganapathy Subramanian, and K. Ganesan, Resource Management Techniques, A.R. Publications, 2009. 4. Pannerselvam, R. Operations Research, Prentice Hall of India, 4th Edition, 2008. 5. Sankara Iyer P., Operations Research, Tata McGraw Hill, 2008.
Web Resources	1. www.cbom.atozmath.com 2. http://www.pondiuni.edu.in/storage/dde/downloads/mbaii_qt.pdf 3. http://164.100.133.129;81/econtent/Uploads/Operations_Research.pdf 4. https://www.journals.elsevier.com/operations-research-perspectives

CO	Course Outcomes
On completion of this course, students will be able to;	
CO1	Obtain insight on the origin and nature of OR and also the application of various models of OR.
CO2	Learn about the graphical, Simplex, Big M and dual methods of Linear programming problem.
CO3	Be well versed with the concept of Transportation and Assignment models.
CO4	Have better understanding on inventory models, replacement models, job sequencing, networking model and Queuing model.
CO5	Be imparted knowledge on the various methods of game model.

CO/PO	PO1	PO2	PO3	PO4	PO5
CO1	H	M	M	H	H
CO2	H	M	M	H	H
CO3	H	M	M	H	H
CO4	H	M	M	H	H
CO5	H	M	M	H	H

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	H	H	H	M	H	H	H	H	M	M
CO2	H	H	H	M	H	H	H	H	M	M
CO3	H	H	H	M	H	H	H	H	M	M
CO4	H	H	H	M	H	H	H	H	M	M
CO5	H	H	H	M	H	H	H	H	M	M

H (High) – 3, M (Moderate) – 2, L (Low) – 1

CO	Course Outcomes
On completion of this course, students will be able to;	
CO1	Extend the knowledge in the concepts of Algebraic structure.
CO2	Understand the importance of various types of groups.
CO3	Analyze the concepts of vector space and linear transformation in linear algebra.
CO4	Acquire the benefits of real number systems.
CO5	Evaluate various types of uniform continuity, differentiability, and mean value theorem.

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	H	M	L	H	M	H
CO2	H	M	L	H	M	H
CO3	H	M	L	H	M	H
CO4	H	M	L	H	M	H
CO5	H	M	L	H	M	H

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	H	H	H	L	M	H
CO2	H	H	H	L	M	H
CO3	H	H	H	L	M	H
CO4	H	H	H	L	M	H
CO5	H	H	H	L	M	H