

DHANALAKSHMI SRINIVASAN INSTITUTE OF RESEARCH AND TECHNOLOGY

**(Deemed to be University under section 3 of UGC Act, 1956.)
PERAMBALUR – 621 212, TAMIL NADU, INDIA.**

SCHOOL OF ARTS AND SCIENCE

CURRICULUM AND SYLLABUS

M.Sc. MATHEMATICS

REGULATION 2026

PROGRAMME:

Vision:

- To serve as a vibrant hub for mathematical excellence at the undergraduate level, inspiring curious young learners, logical thinkers, and analytical minds who master mathematical principles to solve real-world problems and contribute to scientific and technological progress

Mission:

- To cultivate interdisciplinary collaboration, professional ethics, and leadership qualities among students and faculty for holistic development.
- To offer inclusive, flexible, and interdisciplinary undergraduate programs in mathematics that integrate pure and applied concepts with allied disciplines, building graduates with strong logical reasoning, quantitative, and problem-solving skills for diverse career paths and lifelong learning.
- To encourage foundational research and scholarly inquiry in mathematical theories, modeling, statistics, and computational methods, addressing key challenges in science, industry, education, and daily applications.
- To expand access to quality mathematics education for rural and underprivileged students by connecting modern mathematical tools with traditional knowledge systems and developing practical competencies that support entrepreneurial opportunities and self-reliant careers.
- To instill ethical values, social responsibility, and global awareness through hands-on problem solving, industry interactions, community projects, and experiential learning that links theoretical knowledge with real-world mathematical applications

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

PEO	PROGRAM EDUCATIONAL OBJECTIVES
PEO1	To provide graduates with a deep foundation in advanced mathematical theories, techniques, and computational methods, preparing them for successful careers in academia, research organizations, industry, and data-driven sectors.

PEO2	To strengthen logical reasoning, analytical proficiency, and research aptitude so that graduates can formulate, analyze, and solve complex mathematical problems across pure, applied, and interdisciplinary domains.
PEO3	To instill professional ethics, effective communication, teamwork, and collaborative skills that enable graduates to work responsibly in multidisciplinary environments and contribute to knowledge advancement.
PEO4	To promote lifelong learning and adaptability, empowering graduates to keep pace with evolving mathematical applications and pursue higher research, teaching, or entrepreneurial endeavors in mathematics and related fields.

PROGRAM SPECIFIC OUTCOMES(PSOs)

PSO	PROGRAM SPECIFIC OUTCOMES
PSO1	Graduates will be proficient in applying advanced mathematical concepts, theorems, modeling techniques, and computational tools to investigate and resolve theoretical and real-life problems in science, engineering, and finance.
PSO2	Graduates will demonstrate expertise in data interpretation, statistical analysis, optimization strategies, and mathematical software, enabling them to contribute effectively to research, industry projects, and community-oriented analytical initiatives.

PROGRAM OUTCOMES (Pos)

PO	PROGRAMOUTCOMES
PO1	Disciplinary Knowledge Demonstrate comprehensive knowledge and understanding of the fundamental concepts, theories, principles, and applications in the chosen discipline and allied fields.
PO2	Critical Thinking and Problem Solving Identify, analyze, and solve complex academic, professional, and societal problems using logical reasoning, analytical skills, and evidence-based approaches.
PO3	Research and Inquiry Apply scientific methods, research techniques, and investigative skills to conduct studies, analyze data, interpret results, and draw meaningful conclusions.
PO4	Creativity and Innovation Develop innovative ideas, creative solutions, and entrepreneurial approaches to address contemporary challenges in academic, professional, and social contexts.
PO5	Digital and Technological Competence Utilize appropriate digital technologies, software tools, and information resources effectively and ethically for learning, research, communication, and problem-solving.

PO6	Environment and Sustainability Understand environmental issues and sustainable development goals and apply this knowledge to promote ecological balance and responsible resource utilization.
PO7	Ethics and Social Responsibility Demonstrate ethical values, integrity, inclusiveness, and social responsibility while contributing positively to society and professional environments.
PO8	Teamwork and Leadership Work effectively as an individual and as a member or leader of diverse and multidisciplinary teams, demonstrating leadership, collaboration, and interpersonal skills.
PO9	Communication Skills Communicate effectively through oral, written, visual, and digital means with diverse audiences in academic, professional, and societal settings.
PO10	Employability and Entrepreneurship Develop professional competencies, managerial abilities, and entrepreneurial skills required for employment, higher education, and self-employment opportunities.
PO11	Lifelong Learning Recognize the need for continuous learning, adaptability, and self-development to meet evolving personal, professional, and societal demands in a dynamic global environment.

SEMESTER-I

Sem	Course Category	Title of the Course	Course Code	L	T	P	Credits	Marks		
								CAT	ESE	Total
I	Core	Advanced Algebra	PMA26101	3	1	0	4	40	60	100
	Core	Real Analysis	PMA26102	3	1	0	4	40	60	100
	Core	Ordinary Differential Equations	PMA26103	3	0	0	3	40	60	100
	SEC	LaTeX	PMA26S01	1	0	2	2	40	60	100
	MDC	Multi-Disciplinary Course-I	-	3	0	0	3	40	60	100
	DEC	Disciplinary Elective Course -I	PMA26001	3	0	0	3	40	60	100
		Disciplinary Elective Course -II	PMA26002							
		Disciplinary Elective Course -III	PMA26003							
	DEC	Disciplinary Elective Course -IV	PMA26004	3	0	0	3	40	60	100
		Disciplinary Elective Course -V	PMA26005							
Disciplinary Elective Course -VI		PMA26006								
							22			700

SEMESTER-II

Sem	Course Category	Title of the Course	Course Code	L	T	P	Credits	Marks		
								CAT	ESE	Total
II	Core	Linear Algebra	PMA26204	3	1	0	4	40	60	100
	Core	Complex Analysis	PMA26205	3	1	0	4	40	60	100
	Core	Partial Differential Equations	PMA26206	3	0	0	3	40	60	100
	SEC	Introduction to SCILAB	PMA26S02	1	0	2	2	40	60	100
	MDC	Multi-Disciplinary Course-II	-	3	0	0	3	40	60	100
	DEC	Disciplinary Elective Course -VII	PMA26007	3	0	0	3	40	60	100
		Disciplinary Elective Course -VIII	PMA26008							
		Disciplinary Elective Course -IX	PMA26009							
	DEC	Disciplinary Elective Course -X	PMA26010	3	0	0	3	40	60	100
		Disciplinary Elective Course -XI	PMA26011							
		Disciplinary Elective Course -XII	PMA26012							
							22			700

SEMESTER-III

Sem	Course Category	Title of the Course	Course Code	L	T	P	Credits	Marks		
								CAT	ESE	Total
III	Core	Topology	PMA26307	3	1	0	4	40	60	100
	Core	Measure Theory and Integration	PMA26308	3	1	0	4	40	60	100
	Core	Graph Theory	PMA26309	3	1	0	4	40	60	100
	Core	Calculus of Variations and Integral equations	PMA26310	3	1	0	4	40	60	100
	Core	Numerical Analysis	PMA26311	4	0	0	4	40	60	100
	DEC	Disciplinary Elective Course -XIII	PMA26013	3	0	0	3	40	60	100
		Disciplinary Elective Course -XIV	PMA26014							
		Disciplinary Elective Course -XV	PMA26015							
	SEC	Communication and Soft Skill	-	1	0	0	1	40	60	100
	EE	Experiential Elective (Internship)	PMA5EE01				2	*	*	100
							26			700

SEMESTER-IV

Semester	Course Category	Title of the Course	Course Code	L	T	P	Credits	Marks		
								CAT	ESE	Total
IV	Core	Functional Analysis	PMA26412	4	0	0	4	40	60	100
	Core	Differential Geometry	PMA26413	4	0	0	4	40	60	100
	Core	Project	PMA26414	0	0	24	12	40	60	100
							20			300

Multidisciplinary Course offered to other Departments:

PMA26901- Mathematical Foundation for Computer Applications

PMA26902- Mathematics and Statistics

PMA26903- Mathematical Foundation for Artificial Intelligent

PMA26904- Fundamentals of Probability and Statistics

PMA26905- Operation Research

PMA26906- Mathematical Foundation for Computer Science

PMA26907- Statistical Computing

PMA26908- Quantitative Techniques for Business Decisions

PMA26909- Statistical Methods for Biological Data Analysis

Disciplinary Elective Course Offered by the Department:

PMA26001-Discrete Mathematics

PMA26002-Combinatorics

PMA26003-Control Theory

PMA26004-Formal Languages and Automata theory

PMA26005-Mechanics

PMA26006-Optimization Techniques

PMA26007-Mathematical Modelling

PMA26008-Stochastic Process

PMA26009-Probability and Statistics

PMA26010-Fluid Dynamics

PMA26011-Fractal Analysis

PMA26012-Finite Elements Method

PMA26013-Fuzzy Mathematics

PMA26014-Classical Dynamics

PMA26015-Machine Learning

Semester-wise Categorization of Courses

COURSE CATEGORY	Semester				No of Courses	Total Credits
	I	II	III	IV		
Core Courses (Theory & Practical)	3	3	5	3	14	62
SEC–Skill Enhancement Course	1	1	1	-	3	5
MDC–Multi Disciplinary Course	1	1	-	-	2	6
DEC–Disciplinary Elective Course	2	2	1	-	5	15
EE–Experiential Elective	-	-	1	-	1	2
Total Courses Per Semester	7	7	8	3	25(Courses)	
Total Credits	22	22	26	20	90(Credits)	

Sem	Course Code	Title of the Course	Course Category	L	T	P	Credits
I	PMA26101	Advanced Algebra	Core	3	1	0	4
Pre-Requisite: Nil			Co- Requisite: Nil		Progressive Course: Nil		
Course Objectives:							
1. Explain the concepts of groups, normal subgroups, homomorphisms, quotient groups, and basic isomorphism theorems.							
2. Describe automorphisms, inner automorphisms, permutation groups, and the applications of Cayley's theorem.							
3. Apply counting principles, class equations, Sylow theorems, and the structure of finite abelian groups.							
4. Explain ideals, quotient rings, Euclidean rings, greatest common divisors, and the Unique Factorization Theorem.							
5. Describe polynomial rings, the division algorithm, Gauss' Lemma, Eisenstein Criterion, and unique factorization domains.							
Course Outcomes:							
CO1: Define the concepts of groups, normal subgroups, quotient groups, homomorphisms, and isomorphism theorems. (K1)							
CO2: Explain automorphisms, inner automorphisms, permutation groups, and the applications of Cayley's theorem. (K2)							
CO3: Apply counting principles, class equations, Sylow theorems, direct products, and finite abelian groups to solve problems. (K3)							
CO4: Explain ideals, quotient rings, Euclidean rings, greatest common divisors, and the Unique Factorization Theorem. (K2)							
CO5: Apply the division algorithm, Gauss' Lemma, Eisenstein Criterion, and polynomial rings in algebraic computations. (K3)							
Unit-I	Groups						12 Hrs.
Groups-A counting principle - Normal subgroups and quotient groups – Homomorphisms – Cauchy's theorem for abelian groups - Sylow's theorem for abelian groups - Correspondence theorem for groups – First isomorphism theorem							
Unit-II	Automorphism						12 Hrs.
Automorphisms – Inner automorphisms - Automorphism group of cyclic groups - Cayley's theorem – Applications - Permutation groups							
Unit-III	Counting Principle						12 Hrs.
Another counting principle: Conjugate class - Class equation of a group – Applications - Cauchy's theorem - Sylow's theorems - Direct product of groups - Finite abelian groups.							
Unit-IV	Rings						12 Hrs.
Ideals and quotient rings – More ideals and quotient rings: Maximal ideals - Euclidean rings - G.C.D - Unique Factorization Theorem - A particular Euclidean ring - Fermat's theorem							

Unit-V	Polynomial Rings	12 Hrs.
Polynomial rings - Division Algorithm- Polynomials over the rational field Gauss' Lemma - Eisenstein Criterion - Polynomial rings over commutative rings - U.F.D.		

Text Book(s):

I. N. Herstein, Topics in Algebra, 2nd edition, John Wiley & Sons, Singapore, 2006.

Reference Book(s):

1. John. B. Fraleigh, A First Course in Abstract Algebra, 7th Edition, Addison-Wesley, New Delhi, 2003.
2. P. B. Bhattacharya, S. K. Jain & S. R. Nagpaul, Basic Abstract Algebra, Cambridge University Press, USA, 1986.
3. Charles Lanski, Concepts in Abstract Algebra, AMS, USA, 2010.
4. M. Artin, Algebra, Prentice-Hall of India, New Delhi, 1991.
5. D. S. Dummit & R. M. Foot, Abstract Algebra, John Wiley, New York, 1999.

e Resources:

1. https://onlinecourses.nptel.ac.in/noc18_ma15
2. https://onlinecourses.nptel.ac.in/noc18_ma16

Relationship Matrix for COs, POs and PSOs

Semester	Course code		Title of the course									L	T	P	Credit
I	PMA26101		Advanced Algebra									3	1	0	4
Course Outcomes (COs)	Programme Outcomes(POs)											Programme Specific Outcomes (PSOs)		Mean Score of COs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2		
CO1	3	1	1	-	-	-	-	-	1	-	1	3	1	2	
CO2	3	2	1	1	1	-	-	-	1	-	1	3	1	2	
CO3	3	3	2	2	1	-	-	-	1	1	1	3	2	3	
CO4	3	2	2	1	1	-	-	-	1	-	1	3	1	2	
CO5	3	3	2	2	2	-	-	-	1	1	1	3	2	3	
Mean Score	3	2	2	2	1	0	0	0	1	1	1	3	1	2	

Sem	Course Code	Title of the Course	Course Category	L	T	P	Credits
I	PMA26102	Real Analysis	Core	3	1	0	4
Pre-Requisite: Nil			Co- Requisite: Nil	Progressive Course: Nil			
Course Objectives:							
1. Define the fundamental concepts of topology, metric spaces, compactness, connectedness, and convergence of sequences and series.							
2. Explain continuity, differentiation, mean value theorems, Taylor's theorem, and the behavior of monotonic and vector-valued functions.							
3. Apply the principles of the Riemann–Stieltjes integral and its properties to solve integration and differentiation problems.							
4. Analyze uniform convergence, equicontinuity, and the Stone–Weierstrass theorem for sequences and series of functions.							
5. Evaluate functions of several variables using linear transformations, differentiation, and inverse and implicit function theorems.							
Course Outcomes:							
CO1: Define the concepts of finite, countable and uncountable sets, metric spaces, compact sets, connected sets, and convergence of sequences and series. (K1)							
CO2: Explain continuity, compactness, connectedness, differentiation, mean value theorems, Taylor's theorem, and vector-valued functions. (K2)							
CO3: Apply the principles and properties of the Riemann–Stieltjes integral to solve integration and differentiation problems. (K3)							
CO4: Explain uniform convergence, equicontinuity, and the Stone–Weierstrass theorem for sequences and series of functions. (K2)							
CO5: Apply differentiation techniques and the inverse and implicit function theorems to functions of several variables. (K3)							
Unit-I	Topology						12 Hrs.
Basic Topology: Finite, Countable and Uncountable Sets – Metric spaces – Compact sets – Perfect sets – Connected sets. Numerical Sequences and Series: Sequences – Convergence – Subsequences – Cauchy Sequences – Upper and Lower Limits - Some Special Sequences – Tests of convergence – Power series – Absolute convergence – Addition and multiplication of series –Rearrangements.							
Unit-II	Continuity						12 Hrs.
Continuity: Limits of functions – Continuous functions – continuity and Compactness– Continuity and connectedness – Discontinuities – Monotonic functions – Infinite limits and limits at infinity. Differentiation: Derivative of a real function – Mean value Theorems - Intermediate value theorem for derivatives – L'Hospital's Rule – Taylor's Theorem – Differentiation of vector valued functions							
Unit-III	Riemann – Stieltjes Integral						12 Hrs.
Riemann – Stieltjes Integral: Definition and Existence – Properties – Integration and Differentiation – Integration of vector valued functions.							

Unit-IV	Sequences and series of functions	12 Hrs.
Sequences and series of functions: Uniform Convergence and Continuity – Uniform Convergence and Differentiation – Equi continuous families of functions – The Stone – Weierstrass Theorem		
Unit-V	Functions of several variables	12 Hrs.
Functions of several variables: Linear Transformations - Differentiation – The Contraction Principle – The Inverse Function Theorem - The Implicit Function Theorem.		

Text Book(s):

1. Walter Rudin, Principles of Mathematical Analysis, Third Edition, Mc Graw Hill, 1976.

Reference Book(s):

1. Tom P. Apostol, Mathematical Analysis, Narosa Publishing House, New Delhi, 1985.
2. Serge Lang, Analysis I & II, Addison-Wesley Publishing Company, Inc., 1969.
3. Kenneth A. Ross, Elementary Analysis: The Theory of Calculus, Springer, New York, 2004.

e Resources:

1. https://onlinecourses.nptel.ac.in/noc20_ma03/preview
2. <https://nptel.ac.in/courses/111106142>
3. https://onlinecourses.nptel.ac.in/noc25_ma75/preview
4. <https://nptel.ac.in/courses/111105098>
5. <https://archive.nptel.ac.in/noc/courses/noc21/SEM1/noc21-ma04/>

Relationship Matrix for COs, POs and PSOs

Semester	Course code			Title of the course								L	T	P	Credit
I	PMA26102			Real Analysis								3	1	0	4
Course Outcomes (COs)	Programme Outcomes(POs)											Programme Specific Outcomes (PSOs)		Mean Score of COs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2		
CO1	3	1	-	-	1	-	-	-	-	-	2	2	1	2	
CO2	3	2	1	-	1	-	-	-	1	-	2	3	2	3	
CO3	3	3	2	-	2	-	-	-	1	1	2	3	2	3	
CO4	3	2	2	1	1	-	-	-	1	-	2	2	2	2	
CO5	3	3	2	1	2	-	-	-	1	1	2	3	3	3	
Mean Score	3	2	2	1	1	0	0	0	1	1	2	3	2	2	

Sem	Course Code	Title of the Course	Course Category	L	T	P	Credits
I	PMA26103	Ordinary Differential Equations	Core	3	0	0	3
Pre-Requisite: Nil			Co- Requisite: Nil	Progressive Course: Nil			
Course Objectives:							
1.To introduce the fundamental concepts of metric spaces, compactness, connectedness, and topology.							
2.To develop a rigorous understanding of sequences, series, continuity, and differentiability of real-valued functions.							
3.To study the theory and applications of the Riemann–Stieltje’s integral.							
4.To analyze uniform convergence and its impact on continuity and differentiation of functions.							
5.To understand differentiation in several variables and the fundamental theorems associated with multivariable analysis.							
Course Outcomes:							
CO1: Define the concepts of second-order linear differential equations, homogeneous equations, reduction of order, variation of parameters, and power series solutions. (K1)							
CO2: Explain regular singular points, the Frobenius method, Legendre polynomials, Bessel functions, and their basic properties. (K2)							
CO3: Apply the existence and uniqueness theorem and Picard’s method to solve first-order linear systems of differential equations. (k3)							
CO4: Explain boundary value problems, Sturm comparison theorem, eigenvalues, eigenfunctions, and the vibrating string problem. (K2)							
CO5: Apply phase plane analysis, stability concepts, and Liapunov’s direct method to autonomous systems (k3)							
Unit-I							9 Hrs.
Linear Differential Equations of Second Order – General Solution of Homogeneous Equations – Reduction of Order (Use of One Known Solution to Find Another) – Method of Variation of Parameters – Power Series Solutions – Ordinary Points.							
Unit-II							9 Hrs.
Regular Singular Points – Frobenius Method – Legendre Polynomials – Bessel Functions – Basic Properties of Legendre Polynomials and Bessel Functions.							
Unit-III							9 Hrs.
Linear Systems of First Order Differential Equations – Homogeneous Systems with Constant Coefficients – Existence and Uniqueness Theorem for Initial Value Problems – Picard’s Method of Successive Approximations.							
Unit-IV							9 Hrs.
Boundary Value Problems – Qualitative Properties of Solutions – Sturm Comparison Theorem – Eigenvalues and Eigenfunctions – Vibrating String Problem.							

Unit-V	9 Hrs.
Autonomous Systems – Phase Plane Analysis – Critical Points and Their Classification – Stability of Linear Systems – Liapunov’s Direct Method.	

Text Book(s):

1.G.F. Simmons, *Differential Equations with Applications and Historical Notes*, TMH, New Delhi, 2003.

Reference Book(s):

1. W.T. Reid, *Ordinary Differential Equations*, John Wiley & Sons, New York, 1971.
2. E.A. Coddington and N. Levinson, *Theory of Ordinary Differential Equations*, McGraw-Hill Publishing Company, New York, 1955.
3. George F. Simmons, *Differential Equations with Applications and Historical Notes*, 2nd Edition, McGraw-Hill Education, New York, 1991.

e Resources:

1. <https://nptel.ac.in/courses/111106100>
2. <https://nptel.ac.in/courses/111106101>
3. <https://ocw.mit.edu/courses/18-03-differential-equations-spring-2010/>
4. <https://tutorial.math.lamar.edu/classes/de/de.aspx>

Relationship Matrix for COs, POs and PSOs

Semester	Course code				Title of the course							L	T	P	Credit
I	PMA26103				Ordinary Differential Equations							3	0	0	3
Course Outcomes (COs)	Programme Outcomes(POs)											Programme Specific Outcomes (PSOs)		Mean Score of COs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2		
CO1	3	1	-	-	1	-	-	-	-	-	2	2	1	1	
CO2	3	2	1	-	1	-	-	-	1	-	2	3	2	3	
CO3	3	3	2	-	2	-	-	-	1	1	2	3	2	3	
CO4	3	2	2	1	1	-	-	-	1	-	2	2	2	2	
CO5	3	3	2	1	2	-	-	-	1	1	2	3	3	3	
Mean Score	3	2	2	1	1	0	0	0	1	1	2	2	2	2	

Sem	Course Code	Title of the Course	Course Category	L	T	P	Credits
I	PMA26S01	LaTeX	Skill Enhancement Course-I	1	0	2	2
Pre-Requisite: Nil			Co- Requisite: Nil	Progressive Course: Nil			
Course Objectives:							
1. To understand the theory and methods of solving higher-order differential equations.							
2. To develop proficiency in power series solutions and special functions.							
3. To analyze systems of differential equations and existence–uniqueness theorems.							
4. To study boundary value problems, eigenvalues, and oscillation theory.							
5. To investigate nonlinear systems and stability of solutions.							
Course Outcomes:							
CO1: Define the basic structure of LaTeX documents, input file organization, editors, search functions, compilation processes, and file conversions. (K1)							
CO2: Explain the methods of typesetting simple documents, sectioning, titles, page layouts, lists, quotations, letters, and mathematical formulas in LaTeX.(K2)							
CO3: Apply the AMSMath package to create, label, and reference mathematical equations effectively(K3)							
CO4: Explain the procedures for inserting and formatting figures, tables, and graphics in LaTeX documents. (K2)							
CO5: Apply bibliography management, indexing techniques, and presentation tools in LaTeX for professional document preparation. (K3)							
Unit-I							9 Hrs.
Basic structure of Latex 2e- Input file structure – Layout- Editors- Forward search- Inverse search- Complying - Conversion to various formats.							
Unit-II							9 Hrs.
Typesetting simple documents- sectioning- Titles- Page layout- listing- enumerating- quote- letter formula.							
Unit-III							9 Hrs.
Using the AMS Math Package: Typesetting Equations, Labeling, and Referencing.							
Unit-IV							9 Hrs.
Figures, Tables and Graphics in LaTeX							
Unit-V							9 Hrs.
Bibliography, Indexing and Presentations							

Text Book(s):

1. Leslie Lamport, LaTeX: A Document Preparation System, 2nd Edition, Addison-Wesley, Reading, Massachusetts, 1994.
2. Tobias Oetiker, Hubert Partl, Irene Hyna and Elisabeth Schlege, The Not So Short Introduction to LaTeX2 ϵ , Version 6.4, 2021.

Reference Book(s):

1. Frank Mittel bach and Michel Goossens, The LaTeX Companion, 2nd Edition, Addison-Wesley Professional, 2004.
2. Helmut Kopka and Patrick W. Daly, A Guide to LaTeX, 4th Edition, Addison-Wesley, 2003.
3. George Grätzer, More Math into LaTeX, 5th Edition, Springer, 2016.
4. Stefan Kottwitz, LaTeX Beginner's Guide, 2nd Edition, Packt Publishing, 2015.
5. Michel Goossens, Frank Mittel bach and Alexander Samarin, The LaTeX Companion: Tools and Techniques for Computer Typesetting, Addison-Wesley, 1994.

e Resources:

1. <https://www.latex-project.org/>
2. <https://www.overleaf.com/learn>
3. <https://www.tug.org/>
4. <https://tobi.oetiker.ch/lshort/lshort.pdf>
5. <https://www.overleaf.com/learn/latex/Tutorials>

Relationship Matrix for COs, POs and PSOs

Semester	Course code			Title of the course								L	T	P	Credit
I	PMA26S01			LaTeX								1	0	2	2
Course Outcomes (COs)	Programme Outcomes(POs)											Programme Specific Outcomes (PSOs)		Mean Score of COs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2		
CO1	3	1	-	-	2	-	-	-	1	-	2	2	2	2	
CO2	3	2	1	1	2	-	-	-	2	-	2	2	2	2	
CO3	3	3	2	2	3	-	-	1	2	1	2	3	3	3	
CO4	3	2	1	1	3	-	-	-	2	-	2	2	3	3	
CO5	3	3	2	2	3	-	-	1	2	2	3	3	3	3	
Mean Score	3	2	2	2	3	0	0	1	2	2	2	2	3	3	

Sem	Course Code	Title of the Course	Course Category	L	T	P	Credits
I	PMA26001	Discrete Mathematics	Disciplinary Elective Course -I	3	0	0	3
Pre-Requisite: Nil			Co- Requisite: Nil	Progressive Course: Nil			
Course Objectives:							
1. Understand the basic concepts of mathematical logic, predicates, and quantifiers.							
2. Apply relations, functions, and principles such as the pigeonhole principle and Hasse diagrams to solve problems.							
3. Explain the properties and structures of lattices and their different types.							
4. Use Boolean algebra and Boolean functions to design and simplify switching circuits and finite-state machines.							
5. Describe computability concepts, formal languages, and different types of grammars.							
Course Outcomes:							
CO1: Define the fundamental concepts of mathematical logic, predicates, quantifiers, and truth tables. (K1)							
CO2: Explain the properties of relations, functions, partial orders, and the pigeonhole principle. (K2)							
CO3: Apply the concepts of lattices and their operations to solve mathematical problems. (K3)							
CO4: Demonstrate the use of Boolean algebra for simplifying Boolean functions and designing finite-state machines. (K3)							
CO5: Describe the principles of computability, formal languages, and different types of grammars. (K2)							
Unit-I							9 Hrs.
Mathematical Logic: Logic operators, Truth tables, Theory of inference and deduction, mathematical calculus, predicate calculus, predicates and quantifiers.							
Unit-II							9 Hrs.
Relations and Functions: Binary relations, equivalence relations and partitions, partial order relations, inclusion and exclusion principle, Hasse diagram, Pigeon hole principle. Functions, inverse functions, compositions of functions, recursive functions.							
Unit-III							9 Hrs.
Lattices: Lattices as Partially Ordered Sets. Their Properties, Lattices as algebraic Systems, Sub lattices, Direct Product and homomorphism. Some Special Lattices - Complete, Complemented and Distributive Lattices, Isomorphic Lattices.							
Unit-IV							9 Hrs.
Boolean Algebra: Various Boolean identities, the switching Algebra Example, Sub Algebras, Direct Production and Homomorphism. Boolean Forms and their Equivalence, Midterm Boolean forms, Sum of Products, Canonical Forms. Minimization of Boolean Functions: Design Examples Using Boolean Algebra, Finite-state Machine							

Unit-V	9 Hrs.
Computability and Languages: Russell's Paradox and Non computability, Ordered Sets, Languages, Phrase structure grammars, Types of Grammars and Languages, Remarks and Reference.	

Text Book(s):

1. Trembly. J.P & Manohar.P., "Discrete Mathematical Structures with Applications to Computer Science" McGraw- Hill, 2003.
2. Liu, C.L., "Elements of Discrete Mathematics", McGraw-Hill Book co, 1985

Reference Book(s):

1. Bernard Kolman, Robert C. Busby and Sharon Ross, Discrete Mathematical Structures, PHI Learning, 1996.
2. K.D. Joshi, Foundations of Discrete Mathematics, New Age International Publishers, 2003.
3. Seymour Lipschutz and Marc Lipson, Discrete Mathematics, Schaum's Outline Series, McGraw-Hill Education, 2017.
4. Kenneth H. Rosen, Discrete Mathematics and Its Applications, 8th Edition, McGraw-Hill Education, 2019.
5. Ralph P. Grimaldi, Discrete and Combinatorial Mathematics: An Applied Introduction, 5th Edition, Pearson Education, 2004.

e Resources:

1. <https://onlinecourses.nptel.ac.in>
2. <https://ocw.mit.edu/courses/6-042j-mathematics-for-computer-science-spring-2015/>
3. <https://see.stanford.edu>
4. https://math.libretexts.org/Bookshelves/Combinatorics_and_Discrete_Mathematics
5. <https://discretemath.org>

Relationship Matrix for COs, POs and PSOs

Semester	Course code		Title of the course									L	T	P	Credit
I	PMA26001		Discrete Mathematics									3	0	0	3
Course Outcomes (COs)	Programme Outcomes(POs)											Programme Specific Outcomes (PSOs)		Mean Score of COs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2		
CO1	3	2	1	0	1	0	0	0	1	0	2	3	1	1	
CO2	3	3	2	1	1	0	0	0	1	0	2	3	2	1	
CO3	3	3	2	2	1	0	0	0	1	1	2	3	2	2	
CO4	3	3	2	3	3	0	0	1	1	2	2	3	2	2	
CO5	3	2	3	1	2	0	0	0	1	1	3	2	2	2	
Mean Score	3	3	2	1	2	0	0	0	1	1	2	3	2	2	

Sem	Course Code	Title of the Course	Course Category Disciplinary	L	T	P	Credits
I	PMA26002	Combinatorics	Elective Course -II Co- Requisite: Nil	3	0	0	3
Pre-Requisite: Nil			Progressive Course: Nil				

Course Objectives:

1. **Understand** the concepts of permutations, combinations, and the distributions of distinct and non-distinct objects.
2. **Explain** generating functions, integer partitions, Ferrer's graphs, and their applications in combinatorial analysis.
3. **Apply** recurrence relations and generating function techniques to solve counting problems.
4. **Analyze** the principle of inclusion and exclusion, derangements, rook polynomials, and permutations with restrictions.
5. **Describe** Polya's theory of counting, Burnside's theorem, and equivalence classes under permutation groups.

Course Outcomes:

CO1: Define the principles of permutations, combinations, distributions of objects, and Stirling's formula. **(K1)**

CO2: Explain generating functions, integer partitions, Ferrer's graphs, and their elementary relations. **(K2)**

CO3: Apply recurrence relations and generating function techniques to solve combinatorial problems. **(K3)**

CO4: Demonstrate the principle of inclusion and exclusion, derangements, rook polynomials, and restricted permutations. **(K3)**

CO5: Describe Polya's theory of counting, Burnside's theorem, and equivalence classes under permutation groups. **(K2)**

Unit-I 9 Hrs.

Permutations and combinations - distributions of distinct objects - distributions of non-distinct objects - Stirling's formula.

Unit-II 9 Hrs.

Generating functions - generating function for combinations - enumerators for permutations - distributions of distinct objects into non-distinct cells - partitions of integers - the Ferrer's graphs - elementary relations.

Unit-III 9 Hrs.

Recurrence relation - linear recurrence relations with constant coefficients solutions by the technique of generating functions - a special class of nonlinear difference equations - recurrence relations with two indices.

Unit-IV 9 Hrs.

The principle of inclusion and exclusion - general formula - permutations with restriction on relative positions - derangements - the rook polynomials - permutations with forbidden positions.

Unit-V 9 Hrs.

Polya's theory of counting - equivalence classes under a permutation group Burnside theorem - equivalence classes of functions - weights and inventories of functions - Polya's fundamental theorem - generation of Polya's theorem.

Text Book(s):

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

Reference Book(s):

1. H. J. Ryser, Combinatorial Mathematics, Carus Mathematical Monographs No. 14, Mathematical Association of America, 1963.
2. Richard A. Brualdi, Introductory Combinatorics, 5th Edition, Pearson Education, 2010.
3. Kenneth P. Bogart, Introductory Combinatorics, Harcourt Academic Press, 2000.
4. V. K. Balakrishnan, Schaum's Outline of Combinatorics, McGraw-Hill Education, 1995.
5. Alan Tucker, Applied Combinatorics, 6th Edition, Wiley, 2012.

e Resources:

1. <https://nptel.ac.in/courses/111106102>
2. <https://ocw.mit.edu/courses/18-314-combinatorial-analysis-fall-2014/>
3. <https://ocw.mit.edu/courses/6-042j-mathematics-for-computer-science-spring-2015/>
4. <https://www.appliedcombinatorics.org>
5. https://math.libretexts.org/Bookshelves/Combinatorics_and_Discrete_Mathematics

Relationship Matrix for COs, POs and PSOs

Semester	Course code			Title of the course								L	T	P	Credit
I	PMA26002			Combinatorics								3	0	0	3
Course Outcomes (COs)	Programme Outcomes(POs)											Programme Specific Outcomes (PSOs)		Mean Score of COs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2		
CO1	3	2	1	0	1	0	0	0	1	0	2	3	1	1	
CO2	3	2	2	1	1	0	0	0	1	0	2	3	2	1	
CO3	3	3	3	1	2	0	0	0	1	1	2	3	2	2	
CO4	3	3	2	2	1	0	0	0	1	1	2	3	2	2	
CO5	3	3	2	2	1	0	0	0	1	1	3	3	2	2	
Mean Score	3	3	2	1	1	0	0	0	1	1	2	3	2	2	

Sem	Course Code	Title of the Course	Course Category	L	T	P	Credits
I	PMA26003	Control Theory	Disciplinary Elective Course -III	3	0	0	3
Pre-Requisite: Nil			Co- Requisite: Nil	Progressive Course: Nil			
Course Objectives:							
1. Understand the fundamental concepts of observability, controllability, stability, stabilizability, and optimal control in dynamical systems.							
2. Analyze the controllability and observability properties of linear and nonlinear control systems.							
3. Apply stability theory to investigate the behavior of linear time-invariant, time-varying, and nonlinear systems.							
4. Design feedback control strategies for system stabilization and evaluate their effectiveness.							
5. Develop mathematical models and solve optimal control problems using Riccati equations and quadratic performance criteria.							
Course Outcomes:							
CO1:Define the fundamental concepts of observability, observability Grammians, and reconstruction kernels in linear and nonlinear systems. (K1)							
CO2:Explain the principles of controllability, adjoint systems, controllability Grammians, and steering functions(K2)							
CO3:Apply stability concepts to analyze linear, time-varying, perturbed, and nonlinear systems. (K3)							
CO4:Demonstrate stabilization techniques using linear feedback control, controllable subspaces, and restricted feedback methods. (K3)							
CO5:Describe optimal control methods, quadratic performance criteria, and Riccati equations for linear and nonlinear systems. (K2)							
Unit-I							9 Hrs.
Observability: Linear systems – Observability Grammian – Constant coefficient systems – Reconstruction kernel – Nonlinear Systems							
Unit-II							9 Hrs.
Controllability: Linear systems – Controllability Grammian – Adjoint systems – Constant coefficient systems – Steering function – Nonlinear systems							
Unit-III							9 Hrs.
Stability: Stability – Uniform stability – Asymptotic stability of linear Systems - Linear time varying systems – Perturbed linear systems – Nonlinear systems.							
Unit-IV							9 Hrs.
Stabilizability: Stabilization via linear feedback control – Bass method – Controllable subspace –Stabilization with restricted feedback.							
Unit-V							9 Hrs.
Optimal Control: Linear time varying systems with quadratic performance criteria – Matrix Riccati equation – Linear time invariant systems – Nonlinear Systems							

Text Book(s):

1. K. Balachandran & J. P. Dauer, Elements of Control Theory, Narosa, New Delhi, 1999.

Reference Book(s):

1. R. Conti, Linear Differential Equations and Control, Academic Press, London, 1976.
2. R.F. Curtain and A.J. Pritchard, Functional Analysis and Modern Applied Mathematics, Academic Press, New York, 1977.
3. J. Klamka, Controllability of Dynamical Systems, Kluwer Academic Publisher, Dordrecht, 1991.

e Resources:

1. <https://ocw.mit.edu/resources/res-6-010-electronic-feedback-systems-spring-2013/course-videos/>
2. <https://nptel.ac.in/courses/108101037/>

Relationship Matrix for COs, POs and PSOs

Semester	Course code			Title of the course								L	T	P	Credit
I	PMA26003			Control Theory								3	0	0	3
Course Outcomes (COs)	Programme Outcomes(POs)											Programme Specific Outcomes (PSOs)		Mean Score of COs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2		
CO1	3	2	1	0	1	0	0	0	1	0	2	3	1	1	
CO2	3	3	2	1	1	0	0	0	1	0	2	3	2	2	
CO3	3	3	3	2	2	0	0	0	1	1	2	3	2	2	
CO4	3	3	2	3	2	0	0	1	1	1	2	3	2	2	
CO5	3	3	3	2	2	0	0	0	1	1	3	3	2	2	
Mean Score	3	3	2	2	2	0	0	0	1	1	2	3	2	2	

Sem	Course Code	Title of the Course	Course Category	L	T	P	Credits
I	PMA26004	Formal Languages And Automata Theory	Disciplinary Elective Course -IV	3	0	0	3
Pre-Requisite: Nil			Co- Requisite:Nil	Progressive Course:Nil			
Course Objectives:							
1. Understand the fundamental concepts of formal languages, alphabets, strings, grammars, and finite automata.							
2. Analyze deterministic and nondeterministic finite automata and their equivalence with regular expressions.							
3. Develop context-free grammars and pushdown automata for modeling context-free languages.							
4. Explain the concepts of Turing machines, decidability, computability, and complexity.							
5. Apply automata and formal language concepts in compiler design, text processing, pattern matching, and computational problem solving.							
Course Outcomes:							
CO1: Describe the basic concepts of formal languages, grammars, finite automata, and regular languages. (K1)							
CO2: Explain deterministic finite automata, nondeterministic finite automata, regular expressions, and their equivalence. (K2)							
CO3: Apply context-free grammars and pushdown automata to solve problems involving context-free languages. (K3)							
CO4: Explain the working principles of Turing machines, decidability, and computability. (K2)							
CO5: Apply automata theory in compiler construction, lexical analysis, parsing, and pattern recognition. (K3)							
Unit-I	Introduction to Formal Languages:						9 Hrs.
Alphabets – Strings – Languages – Operations on Languages – Grammars – Chomsky Hierarchy – Finite State Systems – Deterministic Finite Automata (DFA) – Language Accepted by DFA – Applications.							
Unit-II	Regular Languages and Properties						9 Hrs.
Finite Automata with ϵ -Moves – Regular Grammars – Pumping Lemma for Regular Languages – Closure Properties of Regular Languages – Minimization of DFA – Applications of Regular Languages.							
Unit-III	Context-Free Languages and Pushdown Automata						9 Hrs.
Context-Free Grammars – Derivations – Parse Trees – Ambiguity – Chomsky Normal Form – Greibach Normal Form – Pushdown Automata – Equivalence of PDA and CFG – Applications in Syntax Analysis.							

Unit-IV	Turing Machines and Computability	9 Hrs.
Turing Machines – Variants of Turing Machines – Recursive and Recursively Enumerable Languages – Universal Turing Machine – Church-Turing Thesis – Decidability – Undecidable Problems – Halting Problem.		
Unit-V	Computational Complexity	9 Hrs.
Time Complexity – Space Complexity – Complexity Classes P and NP – NP-Complete Problems – NP-Hard Problems – Polynomial Time Reduction – Introduction to Approximation Algorithms – Applications in Computer Science		

Text Book(s):

1. John E. Hopcroft, Rajeev Motwani and Jeffrey D. Ullman, Introduction to Automata Theory, Languages and Computation, 3rd Edition, Pearson Education, 2008.
2. Michael Spier, Introduction to the Theory of Computation, 3rd Edition, Cengage Learning, 2013.
3. Peter Linz, An Introduction to Formal Languages and Automata, 6th Edition, Jones & Bartlett Learning, 2017.
4. John C. Martin, Introduction to Languages and the Theory of Computation, 4th Edition, McGraw-Hill Education, 2011.
5. K. L. P. Mishra and N. Chandrasekaran, Theory of Computer Science (Automata, Languages and Computation), 3rd Edition, PHI Learning, 2012.

Reference Book(s):

1. Dexter C. Kozen, Automata and Computability, Springer, 1997.
2. Harry R. Lewis and Christos H. Papadimitriou, Elements of the Theory of Computation, 2nd Edition, Pearson Education, 1998.
3. Daniel I. A. Cohen, Introduction to Computer Theory, 2nd Edition, Wiley India, 2008.
4. Elaine Rich, Automata, Computability and Complexity: Theory and Applications, Pearson Education, 2008.
5. Jean Gallier, Logic for Computer Science, Dover Publications, 2015.

e Resources:

1. <https://nptel.ac.in>
2. <https://ocw.mit.edu>
3. <https://link.springer.com>
4. <https://www.sciencedirect.com>
5. <https://www.coursera.org>

Relationship Matrix for COs, POs and PSOs

Semester	Course code			Title of the course								L	T	P	Credit
I	PMA26004			Languages And Atomata Theory								3	0	0	3
Course Outcomes (COs)	Programme Outcomes(POs)											Programme Specific Outcomes (PSOs)		Mean Score of COs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2		
CO1	3	2	1	1	2	2	2	1	2	1	0	3	2	2.0	
CO2	3	3	2	2	2	2	2	1	2	2	0	3	2	2.0	
CO3	3	3	3	2	2	2	2	1	2	2	0	3	3	2.2	
CO4	2	2	2	2	2	2	2	1	2	2	0	3	2	2	
CO5	3	3	3	3	3	2	2	1	2	2	0	3	3	2	
Mean Overall Score	3	3	2	2	2	2	2	1	2	2	0	3	2	2	

Sem	Course Code	Title of the Course	Course Category	L	T	P	Credits
I	PMA26005	Fluid Dynamics	Disciplinary Elective Course - V	3	0	0	3
Pre-Requisite: Nil			Co- Requisite: Nil	Progressive Course: Nil			
Course Objectives:							
Understand the fundamental concepts of fluid kinematics, fluid properties, continuity equation, and the governing equations of ideal fluid motion.							
1. Analyze irrotational, incompressible, and axisymmetric fluid flows using velocity potential, stream function, and potential function techniques.							
2. Apply complex variable methods, conformal transformations, and circle theorems to solve two-dimensional fluid flow problems.							
3. Develop the governing equations for viscous fluid motion and examine stress, strain, viscosity, and Navier–Stokes equations.							
4. Solve engineering and mathematical problems involving viscous flow, boundary layer theory, dimensional analysis, and Reynolds number.							
Course Outcomes:							
CO1: Define the concepts of real and ideal fluids, fluid kinematics, streamlines, pathlines, velocity potential, continuity equation, Euler's equation, and Bernoulli's equation. (K1)							
CO2: Explain the principles of steady and unsteady flows, potential flow, axisymmetric flow, sources, sinks, doublets, and Stokes stream function. (K2)							
CO3: Apply the concepts of stream function, complex potential, Milne–Thomson circle theorem, Blasius theorem, and conformal transformation to solve two-dimensional fluid flow problems. (K3)							
CO4: Explain the concepts of viscous fluid motion, stress and strain relations, coefficient of viscosity, laminar flow, and Navier–Stokes equations. (K2)							
CO5: Apply the principles of viscous flow, dimensional analysis, Reynolds number, boundary layer theory, and flow through pipes and past spheres to solve fluid dynamics problems. (K3)							
Unit-I						9Hrs.	
Real Fluids and Ideal Fluids - Velocity of a Fluid at a point – Streamlines and Path lines: Steady and Unsteady Flows – The Velocity potential – The Velocity vector– The Equation of continuity – Worked examples – Acceleration of a Fluid – Conditions at a rigid boundary – Euler's equation of motion – Bernoulli's equation – Worked example							
Unit-II						9 Hrs.	
Discussions of a case of steady motion under conservative body forces – Some potential theorems – Some Flows Involving Axial Symmetry – Some special two- Dimensional Flows-Impulsive Motion.							
Unit-III						9Hrs.	
Some Two- Dimensional Flows: Meaning of a Two- Dimensional Flow – Use of cylindrical polar co-ordinates – The stream function – The Complex Potential for Two- Dimensional, Irrotational , Incompressible Flow							

Unit-IV		9Hrs.
The use of conformal Transformation and Hydro dynamical Aspects – Vortex rows. Viscous flow Stress components in a real fluid - relations between cartesian components of stress - Translational Motion of Fluid element – The Rate of Strain Quadraic and Principle Stresses		
Unit-V		9Hrs.
Some solvable problems in viscous flow – Steady viscous flow in tubes of uniform cross section – Diffusion of vorticity – Energy Dissipation due to viscosity – Steady Flow past a Fixed Sphere		

Text Book(s):

- 1.F. Chorlton, Textbook of Fluid Dynamics, CBS Publishers & Distributors, New Delhi, 2004.

Reference Book(s):

1. L. M. Milne-Thomson, Theoretical Hydrodynamics, 5th Edition, Macmillan & Co. Ltd., London, 1968.
2. G. K. Batchelor, An Introduction to Fluid Dynamics, Cambridge University Press, Cambridge, 1967.
3. H. Schlichting and K. Gersten, Boundary-Layer Theory, 9th Edition, Springer, 2017.
4. L. D. Landau and E. M. Lifshitz, Fluid Mechanics, 2nd Edition, Butterworth-Heinemann (Elsevier), 1987.
5. Frank M. White, Fluid Mechanics, 9th Edition, McGraw-Hill Education, 2021.

e Resources:

1. <https://ocw.mit.edu/courses/find-by->
2. <https://swayam.gov.in>
3. <https://www.sciencedirect.com>
4. <https://www.siam.org>
5. <https://mathworld.wolfram.com>

Relationship Matrix for COs, POs and PSOs

Semester	Course code		Title of the course									L	T	P	Credit
I	PMA26005		Fluid Dynamics									3	0	0	3
Course Outcomes (COs)	Programme Outcomes(POs)											Programme Specific Outcomes (PSOs)		Mean Score of COs	
	PO 1	PO 2	PO3	PO4	PO5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PSO1	PSO2		
CO1	3	2	1	-	1	-	-	-	-	-	1	3	1	2	
CO2	3	2	2	1	1	-	-	-	-	-	1	3	2	2	
CO3	3	3	2	2	2	-	-	-	-	-	1	3	2	2	
CO4	3	2	2	1	2	1	-	-	-	-	1	3	2	2	
CO5	3	3	3	2	2	2	1	-	-	1	2	3	3	2	
Mean Overall Score	3	2	2	1	2	1	1	0	0	1	1	3	2	2	

Sem	Course Code	Title of the Course	Course Category	L	T	P	Credits
I	PMM26006	Optimization Techniques	Disciplinary Elective Course -VI	3	0	0	3
Pre-Requisite: Nil			Co- Requisite: Nil		Progressive Course: Nil		
Course Objectives:							
1.To understand Integer Programming models and solution techniques..							
2.To learn Dynamic Programming for solving multistage decision problems.							
3.To understand decision-making methods and game theory concepts.							
4.To apply inventory models for effective inventory control..							
5.To understand nonlinear optimization techniques and algorithms.							
Course Outcomes:							
CO1: Identify the concepts, types, and formulation methods of Integer Programming Problems. (K1)							
CO2: Explain the principles and techniques of Dynamic Programming for multistage decision problems.(K2)							
CO3: Apply decision theory and game theory techniques to solve decision-making problems. (K3).							
CO4: Analyze inventory models and apply EOQ techniques for effective inventory control. (K2)							
CO5: Apply nonlinear programming algorithms to solve optimization problems. (K3)							
Unit-I	Integer Programming						.9 Hrs
Introduction to Integer Programming – Types of Integer Programming Problems – Formulation of Integer Linear Programming Models – Gomory Cutting Plane Method – Branch and Bound Method .							
Unit-II	Dynamic (Multistage) Programming						9 Hrs
Introduction to Dynamic Programming – Characteristics of Multistage Decision Problems – Principle of Optimality – Recursive Formulation – Forward and Backward Recursion – Applications in Shortest Path, Resource Allocation, and Equipment Replacement Problems.							
Unit-III	Decision Theory and Games						9 Hrs
Decision Making under Certainty, Risk, and Uncertainty – Decision Criteria (Maximax, Maximin, Minimax Regret, Hurwicz, Laplace) – Introduction to Game Theory – Two-Person Zero-Sum Games – Pure and Mixed Strategies – Saddle Point .							
Unit-IV	Inventory Models						9 Hrs.
Introduction to Inventory Control – Objectives and Costs of Inventory – Economic Order Quantity (EOQ) Model – EOQ with Shortages – Quantity Discount Models – Probabilistic Inventory Models .							
Unit-V	Nonlinear Programming Algorithms						0 Hrs.
Introduction to Nonlinear Programming – Classification of Nonlinear Optimization Problems – Unconstrained Optimization Techniques – Constrained Optimization – Kuhn-Tucker Conditions – Gradient-Based Optimization Methods – Applications of Nonlinear Programming.							

Text Book(s):

- 1 . Hamdy A. Taha, Operations Research: An Introduction, Macmillan Publishing Company, 4th Edition.

Reference Book(s):

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

e Resources:

1. <https://nptel.ac.in/courses>
2. <https://ocw.mit.edu/search/?q=operations+research>
3. <https://nptel.ac.in/courses/110104137>
4. <https://people.brunel.ac.uk/~mastjjb/jeb/or/invent.html>
5. <https://nptel.ac.in/courses/111104030>

Sem	Course Code	Title of the Course	Course Category	L	T	P	Credits
II	PMA26204	Linear Algebra	Core Course	3	1	0	4
Pre-Requisite: Nil			Co- Requisite: Nil	Progressive Course: Nil			
Course Objectives:							
1.To provide a strong foundation in matrices, systems of linear equations, vector spaces, bases, and dimensions.							
2.To develop an understanding of linear transformations, isomorphisms, matrix representations, linear functionals, and dual spaces.							
3.To introduce the algebra of polynomials, interpolation techniques, polynomial ideals, factorization, and determinant functions.							
4.To impart knowledge of determinants, characteristic values, and annihilating polynomials for matrix analysis.							
5. To enable students to apply diagonalization techniques and decomposition theorems to study invariant subspaces and linear operators.							
Course Outcomes:							
CO1:Define the concepts of matrices, elementary row operations, row-reduced echelon form, invertible matrices, bases, and dimension. (K1)							
CO2:Explain the properties of linear transformations, vector space isomorphisms, linear functionals, and matrix representations. (K2)							
CO3:Apply the concepts of polynomial algebra, Lagrange interpolation, polynomial ideals, and determinant functions to solve algebraic problems. (K3)							
CO4:Explain the concepts of determinants, adjoint matrices, inverse matrices, characteristic values, and annihilating polynomials. (K2)							
CO5:Apply the concepts of invariant subspaces, diagonalization, direct sum decompositions, and the primary decomposition theorem to solve linear algebra problems. (K3)							
Unit-I	Matrices						12Hrs.
Systems of linear Equations - Matrices and Elementary Row operations -Row-reduced Echelon Matrices - Matrix Multiplication - Invertible Matrices -Bases and Dimension (Only revision of Vector spaces and subspaces)							
Unit-II	Linear Transformations						12Hrs.
The algebra of linear transformations - Isomorphism of Vector Spaces -Representations of Linear Transformations by Matrices - Linear Functional– The Double Dual - The Transpose of a Linear Transformation.							
Unit-III	Algebra Of Polynomials						12Hrs.
The algebra of polynomials - Lagrange Interpolation - Polynomial Ideals -The prime factorization of a polynomial - Commutative rings – Determinant functions.							
Unit-IV	Determinants						12Hrs.
Permutations and the uniqueness of determinants - Classical Adjoint of a (square) matrix - Inverse of an invertible matrix using determinants -Characteristic values -Annihilating polynomials.							

Unit-V	Diagonalization	12Hrs.
Invariant subspaces - Simultaneous triangulation and simultaneous Diagonalization Direct - sum Decompositions - Invariant Direct sums – Primary Decomposition theorem.		

Text Book(s):

1. Kenneth Hoffman and Ray Alden Kunze, Linear Algebra, Second Edition, Prentice Hall of India Private Limited, New Delhi, 2005.
2. Stephen H. Friedberg, Arnold J. Insel, and Lawrence E. Spence, *Linear Algebra*, 4th Edition, Pearson Education, 2013.
3. I. N. Herstein, Topics in Algebra, 2nd Edition, John Wiley & Sons, Singapore, 1993.
4. David C. Lay, Steven R. Lay, and Judi J. McDonald, *Linear Algebra and Its Applications*, 5th Edition, Pearson, 2016.

Reference Book(s):

1. S. Kumaresan, Linear Algebra: A Geometric Approach, Prentice-Hall of India Ltd, 2004.
2. A.R. Rao, P. Bhima shankaram, Linear Algebra, Second Edition, Tata McGraw Hill, 2000.
3. V.Krishnamurthy, V.P.Mainra, J.L.Arora, Introduction to Linear Algebra, East West Press Ltd, 1985.
4. Vivek Sahai & Vikas Bist, Linear Algebra, Narosa Publishing House, New Delhi, 2002.
5. A. R. Rao & P. Bhimashankaram, Linear Algebra, Hindustan Book Agency, New Delhi, 2000.

e Resources:

1. <https://nptel.ac.in/courses/111106051>
2. <https://ocw.mit.edu/courses/18-06-linear-algebra-spring-2010/>
3. https://math.libretexts.org/Bookshelves/Linear_Algebra
4. <https://nptel.ac.in/courses/111106130>
5. <https://www.wolfram.com/mathematica/>

Relationship Matrix for COs, POs and PSOs

Semester	Course code		Title of the course									L	T	P	Credit
II	PMA26204		LINEAR ALGEBRA									3	1	0	4
Course Outcomes (COs)	Programme Outcomes(POs)											Programme Specific Outcomes (PSOs)		Mean Score of COs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2		
CO1	3	2	1	-	1	-	-	-	-		1	3	2	2	
CO2	3	3	2	1	2	-	-	-	-		1	3	2	2	
CO3	3	3	2	2	2	-	-	-	-	1	1	3	3	2	
CO4	3	2	2	1	1	-	-	-	-		1	3	2	1	
CO5	3	3	3	2	2	-	-	-	-	2	2	3	3	3	
Mean Overall Score	3	3	2	2	2	-	-	-	-	2	1	3	2	2	

Sem	Course Code	Title of the Course	Course Category	L	T	P	Credits
II	PMA26205	Complex Analysis	Core Course	3	1	0	4
Pre-Requisite: Nil			Co- Requisite: Nil	Progressive Course: Nil			
Course Objectives:							
1. To introduce the fundamental concepts of topology, conformal mappings, and linear transformations in the complex plane.							
2. To develop an understanding of complex integration, Cauchy's theorem, and Cauchy's integral formula.							
3. To impart knowledge of analytic functions, singularities, Taylor series, and local properties of complex functions.							
4. To familiarize students with the general form of Cauchy's theorem, homology, residue calculus, and applications to contour integration.							
5. To enable students to study harmonic functions, power series expansions, Laurent series, and their applications in complex analysis.							
Course Outcomes:							
CO1:Define the concepts of metric spaces, topological spaces, connectedness, compactness, continuous functions, and conformal mappings. (K1)							
CO2:Explain the fundamental theorems of complex integration, including Cauchy's theorem and Cauchy's integral formula. (K2)							
CO3:Apply the properties of analytic functions, Taylor's theorem, singularities, zeros, and poles to solve complex function problems. (K3)							
CO4:Explain the general form of Cauchy's theorem, homology, residue theorem, and the argument principle in complex analysis. (K2)							
CO5:Apply the concepts of harmonic functions, Poisson's formula, Schwarz's theorem, Taylor series, and Laurent series to solve complex analysis problems. (K3)							
Unit-I	Elementary Point Set Topology						12 Hrs.
Sets and Elements – Metric Spaces – Connectedness – Compactness – Continuous Functions – Topological Spaces; Conformality: Arcs and Closed Curves – Analytic Functions in Regions – Conformal Mapping – Length and Area; Linear Transformations: The Linear Group – The Cross Ratio – Symmetry							
Unit-II	Fundamental theorems in complex integration						12 Hrs.
Line Integrals – Rectifiable Arcs – Line Integrals as Functions of Arcs – Cauchy's Theorem for a Rectangle – Cauchy's Theorem in a Disk; Cauchy's Integral Formula: The Index of a Point with Respect to a Closed Curve – The Integral Formula – Higher Derivatives.							
Unit-III	Analytic Functions						12 Hrs.
Local Properties of Analytic Functions - Removable Singularities - Taylor's Theorem – Integral representation of the nth term - Zeros and Poles – Algebraic order of $f(z)$ – Essential Singularity - The Local Mapping – The Open Mapping Theorem – The Maximum Principle.							

Unit-IV	The General Form of Cauchy's Theorem	12 Hrs.
Chains and Cycles – Simple Connectivity – Homology – The General Statement of Cauchy's Theorem – Proof of Cauchy's Theorem – Locally Exact Differentials – Multiply Connected Regions; The Calculus of Residues: The Residue Theorem – The Argument Principle – Evaluation of Definite Integrals.		
Unit-V	Harmonic Functions	12 Hrs.
Definition and Basic Properties – The Mean-value Property – Poisson's Formula – Schwarz's Theorem – The Reflection Principle; Power series expansions-Weierstrass's Theorem – The Taylor Series – The Laurent Series;		

Text Book(s):

1. Lars V. Ahlfors, Complex Analysis: An Introduction to the Theory of Analytic Functions of One Complex Variable, 3rd Edition, McGraw-Hill Education, New York, 1979.
2. James Ward Brown and Ruel V. Churchill, Complex Variables and Applications, 9th Edition, McGraw-Hill Education, New York, 2014.
3. Dennis G. Zill and Patrick D. Shanahan, A First Course in Complex Analysis with Applications, Jones and Bartlett Publishers, 2009.

Reference Book(s):

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

e Resources:

1. <https://nptel.ac.in/courses/111106137>
2. <https://nptel.ac.in/courses/111105122>
3. <https://nptel.ac.in/courses/111106088>
4. <https://ocw.mit.edu/courses/18-112-functions-of-a-complex-variable-fall-2008/>
5. https://math.libretexts.org/Bookshelves/Analysis/Complex_Analysis

Relationship Matrix for COs, POs and PSOs

Semester	Course code			Title of the course								L	T	P	Credit
II	PMA26205			COMPLEX ANALYSIS								3	1	0	4
Course Outcomes (COs)	Programme Outcomes(POs)											Programme Specific Outcomes (PSOs)		Mean Score of COs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2		
CO1	3	2	1	1	1	-	-	-	-	1	1	3	2	2	
CO2	3	3	2	1	1	-	-	-	-	-	1	3	2	2	
CO3	3	3	2	2	2	-	-	-	-	1	1	3	3	2	
CO4	3	3	2	1	1	-	-	-	-	-	1	3	2	2	
CO5	3	3	3	2	2	1	-	-	-	2	1	3	3	3	
Mean Overall Score	3	3	2	2	1	1	-	-	-	2	1	3	2	2	

Sem	Course Code	Title of the Course	Course Category	L	T	P	Credits
II	PMA26206	Partial Differential Equations	Core Course	3	0	0	3
Pre-Requisite: Nil			Co- Requisite: Nil	Progressive Course: Nil			
Course Objectives:							
1. Understand the formulation and classification of first-order partial differential equations and their geometrical interpretation.							
2. Apply analytical techniques such as Cauchy's method, Charpit's method, and Jacobi's method to solve first-order PDEs.							
3. Analyze second-order partial differential equations arising in physical phenomena and solve linear PDEs with constant and variable coefficients.							
4. Employ methods such as separation of variables and integral transforms to solve hyperbolic and nonlinear second-order PDEs.							
5. Solve Laplace equations and boundary value problems, including problems involving axial symmetry and equipotential surfaces, with applications in engineering and physics.							
Course Outcomes:							
CO1:Define the concepts of first-order partial differential equations, Cauchy's problem, and linear and nonlinear partial differential equations. (K1)							
CO2:Explain the methods of characteristics, Charpit's method, Jacobi's method, and compatible systems for solving first-order partial differential equations. (K2)							
CO3:Apply the techniques for solving second-order partial differential equations with constant and variable coefficients. (K3)							
CO4:Explain the methods for solving linear hyperbolic equations, integral transforms, separation of variables, and nonlinear second-order equations. (K2)							
CO5:Apply the concepts of Laplace's equation, boundary value problems, equipotential surfaces, and axial symmetry to solve partial differential equation problems. (K3)							
Unit-I							9 Hrs.
Partial differential equations- origins of first order Partial differential equations-Cauchy's problem for first order equations- Linear equations of the first order- Integral surfaces Passing through a Given curve-surfaces Orthogonal to a given system of surfaces -Nonlinear Partial differential equations of the first order.							
Unit-II							9 Hrs.
Cauchy's method of characteristics- compatible systems of first order equations - Charpits method- Special types of first order equations- Solutions satisfying given conditions- Jacobi's method							
Unit-III							9 Hrs.
Partial differential equations of the second order: The origin of second order equations--second order equations in Physics -- Higher order equations in Physics - Linear partial differential equations with constant co-efficient- Equations with variable coefficients-Characteristic curves of second order equations							

Unit-IV		9 Hrs.
Characteristics of equations in three variables - The solution of Linear Hyperbolic equations -Separation of variables. The method of Integral Transforms – Non-Linear equations of the second order		
Unit-V		9 Hrs.
Laplace equation - Elementary solutions of Laplace's Equations-Families of equipotential Surfaces-Boundary value problems-Separation of variables –Problems with Axial Symmetry		

Text Book(s):

1. Ian N. Sneddon, Elements of Partial differential equations, Dover Publication –INC, New York, 2006.
2. Tyn Myint-U and Lokenath Debnath, Linear Partial Differential Equations for Scientists and Engineers, Birkhäuser, 4th Edition, 2007.
3. Ian Sneddon, Elements of Partial Differential Equations, McGraw-Hill International Edition, 2006.

Reference Book(s):

1. M.D. Raisinghania, Advanced Differential Equations, S. Chand and company Ltd., New Delhi, 2001
2. E.T. Copson, Partial Differential Equations, Cambridge University Press.
3. I.C.Evans, Partial differential equations, Graduate studies in mathematics vol.19 AMS, 1998

e Resources:

1. <https://nptel.ac.in/courses/111106100>
2. <https://nptel.ac.in/courses/111105122>
3. <https://nptel.ac.in/courses/111105122>
4. <https://www.youtube.com/playlist?list=PLBlnK6fEyqRjM6M5guwQ6Q7w5S8P3V4rL>
5. <https://www.mathworks.com/products/pde.html>

Relationship Matrix for COs, POs and PSOs

Semester	Course code		Title of the course									L	T	P	Credit
II	PMA26206		PARTIAL DIFFERENTIAL EQUATIONS									3	0	0	3
Course Outcomes (COs)	Programme Outcomes(POs)											Programme Specific Outcomes (PSOs)		Mean Score of COs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2		
CO1	3	2	1	-	1	-	-	-	-		1	3	2	2	
CO2	3	3	2	1	1	-	-	-	-		1	3	2	2	
CO3	3	3	3	2	2	-	-	-	-	1	2	3	3	2	
CO4	3	3	2	1	2	-	-	-	-		1	3	2	2	
CO5	3	3	3	2	2	-	-	-	-	2	2	3	3	3	
Mean Overall Score	3	3	2	2	2	-	-	-	-	2	1	3	2	2	

Sem	Course Code	Title of the Course	Course Category	L	T	P	Credits
II	PMA26S02	Introduction to SCILAB	Skill Enhancement Course	1	0	2	2
Pre-Requisite:Nil			Co- Requisite:Nil	Progressive Course:Nil			
Course Objectives:							
1. To introduce the Scilab environment and familiarize students with its basic commands and features.							
2. To develop skills in matrix computations, vector operations, and graphical visualization using Scilab.							
3. To provide knowledge of programming constructs and user-defined functions in Scilab.							
4. To enable students to create and customize graphical representations for data analysis and visualization							
5. To apply Scilab tools for solving engineering and scientific problems.							
Course Outcomes:							
CO1:Define the basic concepts of Scilab, including its features, user interface, data types, operators, and built-in functions. (K1)							
CO2:Explain the creation and manipulation of vectors, matrices, polynomials, complex numbers, and graphical plots in Scilab. (K2)							
CO3:Apply programming constructs such as conditional statements, loops, functions, recursion, and debugging techniques to develop Scilab programs. (K3)							
CO4:Explain the methods for creating and customizing two-dimensional and three-dimensional graphics, plots, and animations in Scilab. (K2)							
CO5:Apply Scilab toolboxes and numerical methods to solve engineering and mathematical problems involving equations, interpolation, differential equations, optimization, signal processing, and image processing. (K3)							
Unit-I	Introduction to Scilab						9 Hrs.
Overview of Scilab – Features and Applications – Installation and User Interface – Variables and Constants – Data Types – Operators – Input and Output Commands – Built-in Mathematical Functions – Scripts and Comments.							
Unit-II	Vectors and Matrices						9 Hrs.
Creation of Vectors and Matrices – Matrix Operations – Special Matrices – Matrix Manipulation Functions – Polynomial Operations – Complex Numbers – Relational and Logical Operations – String Handling – Basic Plotting Commands.							
Unit-III	Programming Constructs						9 Hrs.
Conditional Statements – if, if-else and select Statements – Looping Structures (for, while) – Break and Continue Statements – User-defined Functions – Recursion – Passing Arguments – Variable Scope – Debugging Techniques.							
Unit-IV	Graphics and Visualization						9 Hrs.
Two-dimensional Plots – Plot Customization – Multiple Plots – Three-dimensional Graphics – Surface Plots – Histograms – Contour Plots – Animation Basics – Graphical User Interface Components.							
Unit-V	Applications and Toolboxes						9 Hrs.
Numerical Methods using Scilab – Solving Linear and Nonlinear Equations – Curve Fitting and Interpolation – Differential Equations – Optimization Problems – Signal Processing Toolbox – Image Processing Toolbox – Simulation and Engineering Applications.							

Text Book(s):

1. Michael Baudin, Introduction to Scilab, The Scilab Consortium, Digiteo, 2010.
2. **Claude Gomez, Praveen R. Nair and Rajan A. Thukral**, Scilab by Example, Oxford University Press, 2016.
3. **Stephen L. Campbell, Jean-Philippe Chancelier and Ramine Nikoukhah**, Modeling and Simulation in Scilab/Scicos, Springer, 2010.
4. **S. Sridhar**, *Programming with Scilab*, Oxford University Press, 2015.

Reference Book(s):

1. Stephen L. Campbell, Jean-Philippe Chancelier, Ramine Nikoukhah, Modeling and Simulation in Scilab/Scicos with Scicos Lab 4.4, Springer-Verlag New York, 2006.
2. Eike Rietsch, An Introduction to Scilab from a Matlab User's Point of View, INRIA, France, 2010.
3. **M. Affouf**, Scilab Textbook Companion for Numerical Methods, Scilab Enterprises, 2012.
4. **H. P. Gavin**, Scilab for Numerical Methods, Duke University, 2011.
5. **Abhijit Jana**, Scilab Projects, BPB Publications, 2013.

e Resources:

1. <https://nptel.ac.in/courses/111105122>
2. <https://www.tutorialspoint.com/scilab>
3. <https://www.scilab.org/download>
4. <https://nptel.ac.in>
5. <https://help.scilab.org>

Relationship Matrix for COs, POs and PSOs

Semester	Course code			Title of the course								L	T	P	Credit
II	PMA26S02			INTRODUCTION TO SCILAB								1	0	2	2
Course Outcomes (COs)	Programme Outcomes(POs)											Programme Specific Outcomes (PSOs)		Mean Score of COs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2		
CO1	3	1	1	-	3	-	-	-	1	1	1	2	2	2	
CO2	3	2	2	1	3	-	-	-	1	1	1	3	3	1	
CO3	3	3	2	2	3	-	-	1	1	2	2	3	3	2	
CO4	3	2	2	2	3	-	-	-	2	1	1	2	3	2	
CO5	3	3	3	2	3	-	-	1	2	1	2	3	3	3	
Mean Overall Score	3	2	2	2	3	-	-	1	1	1	1	3	3	2	

Sem	Course Code	Title of the Course	Course Category	L	T	P	Credits
II	PMA26007	Mathematical Modelling	Disciplinary Elective Course - VII	3	0	0	3
Pre-Requisite: Nil			Co- Requisite: Nil	Progressive Course: Nil			
Course Objectives:							
1. Formulate and solve first-order ordinary differential equation models arising in growth, decay, compartmental, and geometric applications.							
2. Develop and analyze systems of first-order differential equations to model interacting dynamic systems in science, economics, and social sciences.							
3. Apply second-order ordinary differential equations to model and investigate physical and mechanical phenomena.							
4. Construct and solve linear difference equation models for discrete-time processes in diverse application domains.							
5. Translate real-world problems into appropriate differential or difference equation models and interpret their solutions in context.							
Course Outcomes:							
CO1: Define the basic concepts of mathematical modeling using first-order ordinary differential equations for growth, decay, compartment, dynamics, and geometrical problems. (K1)							
CO2: Explain mathematical models based on systems of first-order ordinary differential equations for population, epidemics, economics, medicine, and dynamic problems. (K2)							
CO3: Apply second-order ordinary differential equations to model planetary motion, circular motion, satellite motion, and other engineering problems. (K3)							
CO4: Explain the principles of difference equations and apply them to solve problems in economics, finance, population dynamics, genetics, and probability. (K2)							
CO5: Apply graph-based mathematical models using directed, signed, weighted, and unoriented graphs to solve real-world problems. (K3)							
Unit-I							9 Hrs.
Mathematical Modeling through Ordinary Differential Equations of First order: Linear Growth and Decay Models – Non-Linear Growth and Decay Models – Compartment Models – Dynamics problems – Geometrical problems.							
Unit-II							9 Hrs.
Mathematical Modeling through Systems of Ordinary Differential Equations of First Order: Population Dynamics – Epidemics – Compartment Models – Economics – Medicine, Arms Race, Battles and International Trade – Dynamics.							
Unit-III							9 Hrs.
Mathematical Modeling through Ordinary Differential Equations of Second Order: Planetary Motions – Circular Motion and Motion of Satellites – Mathematical Modeling through Linear Differential Equations of Second Order Miscellaneous Mathematical Models.							

Unit-IV		9 Hrs.
Mathematical Modeling through Difference Equations: Simple Models – Basic Theory of Linear Difference Equations with Constant Coefficients – Economics and Finance – Population Dynamics and Genetics –Probability Theory.		
Unit-V		9 Hrs.
Mathematical Modeling through Graphs: Solutions that can be Modeled through Graphs – Mathematical Modeling in Terms of Directed Graphs, Signed Graphs, Weighted Digraphs and Unoriented Graphs.		

Text Book(s):

1. J.N. Kapur, Mathematical Modeling, Wiley Eastern Limited, New Delhi, 1988.
2. Frank R. Giordano, Maurice D. Weir, and William P. Fox , **Edition** 5th Edition (2014)
3. An Introduction to Mathematical Modeling Edward A. Bender , **Edition** Revised Dover Edition (2000)
4. Mathematical Models in Biology and Medicine, **Author** J. N. Kapur
5. Giordano, F. R., Weir, M. D., and Fox, W. P., A First Course in Mathematical Modeling, 5th Edition, Cengage Learning, 2014.

Reference Book(s):

1. J. N. Kapur, Mathematical Models in Biology and Medicine, EWP New Delhi, 1985.
2. An Introduction to Mathematical Modeling , **Author:** Edward A. Bender, Revised Dover Edition (2000)
3. Nonlinear Dynamics and Chaos, **Author:**Steven H. Strogatz, **Edition** 2nd Edition (2018)
4. Mathematical Models in Biology and Medicine , **Author** J. N. Kapur, **Edition** Reprint Edition
5. Elementary Differential Equations and Boundary Value Problems , William E. Boyce, Richard C. DiPrima, and Douglas B. Meade , 11th Edition (2017)

e Resources:

1. <https://link.springer.com>
2. <https://www.sciencedirect.com>
3. <https://books.google.com>
4. <https://openstax.org>
5. <https://www.jstor.org>

Relationship Matrix for COs, POs and PSOs

Semester	Course code			Title of the course								L	T	P	Credit
II	PMA26007			Mathematical Modelling								3	0	0	3
Course Outcome s (COs)	Programme Outcomes(POs)											Programme Specific Outcomes (PSOs)		Mean Score of COs	
	PO1	PO 2	PO 3	PO4	PO5	PO6	PO7	PO 8	P09	PO10	PO11	PSO1	PSO2		
CO1	3	2	1	1	2	2	2	1	2	1	0	3	2	2	
CO2	3	3	2	2	2	2	2	1	2	2	0	3	2	2	
CO3	3	3	3	2	3	2	2	1	2	2	0	3	3	2	
CO4	2	2	2	2	2	2	2	1	2	2	0	3	2	2	
CO5	2	3	2	3	3	2	2	2	2	2	0	3	3	2	
Mean Overall Score	3	3	2	2	2	2	2	1	2	2	0	3	2	2	

Sem	Course Code	Title of the Course	Course Category	L	T	P	Credits
II	PMA26008	Stochastic Processes	Disciplinary Elective Course -VIII	3	0	0	3
Pre-Requisite: Nil			Co- Requisite: Nil	Progressive Course: Nil			
Course Objectives:							
1.The Course aims to introduce a wide variety of stochastic processes and their applications.							
2. Understand the fundamental concepts of probability theory and stochastic processes including random variables and distributions.							
3.Analyze discrete and continuous-time stochastic processes such as Markov chains and Poisson processes.							
4. Apply Markov property and transition probability concepts to model real-world random systems.							
5. Evaluate long-term behavior of stochastic models including steady-state and limiting distributions.							
Course Outcomes:							
CO1: Define the basic concepts of random variables, stochastic processes, and Markov chains. (K1)							
CO2: Explain Poisson processes, birth–death processes, and their applications in discrete-state Markov processes. (K2)							
CO3: Apply continuous-state Markov processes, Wiener processes, and Kolmogorov equations to solve stochastic problems. (K3)							
CO4: Explain the properties and applications of branching processes using generating functions and continuous-time Markov models. (K2)							
CO5: Apply stochastic models to analyze queueing systems, Markovian models, and reliability problems. (K3)							
Unit-I							9 Hrs.
Random variables and stochastic processes: Generating functions - Stochastic processes: An Introduction - Markov chains: Definition and examples - Higher transition probabilities-Generalization of independent Bernoulli trials: sequence of chain - dependent trials-Classification of states and chains - Determination of higher transition probabilities.							
Unit-II							9 Hrs.
Markov process with discrete state space: Poisson process and its extensions - Poisson process - Poisson process and related distributions - Generalizations of Poisson process - Birth and death processes.							
Unit-III							9 Hrs.
Markov processes with continuous state space: Introduction - Brownian motion - Wiener process - Differential equations for a Wiener Process - Kolmogorov equations - First passage time distribution for Wiener process - Ornstein - Uhlenbeck process.							
Unit-IV							9 Hrs.
Branching Processes: Introduction – Properties of generating functions of Branching processes – Distribution of the total number of progeny – Continuous –Time Markov branching process.							
Unit-V							9 Hrs.
Applications in stochastic models: Queueing systems and models – Birth and death processes in queueing theory: Markovian models – Reliability Model.							

Text Book(s):

- 1.J. Medhi, Stochastic Processes, New Age International Private limited, New Delhi, 4th Edition, 2017.
2. Introduction to Probability Models, **Authors**, Sheldon M. Ross, **Edition** 15th Edition (2023), Academic Press (Elsevier).
3. Stochastic Processes, **Authors**, Samuel Karlin, Howard M. Taylor, 2nd Edition.
4. A First Course in Stochastic Processes, **Authors**, S. Karlin, H. M. Taylor, 3rd Edition.
5. Stochastic Processes, **Authors**, E. Parzen, 2nd Edition.

Reference Book(s):

- 1.K. Basu, Introduction to Stochastic Process, Narosa Publishing House, New Delhi, 2003
- 2.Goswami & B. V. Rao, A Course in Applied Stochastic Processes, Hindustan Book Agency, New Delhi, 2006.
- 3.G. Grimmett & D. Stirzaker, Probability and Random Processes, 3rd Ed., Oxford University Press, New York, 2001.
4. Stochastic Processes, **Authors**, J. Medhi, 2nd Edition.
5. Karlin, S. and Taylor, H. M., Stochastic Processes, 2nd Edition, Academic Press.

e Resources:

1. <https://nptel.ac.in/courses/111102014/>
2. <https://nptel.ac.in/courses/111103022/>
3. https://onlinecourses.nptel.ac.in/noc18_ma19
4. <https://link.springer.com>
5. <https://www.sciencedirect.com>

Relationship Matrix for COs, POs and PSOs

Semester	Course code			Title of the course								L	T	P	Credit
II	PMA26008			Stochastic Processes								3	0	0	3
Course Outcomes (COs)	Programme Outcomes(POs)											Programme Specific Outcomes (PSOs)		Mean Score of COs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2		
CO1	3	2	2	1	2	1	2	1	2	1	0	3	2	2	
CO2	3	3	2	2	2	1	2	1	2	2	0	3	3	2	
CO3	3	3	3	2	3	1	2	1	2	2	0	3	3	2	
CO4	2	2	3	2	2	1	2	1	2	2	0	3	3	1	
CO5	2	3	2	2	3	2	2	1	2	2	0	3	3	2	
Mean Overall Score	3	3	2	2	2	1	2	1	2	2	0	3	3	2	

Sem	Course Code	Title of the Course	Course Category	L	T	P	Credits
II	PMA26009	Probability and Statistics	Disciplinary Elective Course -IX	3	0	0	3
Pre-Requisite:Nil			Co- Requisite:Nil	Progressive Course:Nil			
Course Objectives:							
1. Understand the theoretical foundations of probability, random variables, and probability distributions.							
2. Compute expectations, variances, moments, and characteristic functions of random variables and interpret their statistical significance.							
3. Apply probability distributions and limit theorems in modeling and analyzing real-world random phenomena.							
4. Compare and apply different methods of parameter estimation and evaluate their properties.							
5. Construct and interpret confidence intervals for population parameters using appropriate statistical inference techniques.							
Course Outcomes:							
CO1: Define the basic concepts of random variables, probability distributions, and distribution functions. (K1)							
CO2: Explain the concepts of expectation, variance, moments, generating functions, and characteristic functions of random variables. (K2)							
CO3: Apply probability distributions and convergence theorems to solve statistical problems. (K3)							
CO4: Explain the principles and methods of parameter estimation, including maximum likelihood, least squares, moments, and Bayesian estimation. (K2)							
CO5: Apply interval estimation techniques to construct and interpret confidence intervals for population parameters. (K3)							
Unit-I							9 Hrs.
Random variables and its Distributions: Introduction-Random Variable Types of Random Variables-Probability Mass Function, Probability Density Function and Probability Distribution- Distribution Function-Functions of Random Variables and their Distributions.							
Unit-II							9 Hrs.
Moments of Random Variable : Introduction-Expected value of a random variable-Properties of expected value-Conditional Expectation-Variance and covariance of Random variables-Properties of variance-Conditional Variance-Theorems on Mean and Variance : Cauchy-Schwartz Inequality-Chebyshev's Inequality-Marko's Inequality-Moments of Random variable-Moment Generating function - Joint Moment Generating function- Characteristics of Moment Generating function- Properties of Moment Generating function Characteristic function- Properties of Characteristic function.							

Unit-III		9 Hrs.
Convergence in probability-Weak Law of Large number-Strong Law of Large Numbers-Central Limit Theorem-Binomial distribution: Definition and origin-First four moments of the Binomial distribution-Generating functions of the Binomial distribution- Applications of Binomial distribution-Poisson distribution: Definition and applications-First four moments of the Poisson distribution-Generating functions of the Poisson distribution-Fitting of Poisson distribution		
Unit-IV		9 Hrs.
Method of Estimation: Introduction-Maximum Likelihood (ML) Method Properties of ML Estimators-Method of Least Squares-Properties of Least squares Estimator-Method of Moment-Method of Minimum Chi-square Bayes method of Estimation.		
Unit-V		9 Hrs.
Interval Estimation: Introduction-Method of construction of Confidence Interval- Pivotal-Method to find Confidence Interval-Confidence interval using large sample-Statistical Method of Confidence Interval-Confidence interval using Chebyshev's Inequality-Uniformly most accurate (UMA) Confidence Interval-Unbiased Confidence Interval-Confidence interval for the difference of two Means-Confidence interval for the Difference of two proportions.		

Text Book(s):

1.K. C. Bhuyan, Probability Distribution Theory and Statistical Inference, New Central Book Agency Pvt. Ltd., London, 2015.

Reference Book(s):

1. Robert V. Hogg & Allen T. Craig, Introduction to Mathematical Statistics, 7th Edition, Pearson Education, Singapore, 2012.
2. Irwin Miller & Marylees Miller, John E. Freund's Mathematical Statistics, 8th Edition, Pearson Education, New Delhi, 2013.

e Resources:

1. https://onlinecourses.nptel.ac.in/noc18_ma19
2. https://onlinecourses.nptel.ac.in/noc18_ma22

Relationship Matrix for COs, POs and PSOs

Semester	Course code			Title of the course								L	T	P	Credit
II	PMA26009			Probability & Statistics								3	0	0	3
Course Outcomes (COs)	Programme Outcomes(POs)											Programme Specific Outcomes (PSOs)		Mean Score of COs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2		
CO1	3	2	2	1	2	1	2	1	2	1	0	3	3	2	
CO2	3	3	2	2	2	1	2	1	2	2	0	3	3	2	
CO3	3	3	3	2	3	1	2	1	2	2	0	3	3	2	
CO4	2	3	3	2	2	1	2	1	2	2	0	3	3	2	
CO5	2	3	2	2	3	2	2	1	2	2	0	3	3	3	
Mean Score	3	3	2	2	2	1	2	1	2	2	0	3	3	2	

Sem	Course Code	Title of the Course	Course Category	L	T	P	Credits
II	PMM26010	Mechanics	Disciplinary Elective Course -X	3	0	0	3
Pre-Requisite: Nil			Co- Requisite: Nil	Progressive Course: Nil			
Course Objectives:							
1.To understand the fundamental concepts of classical mechanics, particle dynamics, constraints, and Lagrangian formulation.							
2.To develop knowledge of Hamilton's principle, calculus of variations, and conservation laws in mechanical systems.							
3.To analyze the motion of two-body systems, central force fields, orbital dynamics, and Kepler's laws.							
4.To understand the rotational motion of rigid bodies, Euler angles, transformations, and Coriolis effects.							
5.To apply concepts of angular momentum, inertia tensors, principal axes, and Euler equations for solving rigid body problems.							
Course Outcomes:							
CO1: Understand the fundamental principles of particle and system mechanics, constraints, D'Alembert's principle, and Lagrangian formulation for solving mechanical problems. (K1)							
CO2: Explain the principles of Hamilton's theory, calculus of variations, conservation laws, and symmetry properties in analytical mechanics. (K2)							
CO3: Apply Lagrangian and Hamiltonian formulations to solve problems related to particle motion, central force fields, and orbital dynamics. (K3)							
CO4: Describe the concepts of rigid body motion, Euler angles, orthogonal transformations, and Coriolis effect. (K2)							
CO5: Apply the concepts of angular momentum, inertia tensor, principal axis transformation, and Euler equations to analyze rigid body problems. (K2)							
Unit-I	MECHANICS OF A PARTICLE						9Hrs.
Mechanics of a particle, Mechanics of a system of particles, Constraints, D'Alembert's principle and Lagrange's equations, Velocity dependent potentials and the dissipation function.							
Unit-II	HAMILTON'S PRINCIPLE						9Hrs.
Hamilton's principle, Some techniques of the calculus of variations, derivation of Lagrange's equation from Hamilton's principle, Extending Hamilton's principle to systems with constraints.							
Unit-III	REDUCTION TO THE EQUIVALENT ONE BODY PROBLEM						9 Hrs.
Reduction to the equivalent one body problem, the equations of motion and first integrals, the equivalent one dimensional problem and classification of orbits, the Virial theorem.							
Unit-IV	THE INDEPENDENT COORDINATES OF A RIGID BODY						9 Hrs.
The independent coordinates of a rigid body, orthogonal transformation, the Euler angles, the Cayley – Klein parameters and related quantities, Euler's theorem on the motion of a rigid body.							

Unit-V	ANGULAR MOMENTUM AND KINETIC ENERGY	9Hrs.
Angular momentum and kinetic energy of motion about a point, tensors, the inertial tensor and the moment of inertia, the eigen values of the inertial tensor and the principal axis transformation.		

Text Book(s):

1. Synge J.L and Griffith B.A, Principles of Mechanics, McGraw – Hill.
2. H. Goldstein, C. Poole and J. Safko, *Classical Mechanics*, 3rd Edition, Pearson Education.
3. D. T. Greenwood, Principles of Dynamics, Prentice Hall of India.

Reference Book(s):

1. N. C. Rana and P. S. Joag, Classical Mechanics, Tata McGraw-Hill.
2. L. D. Landau and E. M. Lifshitz, Mechanics, Volume I, Butterworth-Heinemann.
3. S. T. Thornton and J. B. Marion, Classical Dynamics of Particles and Systems, Cengage Learning.
4. J. C. Upadhyaya, Classical Mechanics, Himalaya Publishing House.

e Resources:

1. <https://ocw.mit.edu/courses/8-09-classical-mechanics-fall-2013/>
2. <https://nptel.ac.in/courses/115/103/115103115/>
3. https://www.feynmanlectures.caltech.edu/I_toc.html
4. https://phys.libretexts.org/Bookshelves/University_Physics
5. <http://hyperphysics.phy-astr.gsu.edu/hbase/hframe.html>

Relationship Matrix for COs, POs and PSOs

Semester	Course code			Title of the course								L	T	P	Credit
II	PMM26010			Mechanics								3	0	0	3
Course Outcomes (COs)	Programme Outcomes(POs)											Programme Specific Outcomes (PSOs)		Mean Score of COs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2		
CO1	3	2	2	1	-	-	-	-	-	-	-	3	2	2	
CO2	3	2	2	1	-	-	-	-	-	-	-	3	2	2	
CO3	3	3	3	2	1	-	-	-	-	-	-	3	3	2	
CO4	2	2	2	1	-	-	-	-	-	-	-	2	2	2	
CO5	2	3	2	2	-	-	-	-	-	-	-	3	3	2	
Mean Overall Score	3	3				0									
	3	2	2	1	0	0	0	0	0	0	0	3	2	2	

Sem	Course Code	Title of the Course	Course Category	L	T	P	Credits
II	PMM26011	Fractal Analysis	Disciplinary Elective Course -XI	3	0	0	3
Pre-Requisite: Nil			Co- Requisite: Nil	Progressive Course: Nil			
Course Objectives:							
1.Understand the fundamental concepts of fractals, self-similarity, and fractal geometry.							
2.Analyze the construction and properties of classical deterministic fractals.							
3.Apply iterated function systems and affine transformations to generate fractal structures.							
4.Develop mathematical models using fractal dimensions and measures for natural phenomena.							
5.Explore applications of fractal analysis in science, engineering, image processing, and computer graphics.							
Course Outcomes:							
CO1: Define the basic concepts of fractals, self-similarity, scaling, and fractal geometry. (K1)							
CO2: Explain the construction and properties of classical fractals and compute their fractal dimensions. (K2)							
CO3: Apply iterated function systems and affine transformations to generate deterministic fractals. (K3)							
CO4: Analyze Julia sets, Mandelbrot sets, and chaotic dynamical systems using fractal concepts. (K4)							
CO5: Evaluate the applications of fractal analysis in image processing, signal analysis, biological systems, and natural phenomena. (K5)							
Unit-I	INTRODUCTION TO FRACTAL GEOMETRY						9 Hrs.
History of Fractals – Self-Similarity – Scaling – Euclidean Geometry versus Fractal Geometry – Fractal Curves – Cantor Set – Koch Curve – Sierpinski Gasket – Menger Sponge – Properties of Fractals							
Unit-II	FRACTAL DIMENSION						9 Hrs.
Hausdorff Measure – Hausdorff Dimension – Similarity Dimension – Box Counting Dimension – Computation of Fractal Dimensions – Applications of Fractal Dimension – Dimension of Classical Fractals.							
Unit-III	ITERATED FUNCTION SYSTEMS						9 Hrs.
Affine Transformations – Contractive Mappings – Fixed Point Theorem – Iterated Function Systems (IFS) – Attractors – Barnsley Fern – Random Iteration Algorithm – Applications of IFS in Computer Graphics.							
Unit-IV	COMPLEX DYNAMICS AND FRACTALS						9 Hrs.
Complex Numbers and Iteration – Julia Sets – Filled Julia Sets – Mandelbrot Set – Escape Time Algorithm – Chaotic Dynamical Systems – Fractal Basin Boundaries – Applications.							
Unit-V	APPLICATIONS OF FRACTAL ANALYSIS						9 Hrs.
Fractals in Nature – Fractal Models in Biology – Fractal Analysis in Image Processing – Texture Analysis – Signal Processing – Computer Graphics – Medical Imaging – Engineering Applications – Environmental Modelling.							

Text Book(s):

1. Kenneth Falconer, Fractal Geometry: Mathematical Foundations and Applications, 3rd Edition, John Wiley & Sons, 2014.
2. Michael F. Barnsley, Fractals Everywhere, 2nd Edition, Academic Press, 1993.
3. Heinz-Otto Peigan, Hartmut Jürgens and Dietmar Saupe, Chaos and Fractals: New Frontiers of Science, 2nd Edition, Springer, 2004.
4. Benoit B. Mandelbrot, The Fractal Geometry of Nature, W. H. Freeman, 1983.
5. Yuval Fisher (Ed.), Fractal Image Compression: Theory and Application, Springer, 1995.

Reference Book(s):

1. Kenneth Falconer, Techniques in Fractal Geometry, John Wiley & Sons, 1997.
2. Edgar E. Peters, Fractal Market Analysis, John Wiley & Sons, 1994.
3. Heinz-Otto Peitgen and Peter H. Richter, The Beauty of Fractals, Springer, 1986.
4. John Briggs, Fractals: The Patterns of Chaos, Simon & Schuster, 1992.
5. H. Peitgen, D. Saupe, The Science of Fractal Images, Springer, 1988.

e Resources:

1. <https://link.springer.com>
2. <https://www.sciencedirect.com>
3. <https://books.google.com>
4. <https://nptel.ac.in>
5. <https://ocw.mit.edu>

Relationship Matrix for COs, POs and PSOs

Semester	Course code			Title of the course								L	T	P	Credit
II	PMM26011			FRACTAL ANALYSIS								3	0	0	3
Course Outcomes (COs)	Programme Outcomes(POs)											Programme Specific Outcomes (PSOs)		Mean Score of COs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2		
CO1	3	2	1	1	2	2	2	1	2	1	0	3	2	2	
CO2	3	3	2	2	2	2	2	1	2	2	0	3	2	2	
CO3	3	3	3	2	3	2	2	1	2	2	0	3	2	2	
CO4	2	2	2	2	2	2	2	1	2	2	0	3	2	2	
CO5	2	3	2	3	3	2	2	2	2	2	0	3	2	2	
Mean Overall Score	3	3	2	2	2	2	2	1	2	2	0	3	2	2	

Sem	Course Code	Title of the Course	Course Category	L	T	P	Credits
II	PMM26012	Finite Elements Method	Disciplinary Elective Course - XII	3	0	0	3
Pre-Requisite: Nil			Co- Requisite: Nil	Progressive Course: Nil			
Course Objectives:							
1.Understand the basic concepts and mathematical foundations of the finite element method.							
2.Develop finite element formulations for one-dimensional boundary value problems.							
3.Apply finite element techniques to solve two-dimensional engineering and mathematical problems.							
4.Analyze interpolation functions, element matrices, and numerical integration techniques.							
5.Explore applications of finite element methods in engineering, applied mathematics, and scientific computing.							
Course Outcomes:							
CO1: Define the basic concepts, terminology, and mathematical foundations of the finite element method. (K1)							
CO2: Explain interpolation functions, element equations, and assembly procedures for finite element analysis. (K2)							
CO3: Apply finite element formulations to solve one-dimensional boundary value problems. (K3)							
CO4: Analyze two-dimensional finite element models using triangular and rectangular elements. (K4)							
CO5: Evaluate finite element solutions for engineering and scientific applications using computational techniques. (K5)							
Unit-I	INTRODUCTION TO FINITE ELEMENT METHOD						9 Hrs.
Introduction – Historical Development – Basic Concepts – Advantages and Limitations – Steps in Finite Element Analysis – Discretization – Types of Elements – Nodes and Degrees of Freedom – Boundary Conditions – Variational Formulation – Rayleigh–Ritz Method.							
Unit-II	ONE-DIMENSIONAL FINITE ELEMENT ANALYSIS						9 Hrs.
Interpolation Functions – Shape Functions – Linear and Quadratic Elements – Element Stiffness Matrix – Load Vector – Assembly Procedure – Imposition of Boundary Conditions – Solution of One-Dimensional Boundary Value Problems – Error Estimation.							
Unit-III	TWO-DIMENSIONAL FINITE ELEMENTS						9 Hrs.
Triangular Elements – Rectangular Elements – Natural Coordinates – Isoparametric Elements – Shape Functions – Numerical Integration – Gaussian Quadrature – Two-Dimensional Heat Conduction Problems.							
Unit-IV	FINITE ELEMENT FORMULATION						9 Hrs.
Galerkin Method – Weighted Residual Method – Plane Stress and Plane Strain Problems – Finite Element Formulation for Elasticity – Eigenvalue Problems – Time Dependent Problems – Introduction to Dynamic Analysis.							
Unit-V	APPLICATIONS OF FINITE ELEMENT METHODS						9 Hrs.
Structural Analysis – Heat Transfer – Fluid Flow Problems – Electromagnetic Applications – Computational Mechanics – Biomedical Engineering – Finite Element Software (ANSYS, ABAQUS, COMSOL) – Recent Developments and Applications.							

Text Book(s):

1. Tirupathi R. Chandrupatla and Ashok D. Belegundu, Introduction to Finite Elements in Engineering, 5th Edition, Pearson, 2019.
2. J. N. Reddy, An Introduction to the Finite Element Method, 4th Edition, McGraw-Hill Education, 2019.
3. O. C. Zienkiewicz, R. L. Taylor and J. Z. Zhu, The Finite Element Method: Its Basis and Fundamentals, 7th Edition, Elsevier, 2013.
4. Daryl L. Logan, A First Course in the Finite Element Method, 6th Edition, Cengage Learning, 2016.
5. David V. Hutton, Fundamentals of Finite Element Analysis, McGraw-Hill, 2004

Reference Book(s):

- 1.K. J. Bathe, **Finite Element Procedures**, Prentice Hall, 1996.
- 2.G. R. Liu and S. S. Quek, **The Finite Element Method: A Practical Course**, 2nd Edition, Butterworth-Heinemann, 2014.
- 3.S. S. Rao, **The Finite Element Method in Engineering**, 6th Edition, Butterworth-Heinemann, 2018.
- 4.Thomas J. R. Hughes, **The Finite Element Method: Linear Static and Dynamic Finite Element Analysis**, Dover Publications, 2000.
- 5.C. S. Krishnamoorthy, **Finite Element Analysis: Theory and Programming**, Tata McGraw-Hill, 2007.

e Resources:

<https://nptel.ac.in>
<https://ocw.mit.edu>
<https://link.springer.com>
<https://www.sciencedirect.com>
<https://www.ansys.com/academic>

Relationship Matrix for COs, POs and PSOs

Semester	Course code			Title of the course								Hours		Credit
II	PMM26012			Finite Element Methods								3		3
Course Outcomes (COs)	Programme Outcomes(POs)											Programme Specific Outcomes (PSOs)		Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
CO1	3	1	-	-	1	-	-	-	-	-	1	2	-	2
CO2	3	2	1	1	2	-	-	-	-	-	1	3	2	2
CO3	3	3	2	1	2	-	-	-	-	-	1	3	2	2
CO4	3	3	2	2	3	-	-	-	-	-	1	3	3	2
CO5	3	3	3	2	3	1	1	-	1	1	2	3	3	2
Mean Overall Score	3	2	2	1	2	1	1	-	1	1	1	3	3	2

MULTI-DISCIPLINARY COURSE

Sem	Course Code	Title of the Course	Course Category	L	T	P	Credits
I	PMA26901	MATHEMATICAL FOUNDATION FOR COMPUTER APPLICATIONS	Multi-Disciplinary Course	3	0	0	3
Pre-Requisite: Nil			Co- Requisite: Nil	Progressive Course: Nil			
Course Objectives: <ol style="list-style-type: none"> To introduce the fundamental concepts and techniques of matrix algebra, including solving systems of linear equations and eigenvalue problems. To develop an understanding of basic set theory, set operations, Cartesian products, and their applications in discrete mathematics. To familiarize students with mathematical logic, logical connectives, truth tables, well-formed formulas, and tautologies for logical reasoning. To provide knowledge of formal languages, grammars, and the basic concepts of syntax analysis used in computing. To introduce the principles of graph theory, including graph representations, paths, connectedness, trees, and graph storage techniques for problem-solving. 							
Course Outcomes:							
CO1: Define the fundamental concepts of matrices, set theory, mathematical logic, formal languages, and graph theory (K1) .							
CO2: Explain the principles of matrix operations, set operations, logical connectives, grammars, and graph representations (K2) .							
CO3: Solve problems involving rank of matrices, systems of linear equations, eigenvalues, eigenvectors, matrix inverses, and the Cayley–Hamilton theorem (K3) .							
CO4: Apply concepts of set theory, mathematical logic, formal languages, and graph theory to analyze mathematical and computational problems (K3) .							
CO5: Construct truth tables, Cartesian products, grammars, and graph representations to model and solve discrete mathematical problems (K3) .							
Unit-I	Matrix Algebra:						9 Hrs.
Matrix Algebra: Matrices – Rank of a matrix – Solving system of equations – Eigenvalues and Eigenvectors – Cayley Hamilton theorem (Problems only).							
Unit-II	Basic Set Theory:						9 Hrs
Basic Set Theory: Notation – Inclusion and Equality of Sets – The Power Set – Some Operations on Sets – Venn Diagrams – Some Basic Set Identities – The Principle of Specification – Ordered Pairs and n – tuples – Cartesian Products.							

Unit-III	Mathematical Logic:	9 Hrs
Mathematical Logic: Statements and Notation – Connectives – Negation – Conjunction – Disjunction – Statement of Formulae and Truth Tables – Logical Capabilities of Programming Languages – Conditional and Biconditional – Well-formed Formulas – Tautologies.		
Unit-IV	Formal Languages:	9 Hrs .
Formal Languages: Discussion of Grammars – Formal Definition of a Language – Notions of Syntax Analysis.		
Unit-V	Graph Theory	9 Hrs
Graph Theory: Basic concepts of graph theory: Basic definitions -Paths, Reachability and Connectedness- Matrix Representation of graphs-Trees-Storage representation and manipulation of graphs.		

Text Book(s):

- 1.S.Arumugam , Isaac .A.T-Modern Algebra Scitech publications Pvt Ltd. Chennai.
- 2.J.P. Tremblay, R. Manohar, Discrete Mathematical Structures with Applications to Computer Science, McGraw-Hill, 2003.

Reference Book(s):

- 1.Discrete Mathematics - Johnson Baugh McGraw-Hill
- 2.Discrete Computational Structures - KorfhafeRr Academic Press
3. Graph theory and Applications – Narsingh Deo, Prentice Hall of India Private Ltd New Delhi 2003.
4. Discrete Mathematics and Its Applications – **Kenneth H. Rosen**
5. Mathematics for Computer Science by Eric Lehman, F. Thomson Leighton, and Albert R. Meyer

e Resources:

1. <https://courses.csail.mit.edu/6.042/spring18/mcs.pdf>
2. <https://ocw.mit.edu/courses/6-042j-mathematics-for-computer-science-spring-2015/>
3. <https://ocw.mit.edu/courses/6-042j-mathematics-for-computer-science-spring-2015/resources/open-textbooks/>
4. <https://ocw.mit.edu/courses/6-042j-mathematics-for-computer-science-spring-2015/download/>
5. <https://discrete.openmathbooks.org/dmoi3.html>

Relationship Matrix for COs, POs and PSOs

Semester	Course code			Title of the course								L	T	P	Credit
I	PMA26901			MATHEMATICAL FOUNDATION FOR COMPUTER APPLICATIONS								3	0	0	3
Course Outcomes (COs)	Programme Outcomes(POs)											Programme Specific Outcomes (PSOs)		Mean Score of COs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2		
CO1	3	1	-	-	-	-	-	-	-	-	1	2	-	1	
CO2	3	2	1	-	1	-	-	-	1	-	1	3	1	2	
CO3	3	3	2	1	2	-	-	-	-	1	1	3	2	2	
CO4	3	3	2	2	2	-	-	-	1	1	1	3	2	2	
CO5	3	3	2	2	2	-	-	1	1	1	1	3	2	2	
Mean Overall Score	3	2	1	1	1	0	0	0	0	0	1	3	1	2	

Sem	Course Code	Title of the Course	Course Category	L	T	P	Credits
I	PMA26902	Mathematics And Statistics	Multi-Disciplinary Course	3	0	0	3
Pre-Requisite: Nil			Co- Requisite: Nil	Progressive Course: Nil			
Course Objectives: <ol style="list-style-type: none"> To provide knowledge of the concepts of maxima, minima, concavity, convexity, and basic differentiation techniques. To develop an understanding of probability concepts, conditional probability, Bayes' theorem, random variables, and probability distributions. To introduce the measures of central tendency and dispersion for statistical data analysis. To familiarize students with correlation and regression techniques for analyzing relationships between variables. To enable students to understand and apply hypothesis testing techniques, including <i>t</i>-test, <i>F</i>-test, and chi-square test, for statistical decision-making. 							
Course Outcomes:							
CO1: Define the concepts of maxima, minima, concavity, convexity, points of inflection, and basic differentiation rules. (K1)							
CO2: Explain the concepts of probability, conditional probability, Bayes' theorem, random variables, and probability distributions. (K2)							
CO3: Apply the measures of central tendency and dispersion to analyze statistical data. (K3)							
CO4: Apply correlation and regression techniques to determine the relationship between variables. (K3)							
CO5: Apply hypothesis testing methods, including <i>t</i> -test, <i>F</i> -test, and chi-square test, to analyze statistical problems. (K3)							
Unit-I							9 Hrs.
Maxima and Minima: Finding Maxima and Minima - Concavity and Convexity – Points of Inflection Differentiation: X^n , e^x , $\log x$, $\sin x$, $\cos x$, $\tan x$, Product rule, quotient rule (Problems Only)							
Unit-II							9 Hrs.
Probability –Axioms of Probability -Conditional Probability-Addition and Multiplication Theorems of Probability- bayes theorem -Random variable-Binomial, Poisson and normal distribution.							
Unit-III							9 Hrs.
Measures of Central Tendency - Mean, Median, Mode, Geometric Mean and Harmonic Mean- Measures of Dispersion - Range, Quartile Deviation, Mean Deviation, Standard Deviation and co-efficient of variation							
Unit-IV							9 Hrs.
Simple Correlation - Karl Pearson's Co-efficient of Correlation and Spearman's Rank Correlation – Regression-lines of regression -Angle between two lines of regression-regression coefficient.							

Unit-V	9 Hrs.
Testing of Hypothesis: t-Test for single mean, t-test for difference mean– chi- square Test-Goodness of fit test, Independence of attributes.	

Text Book(s):

1. S. Narayanan and T.K. Manicavachagom Pillay, Calculus Volume I, S. Viswanathan (Printers & Publishers) Pvt Limited, Chennai.
2. Gupta S.C. and Kapoor V.K: Fundamentals of Mathematical Statistics – Sultan Chand & Sons.

Reference Book(s):

1. Business statistics, Bharat Jhunjhunwala – S. Chand.co.
2. Mathematics for Economics and finance – Martin Anthony and Normanbiggs – Low price Edition – Cambridge University press
3. Higher Engineering Mathematics – B. S. Grewal
4. Fundamentals of Mathematical Statistics – S. C. Gupta and V. K. Kapoor
5. Introduction to Probability and Statistics – Seymour Lipschutz

e Resources:

1. <https://www.khanacademy.org/math/statistics-probability>
2. <https://www.khanacademy.org/math/linear-algebra>
3. <https://web.stanford.edu/class/cs103/>
4. <https://tutorial.math.lamar.edu>
5. <https://mathworld.wolfram.com>

Relationship Matrix for COs, POs and PSOs

Semester	Course code	Title of the course										L	T	P	Credit
I	PMA26902	MATHEMATICES AND STATISTICS										3	0	0	3
Course Outcome s (COs)	Programme Outcomes(POs)											Programme Specific Outcomes (PSOs)		Mean Score of COs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2		
CO1	2	3	3	2	2	2	3	2	-	-	-	3	2	2	
CO2	2	1	2	3	2	2	3	2	-	-	-	3	2	2	
CO3	2	2	1	2	3	3	3	2	-	-	-	3	2	2	
CO4	1	2	2	2	2	3	2	3	-	-	-	3	3	2	
CO5	2	2	2	1	3	3	2	2	-	-	-	3	2	2	
Mean Score	2	2	2	2	2	3	3	2	-	-	-	3	2	2	

Sem	Course Code	Title of the Course	Course Category	L	T	P	Credits
I	PMA26903	MATHEMATICAL FOUNDATION FOR ARTIFICIAL INTELLIGENT	Multi-Disciplinary Course	3	0	0	3
Pre-Requisite: Nil			Co-Requisite: Nil	Progressive Course: Nil			
Course Objectives: <ol style="list-style-type: none"> 1.Understand the concepts of matrices, inverse matrices, rank, systems of equations, eigenvalues, eigenvectors, and the Cayley–Hamilton theorem. 2,Explain the fundamental concepts of sets, set operations, Cartesian products, relations, and properties of binary relations. 3.Describe statements, logical connectives, truth tables, conditional and biconditional statements, and tautologies in mathematical logic. 4.Understand the concepts of formal languages, grammars, syntax, and syntax analysis. 5.Explain the basic concepts of graph theory, including graphs, subgraphs, degrees, isomorphism, and independent sets. 							
Course Outcomes:							
CO1:Recall the fundamental concepts of matrices, inverse matrices, rank, systems of equations, eigenvalues, eigenvectors, and the Cayley–Hamilton theorem. (K1)							
CO2:Explain the concepts of sets, set operations, Cartesian products, relations, and the properties of binary relations. (K2)							
CO3:Apply the principles of mathematical logic, truth tables, conditional statements, biconditional statements, and tautologies to solve logical problems. (K3)							
CO4:Explain the concepts of formal languages, grammars, syntax, and syntax analysis. (K2)							
CO5:Apply the concepts of graph theory, including graphs, subgraphs, degrees, isomorphism, and independent sets, to analyze mathematical structures. (K3)							
Unit-I						9 Hrs.	
Matrix Algebra: Matrices – The Inverse of a Matrix-Rank of a matrix – Solving system of equations – Characteristic Equation and Cayley Hamilton Theorem- Eigenvalues and Eigenvectors.							
Unit-II						9 Hrs.	
Basic Set Theory: Notation – Inclusion and Equality of Sets – The Power Set – Some Operations on Sets – Venn Diagrams – Cartesian Products-Relations- Properties of Binary Relaion in a Set.							

Unit-III		9 Hrs.
Mathematical Logic: Statements and Notation – Connectives – Negation – Conjunction – Disjunction – Statement of Formulae and Truth Tables – Logical Capabilities of Programming Languages – Conditional and Biconditional – Well-formed Formulas – Tautologies.		
Unit-IV		9 Hrs.
Formal Languages: Discussion of Grammars – Formal Definition of a Language – Notions of Syntax Analysis.		
Unit-V		9 Hrs.
Graph Theory: Introduction -The Konigsberg Bridge Problem – Graphs and sub graphs – Definition and Examples – Degrees – Sub graphs – Isomorphism – Independent sets.		

Text Book(s):

- 1.J.P. Tremblay, R. Manohar, Discrete Mathematical Structures with Applications to Computer Science, McGraw-Hill, 2003
- 2.S. Arumugam, A. Thangapandi Isaac, Modern Algebra, Sci Tech Publications (India), Pvt, Ltd, Chennai,2019.
3. S. Arumugam and S. Ramachandran, Invitation to Graph Theory, Sci Tech Publications (India), Pvt, Ltd., Chennai, 2006.

Reference Book(s):

1. Discrete Mathematics - Johnson Baugh McGraw-Hill
2. Discrete Computational Structures - KorfhafeRr Academic Press
3. Graph theory and Applications – Narsingh Deo, Prentice Hall of India Private Ltd New Delhi 2003.
4. Discrete Mathematics and Its Applications – **Kenneth H. Rosen**
5. Mathematics for Computer Science by Eric Lehman, F. Thomson Leighton, and Albert R. Meyer

e Resources:

<https://courses.csail.mit.edu/6.042/spring18/mcs.pdf>
<https://ocw.mit.edu/courses/6-042j-mathematics-for-computer-science-spring-2015/>
<https://ocw.mit.edu/courses/6-042j-mathematics-for-computer-science-spring-2015/resources/open-textbooks/>
<https://ocw.mit.edu/courses/6-042j-mathematics-for-computer-science-spring-2015/download/https://discrete.openmathbooks.org/dmoi3.html>

Semester	Course code		Title of the course									L	T	P	Credit
II	PMA26903		MATHEMATICAL FOUNDATION FOR ARTIFICIAL INTELLIGENT									3	0	0	3
Course Outcomes (COs)	Programme Outcomes (POs)											Programme Specific Outcomes (PSOs)		Mean Score of COs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2		
CO1	3	1	-	-	1	-	-	-	1	-	1	3	1	2	
CO2	3	2	1	1	1	-	-	-	1	1	1	3	2	3	
CO3	3	3	2	1	2	-	1	1	1	1	2	3	3	3	
CO4	3	2	1	1	1	-	-	-	1	1	2	2	2	2	
CO5	3	1	2	2	1	-	-	1	1	1	2	3	3	3	
Mean Score	3	2	1	1	1	-	0	0	1	1	2	3	2	3	

Sem	Course Code	Title of the Course	Course Category	L	T	P	Credits
II	PMA26904	Fundamentals of Probability and Statistics	Multi-Disciplinary Course	3	0	0	3
Pre-Requisite: Nil			Co- Requisite: Nil	Progressive Course: Nil			
Course Objectives: <ol style="list-style-type: none"> 1. To provide a strong foundation in the principles of probability, including conditional probability, Bayes' theorem, and their applications in risk management and information security. 2. To develop an understanding of discrete and continuous random variables, joint, marginal, and conditional probability distributions, and their applications in probabilistic modeling. 3. To equip students with statistical techniques such as measures of central tendency, correlation, and regression models for business intelligence, predictive analysis, and data-driven decision-making. 4. To enable students to perform and interpret statistical hypothesis tests, including Student's <i>t</i>-test, <i>F</i>-test, and Chi-square test, for performance evaluation, comparative analysis, and quality testing 							
Course Outcomes:							
CO1: Explain the fundamental concepts of probability, including axioms, independent events, conditional probability, the Total Probability Theorem, and Bayes' theorem, and solve basic probability problems related to risk management in information security. (K2)							
CO2: Apply the concepts of discrete and continuous random variables, joint, marginal, and conditional probability distributions, and independent random variables to analyze probabilistic models. (K3)							
CO3: Analyze discrete and continuous probability distributions (Binomial, Poisson, Normal, Exponential, and Gamma) and apply them to insurance and financial decision-making problems. (K3)							
CO4: Interpret measures of central tendency, correlation, and regression techniques, including simple and multiple linear regression, Ridge Regression, Lasso Regression, multicollinearity, and rank correlation, for business intelligence and data analysis. (K3)							
CO5: Apply statistical hypothesis testing techniques such as Student's <i>t</i> -test, <i>F</i> -test, and Chi-square test to evaluate goodness of fit, independence of attributes, performance analysis, comparative analysis, and quality testing. (K3)							
Unit-I							9 Hrs.
Basics of Probability: Risk management in information security based on Probability-Definitions and axioms-independent events-conditional probability-Total Theorem-Bayes's Theorem-Problems.							
Unit-II							9 Hrs.
Random Variables: Two Dimensional Random Variables: Discrete and Continuous Random variables, Marginal Probability Distribution-Conditional Probability Distribution-Independent Random Variables.							

Unit-III		9 Hrs.
Probability Distributions: Insurance/Financial applications of probability distributions. Discrete: Binomial and Poisson. Continuous: Normal, Exponential and Gamma Distributions.		
Unit-IV		9 Hrs.
Correlation and Regression: Basic Statistics in business intelligence and planning, Measures of Central tendency- Correlation and Regression–simple and multiple linear Regression–multi co linearity-Ridge Regression-Lasso Regression-Rank correlation		
Unit-V		9 Hrs.
Small Sample Tests: Student t- test, F-test and Chi-square test for goodness of fit and independence of attributes. Application-Performance analysis-Comparative analysis–Quality testing.		
Text Book(s): 1. T.Veerarajan, “Probability, Statistics and Random Processes”, 3 rd Edition, Tata Mc Graw-Hill, New Delhi, 2017. 2. B.S.Grewal, “Higher Engineering Mathematics”, Khanna Publishers, 44 th Edition, 2017.		

Reference Book(s): 1. Erwin Kreyszig, “Advanced Engineering Mathematics”, 10 th Edition, John Wiley & Sons, 2017. 2. S.C.Gupta, V.K.Kapoor, “Fundamentals of Mathematical Statistics”, Sultan Chand & Sons, 11 th Revised Edition 2007. 3. P.G.Hoel, S.C.Port and C.J.Stone, “Introduction to Probability Theory”, Universal Book Stall, 2003 (Reprint).
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e Resources: 1. https://nptel.ac.in/courses/111106112 2. https://ocw.mit.edu/courses/18-05-introduction-to-probability-and-statistics-spring-2014/ 3. https://projects.iq.harvard.edu/stat110 4. https://www.khanacademy.org/math/statistics-probability 5. https://openstax.org/details/books/introductory-statistics

Relationship Matrix for COs, POs and PSOs

Semester	Course code			Title of the course								L	T	P	Credit
II	PMA26904			Fundamentals of Probability and Statistics								3	0	0	3
Course Outcomes (COs)	Programme Outcomes (POs)											Programme Specific Outcomes (PSOs)		Mean Score of COs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2		
CO1	3	3	2	1	1	-	-	-	-	-	-	3	2	2.	
CO2	3	3	3	2	1	-	-	-	-	-	-	3	2	2	
CO3	3	3	3	2	2	-	-	-	-	-	-	3	2	3	
CO4	3	3	3	3	2	1	-	-	-	-	-	3	2	3	
CO5	3	3	3	3	2	1	-	-	-	-	-	3	3	3	
Mean Score	3	3	3	2	2	1	-	-	-	-	-	3	2	3	

Sem	Course Code	Title of the Course	Course Category	L	T	P	Credits
II	PMA26905	Operation Research	Multi Disciplinary Course	3	0	0	3
Pre-Requisite: Nil			Co- Requisite: Nil	Progressive Course: Nil			
Course Objectives: <ol style="list-style-type: none"> To provide knowledge of the fundamental concepts, scope, applications, and techniques of Operations Research and Linear Programming. To develop the ability to solve transportation and assignment problems using appropriate optimization methods. To introduce network scheduling techniques such as PERT and CPM for project planning and management. To familiarize students with inventory control models and decision-making under risk and uncertainty. To enable students to understand and apply game theory concepts and strategies for solving competitive decision-making problems. 							
Course Outcomes:							
CO1: Define the concepts, scope, applications, and limitations of Operations Research and formulate linear programming problems. (K1)							
CO2: Explain the methods for solving transportation and assignment problems, including the travelling salesman assignment problem. (K2)							
CO3: Apply PERT and CPM techniques to construct project networks and determine the critical path and floats. (K3)							
CO4: Apply inventory control models and decision-making criteria under risk and uncertainty to solve operational problems. (K3)							
CO5: Apply the principles of game theory, dominance, and graphical methods to determine optimal strategies. (K3)							
Unit-I	Introduction to Operations Research						9 Hrs.
Introduction to Operations Research, scope, phases– Decision making -Applications of OR- merits and demerits- limitations Linear Programming Problem: Formulation and Graphical Solution Method-canonical and standard forms of L.P.P.							
Unit-II	Transportation problem						9 Hrs.
Transportation problem: North West corner rule-Least cost Method- Vogel’s approximation method; Assignment problem-Maximation Assignment problem- Traveling salesman Assignment Problem .							
Unit-III	Network Scheduling by PERT/CPM						9 Hrs.
Network analysis – drawing of Arrow diagram – critical path method – calculation of critical path duration, total, free and independent floats, PERT problems							

Unit-IV	Inventory Control	9 Hrs.
Inventory Theory, Deterministic models – purchase problem without and with shortages, with price breaks, production problem without shortages. Decision under risk – expected money value criterion – decision trees – decision under uncertainty – minimax criterion		
Unit-V	Games and Strategies	9 Hrs.
Theory of Games – pure and mixed Strategies, Principles of dominance, graphical methods.		

Text Book(s):

1. Kantiswarup, P.K. Gupta , Manmohan- Sultan Chand & Sons – Educational Publishers, New Delhi.

Reference Book(s):

1. Operations Research principles and Applications – G. Srinivasan – PHI learning.
2. Introduction to operations Research – Billy E. Gillett – TATA Mcgraw hill.
3. Introduction to Operations Research – Frederick S. Hillier & Gerald J. Lieberman
4. Operations Research – S.D. Sharma
5. Principles of Operations Research – Harvey M. Wagner

e Resources:

1. <https://eresources.loc.gov/>
2. <https://eresources.nlb.gov.sg/>
3. <https://www.library.gov.au/research/guides-and-resources/start-researching/access-eresources>
4. <https://eresources.com/>
5. <https://bl.libguides.com/free-eresources/by-title-A-Z>

Relationship Matrix for COs, POs and PSOs

Semester	Course code			Title of the course								L	T	P	Credit
II	PMA26905			Operation Research								3	0	0	3
Course Outcomes (COs)	Programme Outcomes(POs)											Programme Specific Outcomes (PSOs)		Mean Score of COs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2		
CO1	3	2	2	1	-	-	-	-	-	-	-	3	2	2	
CO2	3	3	2	2	1	-	-	-	-	-	-	3	2	2	
CO3	2	3	3	2	2	1	-	-	-	-	-	3	3	2	
CO4	3	2	3	3	2	2	1	-	-	-	-	3	2	2	
CO5	3	3	2	2	3	2	1	1	-	-	-	3	3	2	
Mean Score	3	3	2	2	2	2	1	1	-	-	-	3	2	2	

Sem	Course Code	Title of the Course	Course Category	L	T	P	Credits
II	PMA26906	Mathematical foundation for computer science	Multi-Disciplinary Course	3	0	0	3
Pre-Requisite: Nil			Co-Requisite: Nil	Progressive Course: Nil			
Course Objectives:							
6. To introduce the fundamental concepts of set theory, relations, and their applications in mathematics.							
7. To develop the knowledge of matrix algebra, eigenvalues, eigenvectors, and methods for solving systems of linear equations.							
8. To explain the basic concepts of graph theory, graph representations, and their applications in solving real-world problems.							
9. To provide an understanding of statistical measures of central tendency and dispersion for data analysis.							
10. To familiarize students with numerical methods for solving algebraic equations and systems of linear equations using iterative and direct techniques.							
Course Outcomes:							
CO1: Define the fundamental concepts of set theory, set operations, relations, Cartesian products, and properties of binary relations. (K1)							
CO2: Explain the principles of matrix algebra, inverse and rank of matrices, characteristic equation, Cayley–Hamilton theorem, eigenvalues, and eigenvectors. (K2)							
CO3: Apply the concepts of graph theory, graph representations, paths, circuits, connected graphs, and planar graphs to solve mathematical problems. (K3)							
CO4: Apply the measures of central tendency and dispersion to analyze and interpret statistical data. (K3)							
CO5: Apply numerical methods to solve algebraic equations and systems of linear							
Unit-I	SETTHEORY						9 Hrs.
Basic Set Theory: Notation – Inclusion and Equality of Sets – The Power Set – Some Operations on Sets – Venn Diagrams – Cartesian Products-Relations- Properties of Binary Relaion in a Set.							
Unit-II	MATRICES						9 Hrs.
Matrix Algebra: Matrices – The Inverse of a Matrix-Rank of a matrix – Solving system of equations – Characteristic Equation and Cayley Hamilton Theorem- Eigenvalues and Eigenvectors							
Unit-III	GRAPH THEORY						9 Hrs.
Graph Theory: Basic concepts of graph theory: Basic definitions -Paths, Reachability and Connectedness-Matrix Representation of graphs-Trees-Storage representation and manipulation of graphs.							
Unit-IV	STATISTICS						9 Hrs.
Measure of Central Tendency (Arithmetic Mean, Median, Mode); Measure of Dispersion (Range, Quartile Deviation, Mean Deviation, Standard Deviation and Coefficient of Variation)							

Unit-V	NUMERICALMETHODS	9 Hrs.
Basics – Errors- Significant Digits – Solving Simultaneous Linear Equations – Bisection Method -Regula Falsi Method – Newton Raphson Method – Gauss Elimination Method – Gauss Jordan Method – Jacobi Iteration Method – Gauss Seidal Method		

Text Book(s):

1. J.P.Trembley, R. Manohar, “Discrete Mathematical structures with applications to Computer Science”, Tata McGrawHill publications, 2017.
2. M.K.Jain, S.R.K.Iyengar&R.K.Jain, “Numerical Methods Revised Second Edition”, New age international Pvt Ltd Publishers Newdelhi

Reference Book(s):

1. S.Santha, “Discrete Mathematics with Combinatory and Graph Theory”, Third Edition, Cengage Publications, 2015.
2. S.Arumugam,A. Thangapandi Isaac, "Statistics", New Gamma Publishing House, 2018.
- 3.S.C. Gupta,“Fundamentals of Statistics”, Himalaya Publishing House

e Resources:

<https://nptel.ac.in/courses/106106183>
<https://nptel.ac.in/courses/106106094>
<https://ocw.mit.edu/courses/6-042j-mathematics-for-computer-science-spring-2015>
<https://www.geeksforgeeks.org/discrete-mathematics-tutorial>

Relationship Matrix for COs, POs and PSOs

Semester	Course code			Title of the course								L	T	P	Credit
II	PMA26906			Mathematical foundation for Computer Science								3	0	0	3
Course Outcome s (COs)	Programme Outcomes (POs)											Programme Specific Outcomes (PSOs)		Mean Score of COs	
	PO1	PO2	PO ₃	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2		
CO1	3	2	1	1	2	-	-	-	1	-	1	3	1	1	
CO2	3	3	2	2	2	-	-	-	1	-	1	3	2	1	
CO3	3	3	3	2	2	-	-	1	1	1	2	3	2	2	
CO4	2	3	3	2	3	1	-	1	2	1	2	2	3	2	
CO5	3	3	3	2	3	-	-	1	1	2	2	3	3	2	
Mean Score	3	3	2	2	2	0	0	1	1	1	1	2	3	2	

Sem	Course Code	Title of the Course	Course Category	L	T	P	Credits
II	PMA26907	Statistical Computing	Multi-Disciplinary Course	3	0	0	3
Pre-Requisite: Nil			Co- Requisite: Nil	Progressive Course: Nil			
Course Objectives <ol style="list-style-type: none"> Understand the fundamental concepts of probability, including axioms, conditional probability, independence of events, and Bayes' theorem, and apply them to risk management problems. Analyze discrete and continuous random variables, joint probability distributions, marginal distributions, and conditional distributions for real-world applications. Interpret statistical relationships using correlation and regression techniques, including multiple linear regression, ridge regression, lasso regression, and rank correlation for data-driven decision-making. Perform statistical hypothesis testing using Student's t-test, F-test, and Chi-square test to analyze data, evaluate quality, compare performance, and support business and research decisions. 							
Course Outcomes CO1: Explain the fundamental concepts of probability, axioms, conditional probability, independent events, total probability theorem, and Bayes' theorem for risk management in information security. (K2)							
CO2: Apply the concepts of discrete and continuous random variables, marginal and conditional probability distributions, and independence of random variables to solve real-world problems. (K3)							
CO3: Analyze discrete and continuous probability distributions (Binomial, Poisson, Normal, Exponential, and Gamma) and apply them to insurance and financial applications. (K3)							
CO4: Interpret statistical measures, correlation techniques, and regression models (simple, multiple linear, Ridge, Lasso, and rank correlation) for business intelligence and decision-making. (K3)							
CO5: Apply small sample hypothesis testing techniques (Student's t-test, F-test, and Chi-square test) to perform performance analysis, comparative analysis, and quality testing in practical scenarios. (K3)							
Unit-I	Basics of Probability						9 Hrs.
Basics of Probability: Risk management in information security based on Probability-Definitions and axioms-independent events-conditional probability-Total Theorem-Bayes's theorem-Problems.							
Unit-II	Random Variables						9 Hrs.
Random Variables: Two Dimensional Random Variables: Discrete and Continuous Random variables, Marginal Probability Distribution-Conditional Probability Distribution-Independent Random Variables.							
Unit-III	Probability Distributions						9 Hrs.
Probability Distributions: Insurance/Financial applications of probability distributions. Discrete: Binomial and Poisson. Continuous: Normal, Exponential and Gamma Distributions.							
Unit-IV	Correlation and Regression						9 Hrs.
Correlation and Regression: Basic Statistics in business intelligence and planning, Measures of Central tendency-Correlation and Regression-simple and multiple linear Regression-multi co linearity-Ridge Regression-Lasso Regression-Rank correlation							
Unit-V	Small Sample Tests						9 Hrs.
Small Sample Tests: Student t- test, F-test and Chi-square test for goodness of fit and independence of attributes. Application-Performance analysis-Comparative analysis-Quality testing.							

Text Book(s):

1. T.Veerarajan, “Probability, Statistics and Random Processes”, 3rd Edition, Tata Mc Graw-Hill, New Delhi, 2017.

2. B.S.Grewal, “Higher Engineering Mathematics”, Khanna Publishers, 44th Edition, 2017.

Reference Book(s):

1. Erwin Kreyszig, “Advanced Engineering Mathematics”, 10th Edition, John Wiley & Sons, 2017.

2. S.C.Gupta, V.K.Kapoor, “Fundamentals of Mathematical Statistics”, Sultan Chand & Sons, 11th Revised Edition 2007.

3. P.G.Hoel, S.C.Port and C.J.Stone, “Introduction to Probability Theory,” Universal Book Stall, 2003 (Reprint).

e Resources:

1. <https://nptel.ac.in/courses/111106112>

2. <https://ocw.mit.edu/courses/18-05-introduction-to-probability-and-statistics-spring-2014/>

3. <https://projects.iq.harvard.edu/stat110>

4. <https://www.khanacademy.org/math/statistics-probability>

5. <https://openstax.org/details/books/introductory-statistics>

Relationship Matrix for COs, POs and PSOs

Semester	Course code		Title of the course									L	T	P	Credit
II	PMA26907		Statistical Computing									3	0	0	3
Course Outcomes (COs)	Programme Outcomes(POs)											Programme Specific Outcomes (PSOs)		Mean Score of COs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2		
CO1	3	3	2	1	1	-	-	-	-	-	-	3	2	2.	
CO2	3	3	3	2	1	-	-	-	-	-	-	3	2	2	
CO3	3	3	3	2	2	-	-	-	-	-	-	3	2	3	
CO4	3	3	3	3	2	1	-	-	-	-	-	3	2	3	
CO5	3	3	3	3	2	1	-	-	-	-	-	3	3	3	
Mean Score	3	3	3	2	2	1	-	-	-	-	-	3	2	3	

Sem	Course Code	Title of the Course	Course Category	L	T	P	Credits
II	PMA26908	Quantitative Techniques for Decision Making	Multi-Disciplinary Course	3	0	0	3
Pre-Requisite: Nil			Co- Requisite: Nil		Progressive Course: Nil		
Course Objectives							
1. To understand the basic concepts of probability and probability distributions.							
2. To learn the methods of correlation and regression for analyzing data.							
3. To apply statistical tests for testing hypotheses and analyzing sample data.							
4. To understand the principles of linear programming and solve optimization problems.							
5. To learn transportation and assignment techniques for efficient decision-making.							
Course Outcomes:							
CO1: Describe the fundamental concepts of probability, conditional probability, Bayes' theorem, and probability distributions (Binomial, Poisson, and Normal). (K1)							
CO2: Explain the concepts of correlation, rank correlation, regression, and regression coefficients for analyzing relationships between variables. (K2)							
CO3: Apply appropriate statistical tests such as <i>t</i> -test, Chi-square test, and Analysis of Variance (ANOVA) to analyze sample data and draw conclusions. (K3)							
CO4: Apply graphical and simplex methods to solve linear programming problems. (K3)							
CO5: Apply transportation and assignment techniques to obtain optimal solutions for allocation problems. (K3)							
Unit-I							9 Hrs.
Probability: Basic Definitions – Scopes – Limitations – Theorems of probability – Addition Theorem – Multiplicative Theorem - Conditional Probability – Bayes Theorem – Binomial Distribution – Poisson Distribution – Normal Distribution.							
Unit-II							9 Hrs.
Correlation – Basic Definitions& Simple problems – Karl's person coefficient – Limit of correlation coefficient – Rank Correlation – Repeated Rank Correlation – Regression – Line Regression – Angle between two lines of regression – Regression coefficient.							
Unit-III							9 Hrs.
Significance Tests in Small Samples (t - test) – Testing the significance of the mean of a random sample – Testing difference between means of two samples (Independent and Dependent Samples) – Chi-square test- Analysis of Variance (One way and two-way classification).							
Unit-IV							9 Hrs.
Linear Programming: Introduction – Basic Definitions – Simple problems – Formulation of Problem - Graphical Method – Simplex Method: Algorithm and problems.							

Unit-V		9 Hrs.
Transportation Problem –Initial Basic Feasible Solution - North West Corner Method – Least Cost Method – Vogel’s Approximation Method – Assignment Problems		

Text Book(s):

1. Gupta, S.C. and Kapoor, V.K.Fundamentals of Mathematical Statistics, 12th Revised Edition, Sultan Chand & Sons, New Delhi.
2. Kanti Swarup, P.K. Gupta and Man Mohan, Operation Research, Sultan Chand & Sons, Latest Edition, Educational Publishers, New Delhi.

Reference Book(s):

1. S. P. GuptaStatistical Methods, Sultan Chand & Sons, Latest Edition.
2. Richard I. Levin, David S. Rubin, Siddhartha Rastogi Statistics for Management, 8th Edition, Pearson Education.
3. Ronald E. Walpole, Raymond Myers, Sharon Myers and Keying Ye. Probability and Statistics for Engineers and Scientists, Pearson Education.
4. J.K. Sharma Operations Research: Theory and Applications, 7th Edition, Macmillan India Ltd.
5. Hamdy A. Taha, Operations Research: An Introduction, 10th Edition, Pearson.

e Resources:

1. <https://nptel.ac.in/courses>
2. <https://ocw.mit.edu>
3. <https://www.khanacademy.org/math/statistics-probability>
4. <https://www.edx.org>
5. <https://ndl.iitkgp.ac.in>

Relationship Matrix for COs, POs and PSOs

Semester	Course code				Title of the course							L	T	P	Credit
II	PMA26908				Quantitative Techniques for Decision Making							3	0	0	3
Course Outcomes (COs)	Programme Outcomes (POs)											Programme Specific Outcomes (PSOs)		Mean Score of COs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2		
CO1	3	2	1	0	1	0	0	0	1	0	2	3	2	1	
CO2	3	3	2	1	2	0	0	0	1	0	2	3	3	2	
CO3	3	3	3	1	2	0	0	0	1	1	2	3	3	2	
CO4	3	3	2	2	2	0	0	0	1	2	2	3	3	2	
CO5	3	3	2	2	2	0	0	1	1	2	3	3	3	2	
Mean Score	3	3	2	1	2	0	0	0	1	1	2	3	3	2	

Sem	Course Code	Title of the Course	Course Category	L	T	P	Credits
II	PMA26909	Statistical Methods for Biological Data Analysis	Multi-Disciplinary Course	3	0	0	3
Pre-Requisite: Nil			Co- Requisite: Nil	Progressive Course: Nil			
Course Objectives:							
1. Explain the concepts of functions, matrices, determinants, and simultaneous linear equations, and apply them to biological problems.							
2. Describe the methods of collecting, presenting, and analyzing data using measures of central tendency and dispersion.							
3. Understand the basic concepts of probability, conditional probability, Bayes' theorem, and probability distributions.							
4. Analyze the relationship between variables using correlation and regression techniques for biological data.							
5. Explain population growth models and epidemiological models, and apply differential equations to biological applications.							
Course Outcomes:							
CO1: Define the concepts of exponential and logarithmic functions, matrices, determinants, and simultaneous linear equations, and explain their applications in biological sciences. (K1)							
CO2: Explain the methods of data collection, presentation, measures of central tendency, and measures of dispersion for statistical analysis. (K2)							
CO3: Apply the principles of probability, conditional probability, Bayes' theorem, and probability distributions to solve biological and statistical problems. (K3)							
CO4: Apply correlation and regression techniques to analyze relationships between biological variables and interpret statistical data. (K3)							
CO5: Apply population growth models, epidemiological models, and differential equations to model and analyze biological systems. (K3)							
Unit-I							9 Hrs.
Functions and Matrices – Exponential and Logarithmic Functions – Matrices and Determinants – Simultaneous Linear Equations – Applications in Biological Sciences.							
Unit-II							9 Hrs.
Collection and Presentation of Data – Measures of Central Tendency: Mean, Median, Mode, Geometric Mean, Harmonic Mean – Measures of Dispersion: Range, Standard deviation, Quartile deviation, Mean deviation, Co-efficient of variations.							
Unit-III							9 Hrs.
Basic Probability Concepts – Addition Theorem – Multiplicative Theorem – Conditional Probability – Bayes' Theorem – Binomial Distribution – Poisson Distribution – Normal Distribution							

Unit-IV		9 Hrs.
Scatter Diagram – Karl Pearson's Correlation Coefficient – Rank Correlation – Linear Regression – Regression Lines – Biological Applications and Data Analysis.		
Unit-V		9 Hrs.
Population Growth Models – Exponential Growth Model – Logistic Growth Model – Introduction to Epidemiological Models – Applications of Differential Equations		
Text Book(s):		
<ol style="list-style-type: none"> 1. Gupta, S.C. and Kapoor, V.K. Fundamentals of Mathematical Statistics, 12th Revised Edition, Sultan Chand & Sons, New Delhi. 2. J.N. Kapur, Mathematical Modeling, Wiley Eastern Limited, New Delhi, 1988. 		

Reference Book(s):

6. Wayne W. Daniel and Chad L. Cross, Biostatistics: A Foundation for Analysis in the Health Sciences, 11th Edition, Wiley.
7. MedhiJ, Statistical Methods: An Introductory Text, New Age International Publishers.
8. Norman T. J. Bailey, The Mathematical Theory of Infectious Diseases and Its Applications, Charles Griffin & Company.
9. F. Monahan, Numerical Methods of Statistics, Cambridge University Press.
10. James D. Murray, Mathematical Biology I: An Introduction, 3rd Edition, Springer.

e Resources:

1. <https://nptel.ac.in/courses>
2. <https://openstax.org/details/books/introductory-statistics>
3. <https://stats.libretexts.org>
4. <https://www.khanacademy.org/math/statistics-probability>
5. <https://www.cdc.gov/training>

Relationship Matrix for COs, POs and PSOs

Semester	Course code				Title of the course							L	T	P	Credit
II	PMA26909				Statistical Methods for Biological Data Analysis							3	0	0	3
Course Outcomes (COs)	Programme Outcomes (POs)											Programme Specific Outcomes (PSOs)		Mean Score of COs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2		
CO1	3	2	-	-	1	=	-	-	-	-	1	3	1	2	
CO2	3	2	2	-	2	-	-	-	1	-	1	2	3	2	
CO3	2	3	3	1	2	-	-	-	1	1	1	2	3	2	
CO4	2	3	3	2	3	-	-	1	2	1	1	2	3	2	
CO5	3	3	3	2	2	3	1	-	1	1	2	3	2	2	
Mean Score	3	3	3	2	2	3	1	1	1	1	1	2	2	2	