Sadakathullah Appa College

(Autonomous)

.Reaccredited by NAAC at an A^{++} Grade with a CGPA of 3.56/4.0 in the IV Cycle

.An ISO 9001:2015 Certified Institution

Rahmath Nagar, Tirunelveli- 11.

Tamil Nadu.

DEPARTMENT OF MATHEMATICS

CBCS SYLLABUS

For

M. Sc. MATHEMATICS

(Applicable for students admitted in June 2024 and onwards)

(As per the Resolution of the Academic Council Meetings held on 01.06.2024)

CONTENTS

Sadakathullah Appa College, Rahmath Nagar, Tirunelveli – 627 011.
Programme Structure & Credits – PG (Mathematics) – 2024-2027

Sem	Course Type	Title of the Course	Course Code	H/W	C	Marks		
						I	E	T
I	Core-I	Algebraic structures	24PCMA11	6	5	40	60	100
	Core-II	Real Analysis –I	24PCMA12	6	5	40	60	100
	Core-III	Ordinary Differential Equations	24PCMA13	6	4	40	60	100
	Core-IV	Mathematical Programming	24PCMA14	4	3	40	60	100
	Core – I P	Mathematical Programming Practical Using Python	24PCMA1P1	2	1	20	30	50
	EC – I	Graph Theory and Applications	24PEMA11A	4	3	40	60	100
		Number Theory and Cryptography	24PEMA11B					
		Formal Languages and Automata Theory	24PEMA11C					
	EC-II (IDC-I)	Discrete Structure – I	24PIMA11	2	2	15	35	50
		SOP		-	-			
				30	**23**			**600**
II	Core-V	Advanced Algebra	24PCMA21	6	5	40	60	100
	Core-VI	Real Analysis – II	24PCMA22	6	5	40	60	100
	Core-VII	Partial Differential Equations	24PCMA23	5	4	40	60	100
	EC-III	Statistical Data Analysis Using R-Programming	24PEMA21A	4	3	40	60	100
		Neural Networks	24PEMA21B					
		Mathematical Statistics	24PEMA21C					
	EC-IV (IDC-II)	Discrete Structure – II	24PIMA21	2	2	15	35	50
	SEC – I	Statistics using R- Programming Practical	24PSMA2P1	4	2	40	60	100
	SEC – II	NPTEL-SWAYAM Online Certification Course (or) Naan Muthalvan : Professional Competency Course	24PSMA22	2	2	-	-	50
		Library Hour		1	-			
		SOP		-	1			100
	Summer – Internship Industry Training during the 1st year vacation - credits be given in the third semester mark statement							
				30	**23 +1**			**700**

Department of PG & Research Department of Mathematics
Programme: M.Sc.,
Programme Outcomes

PO	Upon completion of M.Sc. Degree Programmes, the graduates will be able to:
PO 1	**Disciplinary Knowledge** • Acquire in-depth scientific knowledge in the core areas of study.
PO 2	**Creative Thinking and Practical Skills / Problem Solving Skills** • Enrich skills of observation to draw logical inferences from scientific experiments /programming and skills of creative thinking to develop novel ideas. • Hone problem solving skills in theoretical, experimental and computational areas and to apply them in real life situations.
PO 3	**Sense of inquiry and Skilled Communicator / Research, Innovation and Entrepreneurship** • Develop the capability for raising appropriate questions relating to the current/emerging issues encountered in the scientific field and to plan, execute and express the results of experiments / investigations through technical writings as well as through oral presentations. • Design innovations for exploring the unexplored areas in diverse fields to accomplish socially relevant and economically beneficial innovative research projects. • Become a skilled entrepreneur for launching start-up / business ventures to improve the economy of the nation.
PO 4	**Ethical Awareness / Team Work / Environmental Conservation and Sustainability** • Equip them for conducting work as an individual / as a member, or as a leader in diverse teams upholding values such as honesty and precision, and thus preventing unethical behaviours such as fabrication, falsification, misrepresentation of data, plagiarism etc. to ensure academic integrity. • Realise that environment and humans are dependent on one another and to know about the responsible management of our ecosystem for survival, and for the well-being of the future generation as well.
PO 5	**Digital Literacy/Self-Directed Learning/Usage of ICT/Lifelong Learning** • Get access to digital resources, to use them judiciously for updation of knowledge and also to engage in remote/ independent learning. • Inculcate the habit of learning continuously through the effective adoption of ICT to update knowledge in the emerging areas in Sciences for inventions/discoveries so that the knowledge transferred from laboratory to land would yield fruitful results for the betterment of global society.

Programme Specific Outcomes (PSO)

PSO	Upon Completion of M.Sc Physics Degree Programme, the Graduates will be able to:	POs Mapped
PSO-1	Acquire good knowledge and understanding, to solve specific theoretical & applied problems in different area of mathematics & statistics.	1,2
PSO-2	Understand, formulate, develop mathematical arguments, logically and use quantitative models to address issues arising in social sciences, business and other context /fields.	1,2,3,4
PSO-3	To prepare the students who will demonstrate respectful engagement with other's ideas, behaviors, beliefs and apply diverse frames of references to decisions and actions.	2,3,4
PSO-4	Motivate themselves towards research studies in Mathematics	1,2,3,4,5
PSO-5	Enhance their career prospects in a huge array of fields by recognizing the need for engaging in lifelong learning through continuing education and research.	1,2,3,4,5

Semester - I	Algebraic Structures		24PCMA11			
Core – I			L	T	P	C
Hrs./Week: 6	Hrs./Semester : 90	Marks :100	4	2	-	5

General Objective:

To introduce the concepts and to develop working knowledge on class equation, solvability of groups, finite abelian groups, linear transformations, real quadratic forms.

Learning Objective:

LO	The learners will be able to:
LO-1	Understand the class equation of the group and the converse of Lagrange's theorem.
LO-2	Define Solvable groups, define direct products and examine the properties of finite Abelian groups.
LO-3	Explain the linear transformation and properties of nilpotent transformation
LO-4	Define Jordan, canonical form, Jordan blocks and rational canonical form
LO-5	Analyze the properties of Hermitian, unitary and normal transformations.

Unit I: Counting Principle - Class equation for finite groups and its applications - Sylow's theorems (For theorem 2.12.1, First proof only).
Unit II: Solvable groups - Direct products - Finite abelian groups- Modules.
Unit III: Linear Transformations: Canonical forms –Triangular form - Nilpotent transformations.
Unit IV: Jordan form - rational canonical form
Unit V : Trace and transpose - Hermitian, unitary, normal transformations, real quadratic form.

Text book:

I.N. Herstein, Topics in Algebra, Wiley India (P.) Ltd, 2nd Edition, 2013.

Unit I : Chapter 2: Sections 2.5, 2.11 and 2.12 (Omit Lemma 2.12.5)

Unit II: Chapter 5 : Section 5.7 (Lemma 5.7.1, Lemma 5.7.2, Theorem 5.7.1)

Chapter 2: Section 2.13 and 2.14 (Theorem 2.14.1 only)

Chapter 4: Section 4.5

Unit III: Chapter 6: Sections 6.4, 6.5

Unit IV: Chapter 6 : Sections 6.6 and 6.7

Unit V : Chapter 6 : Sections 6.8, 6.10 and 6.11 (Omit 6.9)

Reference Books:

1. M.Artin, *Algebra,* Prentice Hall of India, 1991.
2. P.B.Bhattacharya, S.K.Jain, and S.R.Nagpaul, *Basic Abstract Algebra* (II Edition) Cambridge University Press, 1997. (Indian Edition)

Course Outcomes

CO	Upon completion of the course, the students will be able to:	PSOs Addressed	Cognitive Level
CO-1	Summarize the class equation of equations and explain Sylow's theorems and apply the theorem to find number of Sylow subgroups.	1,4,5	K1
CO-2	Apply the direct product of groups to list out the finite Abelian groups for the given order.	1,4,5	K3
CO-3	Examine the invariants of linear transformation, to explore the properties of nilpotent transformation relating nilpotence with invariants.	1,5	K4
CO-4	Determine the characteristic polynomial of linear transformation by applying the Jordan form.	1,2,3,5	K5
CO-5	Discuss the trace and transpose of Hermitian, unitary and normal transformations	1,2,5	K6

K1-Remembering; K2 – Understanding; K3 - Applying; K4 - Analyzing; K5 – Evaluating; K6 - Creating

Relationship Matrix

Semester	Course Code	Title of the Course	Hours	Credit
I	24PCMA11	Algebraic Structures	90	5

Course Outcomes (COS)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)				
	PO1	PO2	PO3	PO4	PO5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1	3	3	3	3	3	3	2	2	3	3
CO-2	3	3	3	3	3	3	1	1	3	3
CO-3	3	3	3	3	3	3	2	2	1	3
CO-4	3	3	3	3	3	3	3	3	2	3
CO-5	3	3	3	3	3	3	3	1	1	3

STRONG (3), MEDIUM (2) and LOW (1)

Prepared by Name: Checked by

Signature: Head of the Department

Semester - I	Real Analysis I		24PCMA12			
Core – II			L	T	P	C
Hrs./Week: 6	Hrs./Semester : 90	Marks :100	4	2	-	5

General Objectives:

- To work comfortably with functions of bounded variation, Riemann-Stieltjes Integration, convergence of infinite series, infinite product and uniform convergence and its interplay between various limiting operations.To recognize the basic properties of monotonic functions.
- To formulate the proofs and structures of Riemann - Stieltjes integral.
- To combine different definitions, theorems and techniques of Riemann - Stieltjes integral.

Learning Objectives:

LO	The learners will be able to:
LO-1	know the fundamental definitions of monotonic functions.
LO-2	learn the properties of Riemann - Stieltjes integral.
LO-3	get a clear ideas about Lebesgue criteriaon for Riemann - Stieltjes integral.
LO-4	gain more ideas in Infinite Series and infinite Products.
LO-5	know about the sequence of functions.

UNIT I

Functions of bounded variation : Introduction - Properties of monotonic functions - Functions of bounded variation - Total variation - Additive property of total variation - Total variation on [a, x] as a function of x - Functions of bounded variation expressed as the difference of two increasing functions - Continuous functions of bounded variation.

Infinite Series : Absolute and conditional convergence - Dirichlet's test and Abel's test - Rearrangement of series - Riemann's theorem on conditionally convergent series.

UNIT II

The Riemann - Stieltjes Integral : Introduction - Notation - The definition of the Riemann - Stieltjes integral - Linear Properties - Integration by parts- Change of variable in a Riemann - Stieltjes integral - Reduction to a Riemann Integral – Euler's summation formula - Monotonically increasing integrators, Upper and lower integrals - Additive and linearity properties of upper, lower integrals - Riemann's condition - Comparison theorems.

UNIT III

The Riemann-Stieltjes Integral :Integrators of bounded variation-Sufficient conditions for the existence of Riemann-Stieltjes integrals-Necessary conditions for the existence of RS integrals- Mean value theorems -integrals as a function of the interval – Second fundamental theorem of integral calculus-Change of variable -Second Mean Value Theorem for Riemann integral- Riemann-Stieltjes integrals depending on a parameter-Differentiation under integral sign-Lebesgue criteriaon for existence of Riemann integrals.

UNIT IV

Infinite Series and infinite Products :Double sequences - Double series - Rearrangement theorem for double series - A sufficient condition for equality of iterated series - Multiplication of series – Cesaro summability - Infinite products.

Power series - Multiplication of power series - The Taylor's series generated by a function - Bernstein's theorem.

UNIT V

Sequences of Functions : Pointwise convergence of sequences of functions - Examples of sequences of real - valued functions - Uniform convergence and continuity - Cauchy condition for uniform convergence - Uniform convergence of infinite series of functions - Riemann - Stieltjes integration – Non-uniform Convergence and Term-by-term Integration - Uniform convergence and differentiation - Sufficient condition for uniform convergence of a series - Mean convergence.

TEXTBOOK:

Tom M.Apostol : *Mathematical Analysis*, 2nd Edition, Addison-Wesley Publishing Company Inc. New York, 1974.

Unit I **:**Chapter 6 (section 6.1-6.8) &
Chapter 8(section 8.8, 8.15, 8.17, 8.18)

Unit II **:** Chapter 7 (section 7.1-7.14)

Unit III **:** Chapter 7 (section 7.15-7.25)

Unit IV **:** Chapter 8 (section 8.20, 8.21-8.26) &
Chapter 9(section-9.14, 9.15, 9.19, 9.20)

Unit V **:** Chapter 9 (section-9.1 to 9.6, 9.8, 9.9,9.10,9.11,9.13)

REFERENCE BOOK:

1. Bartle, R.G. *Real Analysis*, John Wiley and Sons Inc., 1976.
2. Rudin,W. *Principles of Mathematical Analysis*, 3rd Edition. McGraw Hill Company, New York, 1976.
3. Malik,S.C. and Savita Arora. *Mathematical Anslysis*, Wiley Eastern Limited.New Delhi, 1991.

4. Sanjay Arora and Bansi Lal, *Introduction to Real Analysis*, Satya Prakashan, New Delhi, 1991.
5. Gelbaum, B.R. and J. Olmsted, *Counter Examples in Analysis*, Holden day, San Francisco, 1964.
6. A.L.Gupta and N.R.Gupta, *Principles of Real Analysis*, Pearson Education, (Indian print) 2003.

Course Outcomes

CO	Course Outcomes	PSOs Addressed	Cognitive Level
CO-1	Analyze and evaluate functions of bounded variation and Rectifiable Curves.	1,2,4,5	K4
CO-2	Describe the concept of Riemann-Stieltjes integral and its properties.	1,2,3	K5
CO-3	Demonstrate the concept of step function, upper function, Lebesgue function and their integrals.	1,2,5	K2
CO-4	Construct various mathematical proofs using the properties of Lebesgue integrals and establish the Levi monotone convergence theorem.	2,3,4,5	K3
CO-5	Formulate the concept and properties of inner products, norms and measurable functions.	1,2,3,4,5	K6

RelationshipMatrix

Semester	Course Code	Title of the Course	Hours	Credit
I	24PCMA12	Real Analysis I	90	5

Course Outcomes (COS)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)				
	PO1	PO2	PO3	PO4	PO5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1	3	3	2	1	2	3	3	2	3	3
CO-2	3	3	3	3	2	3	3	3	2	1
CO-3	2	3	3	3	1	3	3	1	1	3
CO-4	3	3	3	3	3	2	3	3	3	3
CO-5	3	3	3	3	3	3	3	3	3	3

STRONG (3), MEDIUM (2) and LOW (1)

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Signature: Head of the Department

Semester - I	Ordinary Differential Equations		24PCMA13			
Core – III			L	T	P	C
Hrs./Week: 6	Hrs./Semester : 90	Marks :100	4	2	-	4

General Objective:

To develop strong background on finding solutions to linear differential equations with constant and variable coefficients and also with singular points, to study existence and uniqueness of the solutions of first order differential equations.

Learning Objectives:

LO	The learners will be able to:
LO-1	Remember the concept of linear equations with constant coefficient.
LO-2	Classify the homogeneous and non-homogeneous equation.
LO-3	Analyze the homogeneous equation with analytic coefficients.
LO-4	Evaluate the regular singular point.
LO-5	Understand the Existence and uniqueness of solutions to first order equations.

Unit I: Linear equations with constant coefficients: Second order homogeneous equations-Initial value problems-Linear dependence and independence-Wronskian and a formula for Wronskian-Non-homogeneous equation of order two.

Unit II: Linear equations with constant coefficients: Homogeneous and non-homogeneous equation of order n –Initial value problems-Annihilator method to solve non-homogeneous equation.

Unit III: Linear equation with variable coefficients: Initial value problems -Existence and uniqueness theorems – Solutions to solve a non-homogeneous equation – Wronskian and linear dependence – reduction of the order of a homogeneous equation – homogeneous equation with analytic coefficients-The Legendre equation.

Unit IV: Linear equation with regular singular points: Euler equation – Second order equations with regular singular points –Exceptional cases – Bessel Function.

Unit V: Existence and uniqueness of solutions to first order equations: Equation with variable separated – Exact equation – method of successive approximations – the Lipschitz condition – convergence of the successive approximations and the existence theorem.

Text Book:

E.A.Coddington, *A introduction to ordinary differential equations* (3rd Printing) Prentice-Hall of India Ltd., New Delhi, 1987.

UNIT-I : Chapter 2: Sections 1 to 6

UNIT-II : Chapter 2 : Sections 7 to 12.

UNIT-III : Chapter : 3 Sections 1 to 8 (Omit section 9)

UNIT-IV : Chapter 4 : Sections 1 to 4 and 6 to 8 (Omit sections 5 and 9)

UNIT-V : Chapter 5 : Sections 1 to 6 (Omit Sections 7 to 9)

Reference Books:

1. Williams E. Boyce and Richard C. DI Prima, *Elementary differential equations and boundary value problems*, John Wiley and sons, New York, 1967.
2. George F Simmons, *Differential equations with applications and historical notes,* Tata McGraw Hill, New Delhi, 1974.
3. N.N. Lebedev, *Special functions and their applications*, Prentice Hall of India, New Delhi, 1965.
4. W.T. Reid. *Ordinary Differential Equations*, John Wiley and Sons, New York, 1971
5. M.D.Raisinghania, *Advanced Differential Equations*, S.Chand & Company Ltd. New Delhi 2001
6. B.Rai, D.P.Choudary and H.I. Freedman, *A Course in Ordinary Differential Equations,* Narosa Publishing House, New Delhi, 2002.

Course Outcomes

CO	Upon completion of the course, the students will be able to:	PSOs Addressed	Cognitive Level
CO-1	Establish the qualitative behavior of solutions of systems of differential equations.	1,2,4	K1
CO-2	Recognize the physical phenomena modeled by differential equations and dynamical systems.	2,3	K3
CO-3	Analyze solutions using appropriate methods and give examples.	3,5	K4
CO-4	Formulate Green's function for boundary value problems.	1,4	K5
CO-5	Understand and use various theoretical ideas and results that underlie the mathematics in this course.	3,4,5	K6

K1-Remembering; K2 – Understanding; K3 - Applying; K4 - Analyzing; K5 – Evaluating; K6 - Creating

Relationship Matrix

Semester	Course Code	Title of the Course	Hours	Credit
I	24PCMA13	Ordinary Differential Equations	90	4

Course Outcomes (COS)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)				
	PO1	PO2	PO3	PO4	PO5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1	3	3	3	3	3	3	3	1	3	1
CO-2	3	3	3	3	3	1	3	3	1	2
CO-3	3	3	3	3	3	2	2	3	2	3
CO-4	3	3	3	3	3	3	1	2	3	2
CO-5	3	3	3	3	2	1	2	3	3	3

STRONG (3), MEDIUM (2) and LOW (1)

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Semester - I	Mathematical Programming		24PCMA14			
Core – IV			L	T	P	C
Hrs./Week: 4	Hrs./Semester : 60	Marks :100	4	1	-	3

General Objective:

Mathematical programming is a systematic approach used for optimizing (minimizing or maximizing) the value of an objective function with respect to a set of constraints. The idea is that solving may be done through general methods.

Learning Objectives:

LO	The learners will be able to:
LO-1	Understand the concept of simplex method to solve the LPP.
LO-2	Familiarize the concept of Integer Programming problems.
LO-3	Analyze the Characteristics of Dynamic Programming and Dynamic Programming Algorithm.
LO-4	Formulating a Non – Linear Programming Problem
LO-5	Classify Wolfe's Method Simplex Method and Beale's Method.

UNIT I: Linear Programming: General Linear Programming Problem – Canonical and Standard Forms of L.P.P. –Simplex method: Illustrative Problems – Dual Simplex Method.

UNIT II: Integer Programming: Introduction – Pure and Mixed Integer Programming Problems – Gomory's All I.P.P Method – Construction of Gomory's constraints – Fractional Cut Method – All Integer LPP.

UNIT III: Dynamic Programming: Introduction –Characteristics of Dynamic Programming - Dynamic Programming Algorithm – Solution of L.P.P. by Dynamic Programming.

UNIT IV: Non – Linear Programming: Introduction – Formulating a Non – Linear Programming Problem –General Non – Linear Programming Problem – Constrained Optimization with Equality Constraints.

UNIT V: Non – Linear Programming Methods: Introduction – Graphical Solution - Kuhn Tucker Conditions with Non-negative Constraints – Wolfe's Method Simplex Method – Beale's Method.

Text Book:

Kanti Swarup, P.K. Gupta and Man Mohan, Operation Research, Eleventh Edition Sultan Chand & Sons, New Delhi.

UNIT I: Chapter 3, 4 and 5 (Section 3.4, 3.5, 4.3, 5.9)

UNIT II: Chapter 7 (Section7.1 - 7.5)
UNIT III: Chapter 13 (Section 13.1, 13.3, 13.4, 13.7)
UNIT IV: Chapter 27 (Section 27.1 – 27.4)
UNIT V: Chapter 28 (Section 28.1 – 28.3, 28.5,28.6)

Reference Book:

1. HAMDY A. TAHA, Operations Research An Introduction, 7th Edition, MacMillan Publishing Company, New York.
2. J.K.Sharma, Operations Research, Theory and Applications, Third Edition (2007) Macmillan India Ltd

Course Outcomes

CO	Upon completion of the course, the students will be able to:	PSOs Addressed	Cognitive Level
CO-1	Understand the concept of simplex method to solve the LPP.	1,2,4	K2
CO-2	Identify the fundamental considerations for solving an integer linear programming problem.	1,2,4	K3
CO-3	Apply the techniques of LPP to solve real world problems	1,3,5	K3
CO-4	Compare non-linear programming and linear programming problems	1,2	K5
CO-5	Analyze restricted non-linear programming problems	1, 4	K4

K1-Remembering; K2 – Understanding; K3 - Applying; K4 - Analyzing; K5 – Evaluating; K6 – Creating

Relationship Matrix

Semester	Course Code	Title of the Course				Hours	Credit			
I	24PCMA14	Mathematical Programming				60	3			
Course Outcomes (COS)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)				
	PO1	PO2	PO3	PO4	PO5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1	3	3	3	3	3	3	3	1	3	2
CO-2	3	3	3	3	2	3	3	2	3	1
CO-3	3	3	3	3	3	3	1	3	1	3
CO-4	3	3	3	3	1	3	3	1	2	1
CO-5	3	3	3	3	2	3	2	2	3	2

STRONG (3), MEDIUM (2) and LOW (1)

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Signature: Head of the Department

Semester - I	Mathematical Programming Practical Using Python		24PCMA1P1			
Core P – I			L	T	P	C
Hrs./Week: 2	Hrs./Semester : 30	Marks :50	-	-	1	1

General Objective:

The Python math module offers you the ability to perform common and useful mathematical calculation in real life application.

Learning Objectives:

LO	The learners will be able to:
LO-1	How to write, compile and execute the Python programs.
LO-2	Build basic programs using fundamental programming constructs like variables.
LO-3	Formulate programs using conditions logic, looping and functions
LO-4	Implement matrix concepts in python.
LO-5	Create simple arithmetic calculation in python.

1. Write a Python program for basic calculation?
2. Write a Python program for determine the factorial of the number?
3. Write a Python program for check the number is prime or not?
4. Write a Python program for sum of the squares and cubes of the first n Natural numbers?
5. Write a Python program for sum of the elements in the given array?
6. Write a Python program for rotation of the given array?
7. Write a Python program for reverse the given array using various method?
8. Write a Python program for date and time?
9. Write a Python program for matrix operations?
10. Write a Python program for creation of $n \times n$ matrix?
11. Write a Python program for solving linear programming problem?
12. Write a Python program for solving non-linear programming problem?

Course Outcomes

CO	Upon completion of the course, the students will be able to:	PSOs Addressed	Cognitive Level
CO-1	Understand how to write, compile and execute the Python programs.	1,2,4	K2
CO-2	Apply the basic concepts using fundamental programming.	1,2,4	K3
CO-3	Analysis matrix concepts in python.	1,2,4	K4
CO-4	Evaluate programs using conditions logic, looping and functions.	1,2,5	K5
CO-5	Create simple arithmetic calculation in python.	1,2,3	K6

K1-Remembering; K2 – Understanding; K3 - Applying; K4 - Analyzing; K5 – Evaluating; K6 - Creating

Relationship Matrix

Semester	Course Code	Title of the Course	Hours	Credit
I	24PCMA1P1	Mathematical Programming practical using python	30	1

Course Outcomes (COS)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)				
	PO1	PO2	PO3	PO4	PO5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1	3	3	3	3	3	3	3	1	3	2
CO-2	3	3	3	3	3	3	3	2	3	1
CO-3	3	3	3	3	3	3	3	1	3	3
CO-4	3	3	3	3	3	3	3	2	2	3
CO-5	3	3	3	1	1	3	3	3	1	2

STRONG (3), MEDIUM (2) and LOW (1)

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Signature: Head of the Department

Semester - I	Graph Theory and Application		24PEMA11A			
Elective – IA			L	T	P	C
Hrs./Week: 4	Hrs./Semester : 60	Marks :100	3	1	-	3

General Objective:

To understand the fundamental concepts in graph theory so as to solve day-to-day life problems besides improving the proof writing skills.

Learning Objectives:

LO	The learners will be able to:
LO-1	Understand the basic concepts of trees and their properties.
LO-2	Identify the Eulerian and Hamiltonian graphs.
LO-3	Understand and prove the theorems/lemmas in matching and factorization.
LO-4	Analyze the necessary condition for planar graphs.
LO-5	Recall the edge coloring of graphs.

Unit–I: Trees: Bridges – Trees - Applications: The Minimum Spanning Tree Problem. Connectivity: Cut vertices - Connectivity.

Unit–II: Traversability: Eulerian graphs – Hamiltonian graphs.

Unit–III: Matchings and Factorizations: Matchings - Factorization

Unit–IV: Planarity: Planar graphs – Embedding Graphs on Surfaces.Coloring: Vertex Colouring

Unit–V: Edge Coloring – The Heawood Map Coloring Theorem. Distance: The Centre of a graph.

Text Book:

Introduction to Graph Theory, Gary Chartrand and Ping Zhang, Edition 2006, Tata McGraw-Hill Publishing Company Ltd, New Delhi.

Unit I **:** Chapter 4 (Section 4.1, 4.3), Chapter 5 (Section 5.1, 5.3)

Unit II **:** Chapter 6 (Section 6.1, 6.2)

Unit III **:** Chapter 8 (Section 8.1, 8.2)

Unit IV **:** Chapter 9 (Section 9.1, 9.2), Chapter 10 (Section 10.2)

Unit V **:** Chapter 10 (Section 10.3, 10.4), Chapter 12 (Section 12.1)

Reference Book:

Graph Theory with Applications, J.A. Bondy and U.S.R Murty, Department of Combinatorics and Optimization, Elsevier Science Publishing 1976.

Course Outcomes

CO	Upon completion of the course, the students will be able to:	PSOs Addressed	Cognitive Level
CO-1	Understand the concept of vertex and edge connectivity.	1,5	K2
CO-2	Apply the various characterization of Eulerian and Hamiltonian graphs.	1,3,4	K3
CO-3	Analyze Hall's Marriage theorem to justify that if the graphs have a perfect matching.	1,3,5	K4
CO-4	Evaluate the interpretation of non-planar graphs in higher dimension surfaces.	1,5	K5
CO-5	Discuss the edge colouring of graphs and centre of a graph.	1,2,3,5	K6

K1-Remembering; K2 – Understanding; K3 - Applying; K4 - Analyzing; K5 – Evaluating; K6 - Creating

Relationship Matrix

Semester	Course Code	Title of the Course	Hours	Credit
I	24PEMA11A	Graph Theory and Application	60	3

Course Outcomes (COS)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)				
	PO1	PO2	PO3	PO4	PO5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1	3	3	3	3	3	3	2	1	2	3
CO-2	3	3	3	3	3	3	1	3	3	1
CO-3	3	3	3	3	3	3	2	3	1	3
CO-4	3	3	3	3	3	3	1	2	2	3
CO-5	3	3	3	3	3	3	3	3	1	3

STRONG (3), MEDIUM (2) and LOW (1)

Prepared by Name: Checked by

Signature: Head of the Department

Semester - I	Number Theory and Cryptography		24PEMA11B			
Elective – IB			L	T	P	C
Hrs./Week: 4	Hrs./Semester : 60	Marks :100	3	1	-	3

General Objective:

1. To enrich the students knowledge about the number system and also motivate them to find the solution of Linear congruences using well-known concepts
2. To impart the knowledge of encryption ad decryption techniques and their applications in managing the security of data.

Learning Objectives:

LO	The learners will be ableto:
LO-1	Understand the fundamental definitions about Divisibility.
LO-2	Remember the concept of congruence and its applications.
LO-3	Analyze the relationship between the arithmetic functions.
LO-4	Evaluate the solution of linear Diophantine equations.
LO-5	Understand and analyze data encryption standard.

Unit I: Divisibility and Euclidean algorithm - Congruence's - Euler's theorem -Wilson's Theorem.

Unit II: Chinese Remainder Theorem- Quadratic residues - Quadratic reciprocity– The Jacobi symbol.

Unit III: Arithmetic functions – The Mobius Inversion formula - Multiplication of arithmetic

Unit IV: Linear Diophantine equations – Sum of Four and Five Squares – Sum of Fourth Powers - Sum of Two Squares.

Unit V : Public key Cryptography – Concepts of public key Cryptography – RSA – Discrete logarithm – Elliptic curve Cryptography.

Textbook:

1. An Introduction to Theory of Numbers by Ivan Nivan and HerbertsZucherman, Third Edition, 1972, Wiley Eastern Limited, New Delhi.
2. David M.Burton, Elementary Number Theory, Wm.C.Brown Publishers, Dubuque, Iowa,1989.

Unit I: TB1: Chapter 1 - 1.2, Chapter 2 – 2.1.
Unit II: TB1: Chapter 2 – 2.3, Chapter 3 – 3.1 to 3.3.

Unit III:TB1: Chapter 4 – 4.2, 4.3.
Unit IV: TB2: Chapter 2 – 2.4, Chapter 12 – 12.2,12.3 and Chapter 5 - 5.4.
Unit V : TB2: Chapter 7 – 7.5.

Reference Books:

1. Tom Apostol, Introduction to Analytic Number theory, Narosa Publications, New Delhi
2. Neal Koblitz, A Course in Number Theory and Cryptography, Springer-Verlag, NewYork,1987.
3. Cryptograpy and Network Security Principles and Practice by William Stallings, Prentice Hall, Fifth Edition, New Delhi,2011.

Course Outcomes

CO	Upon completion of the course, the students will be able to:	PSOs Addressed	Cognitive Level
CO-1	List out the definitions in Number theory.	1,2	K1
CO-2	Determine the quadratic residue and the reciprocity and solve the Diophantine equations.	1,2	K3
CO-3	Describe the greatest integer function and the arithmetic functions.	2,3	K2
CO-4	Evaluate the sum of the fourth powers and the sum of two squares.	2,3	K5
CO-5	Apply number theory in Cryptography.	4,5	K5

K1-Remembering; K2 – Understanding; K3 - Applying; K4 - Analyzing; K5 – Evaluating; K6 – Creating

Relationship Matrix

Semester	Course Code	Title of the Course	Hours	Credit
I	24PEMA11B	Number Theory and Cryptography	60	3

Course Outcomes (COS)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)				
	PO1	PO2	PO3	PO4	PO5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1	3	3	3	3	2	3	3	2	2	1
CO-2	3	3	3	3	1	3	3	1	2	2
CO-3	3	3	3	3	2	1	3	3	1	2
CO-4	3	3	3	3	1	1	3	3	1	1
CO-5	3	3	3	3	3	2	1	2	3	3

STRONG (3), MEDIUM (2) and LOW (1)

Prepared by Name: Checked by

Signature: Head of the Department

Semester - I	Formal Languages And Automata Theory		24PEMA11C			
Elective – IC			L	T	P	C
Hrs./Week: 4	Hrs./Semester : 60	Marks :100	3	1	-	3

General Objective:

1. To know the concepts of tractability and decidability , the concepts of NP-completeness and NP-hard problem.
2. To understand the. Basic properties of formal languages and formal grammars
3. To understand the relation between types of languages and types of finite automata.

Learning Objectives:

LO	The learners will be able to:
LO-1	Demonstrate the interplay between different models and formal languages.
LO-2	Design and explain finite automata without $f\tilde{O}$-moves, derivation trees and pushdown automata.
LO-3	Classify machines by their power to recognize the languages.
LO-4	Explain deterministic and non-deterministic machines.
LO-5	Analyze the properties of regular sets

Unit I: Finite Automata and Regular Expressions: Finite state systems - Deterministic Finite state Automata - Non deterministic Finite Automata - Finite Automata with Epsilon -Transitions – Regular Expressions - Finite Automata and Regular Expressions.

Unit II: Properties of Regular Sets: The Pumping Lemma for Regular Sets – Application of the Pumping Lemma – Converting NFA's to DFA'S – Minimization of DFA's.

Unit III: Grammars and Languages: Context Free Grammars – Derivation Trees –Normal forms for Context Free Grammars – Chomsky Normal Form – Greibach Normal Form.

Unit IV: Pushdown Automata: Definition – The languages of a PDA – Equivalence of PDA's and CFG's – Deterministic Pushdown Automata.

Unit V : Properties of Context - Free Languages : The Pumping Lemma for Context – free Languages – Closure Properties of Context - Free Languages – Decision properties of CFL's.

Textbook:

John E. Hopcroft and Jeffery D. Ullman, Introduction to Automata theory, Languagesand Computations, Narosa Publishing House, Chennai, 2002.

Unit I: Chapter 2 - 2.1 to 2.5.
Unit II: Chapter 3 – 3.1, 3.4.
Unit III: Chapter 4 – 4.2 to 4.6.
Unit IV: Chapter 5 – 5.2, 5.3.
Unit V : Chapter 6 – 6.1 to 6.3.

Reference Books:

1. Harry R. Lewis and Christos H.Papadimitriou, Elements of the Theory of Computation, Second Edition, Prentice Hall, 1997.
2. A.V. Aho, Monica S. Lam, R. Sethi, J.D.Ullman, Compilers: Principles, Techniques, and Tools, Second Edition, Addison-Wesley,2007.
3. John C. Martin, Introduction to Languages and theory of Computations (2ndEdn), Tata –McGraw Hill company Ltd., New Delhi, 1997.
4. Dr. Rani Siromoney, Formal Languages and Automata, The Christian Literature Society,1979.

Course Outcomes

CO	Upon completion of the course, the students will be able to:	PSOs Addressed	Cognitive Level
CO-1	Enhance their knowledge in mathematical notions of computation, such as computability, decidability and reducibility of the theory of formal languages and automata	1,2	K1
CO-2	Perceive the techniques of computations including finite state automata, grammars and regular expressions and their relations.	1,3	K2
CO-3	Design and explain finite automata without $f\tilde{O}$-moves, derivation trees and pushdown automata.	2,3	K3
CO-4	Analyze and recognize the patterns of automata and grammars using regular expressions.	1,4	K4
CO-5	State and explain Chomsky Normal Form, Greibach Normal form and Properties of Context-Free Languages.	4,5	K5

K1-Remembering; K2 – Understanding; K3 - Applying; K4 - Analyzing; K5 – Evaluating; K6 - Creating

Relationship Matrix

Semester	Course Code	Title of the Course	Hours	Credit
I	24PEMA11C	Formal Languages and Automata Theory	60	3

Course Outcomes (COS)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)				
	PO1	PO2	PO3	PO4	PO5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1	3	3	3	3	2	3	3	1	2	1
CO-2	3	3	3	3	1	3	2	3	1	2
CO-3	3	3	3	3	1	2	3	3	2	1
CO-4	3	3	3	3	3	3	1	2	3	1
CO-5	3	3	3	3	3	1	2	1	3	3

STRONG (3), MEDIUM (2) and LOW (1)

Prepared by Name: Checked by

Signature: Head of the Department

Semester - I	Discrete Structure - I		24PIMA11			
Elective–II-IDC			L	T	P	C
Hrs./Week: 2	Hrs./Semester : 30	Marks :50				2

General Objective:

To introduce the methods of analytical, critical thinking, deductive reasoning and logical and mathematical tools.

Learning Objectives:

LO	The learners will be able to:
LO-1	Understand the elements of propositional logic such as statements and operations.
LO-2	Represent the logic statements in Mathematics by predicates and quantifiers.
LO-3	Recognize nested quantifiers and interference rules for propositional statements.
LO-4	Define a set operation and its relation.
LO-5	Describe an equivalence relation on a set to discuss the partition of a given set.

Unit–I: Propositional Logic – Propositional Equivalence.

Unit–II: Predicate Logic – Normal Forms.

Unit–III: Nested Quantifiers – Rules of Inferences.

Unit–IV: Set Operations – Representation and Properties of Relations.

Unit–V: Equivalence Relations – Partially Ordering.

Text Book:

Discrete Mathematics & its Applications with Combinatorics and Graph Theory, Kenneth H. Rosen, Tata McGraw-Hill Publishing Company Limited, Sixth Edition.

Unit I : Chapter 1 (Section 1.1, 1.2)

Unit II : Chapter 1 (Section 1.3)

Unit III : Chapter 1 (Section 1.4, 1.5)

Unit IV : Chapter 2 (Section 2.2) and Chapter 7 (Section 7.1, 7.3)

Unit V : Chapter 7 (Section 7.5, 7.6)

Reference Book:

Discrete Mathematics with Applications, Susanna S. Epp, Brooks/Cole, Fourth Edition, 2011.

Course Outcomes

CO	Upon completion of the course, the students will be able to:	PSOs Addressed	Cognitive Level
CO-1	Describe the components such as statements and operations of propositional logic.	2,3	K2
CO-2	Apply predicate logic and quantifiers to express the logic statements in Mathematics.	2,3,5	K3
CO-3	Give examples of various operations on a set.	1,2	K3
CO-4	Interpret the complicated arguments by applying the rules of inferences of propositions and quantified statements.	2,3	K5
CO-5	Estimate the partially ordered sets and equivalence relations.	1,2,4	K6

K1-Remembering; K2 – Understanding; K3 - Applying; K4 - Analyzing; K5 – Evaluating; K6 - Creating

Relationship Matrix

Semester	Course Code	Title of the Course				Hours			Credits	
I	24PIMA11	Mathematical Programming				30			2	
Course Outcomes (COS)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)				
	PO1	PO2	PO3	PO4	PO5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1	3	3	3	3	2	2	3	3	1	2
CO-2	3	3	3	3	3	2	3	3	2	3
CO-3	3	3	3	3	1	3	3	1	1	2
CO-4	3	3	3	3	1	2	3	3	2	1
CO-5	3	3	3	3	3	3	3	1	3	2

STRONG (3), MEDIUM (2) and LOW (1)

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Semester - II	Advanced Algebra		24PCMA21			
Core – V			L	T	P	C
Hrs./Week: 6	Hrs./Semester : 90	Marks :100	4	2	-	5

General Objective:

To study field extension, roots of polynomials, Galois Theory, finite fields, division rings, solvability by radicals and to develop computational skill in abstract algebra.

Learning Objective:

LO	The learners will be able to:
LO-1	Define field extension and transcendence of *e.*
LO-2	Explain the roots of the polynomial in extension fields.
LO-3	Familiarize themselves with the fundamental theorem of Galois Theory and the structure of the finite fields.
LO-4	Classify the finite fields using fundamental theorems
LO-5	Define solvability and Frobenius theorem

Unit I: Extension fields – Transcendence of e.

Unit II: Roots of Polynomials.- More about roots.

Unit III: Elements of Galois theory.

Unit IV: Finite fields - Wedderburn's theorem on finite division rings.

Unit V : Solvability by radicals - A theorem of Frobenius - Integral Quaternions and the Four - Square theorem.

Text book:

I.N. Herstein, Topics in Algebra, Wiley India (P.) Ltd, 2nd Edition, 2013.

Unit I : Chapter 5: Section 5.1 and 5.2

Unit II: Chapter 5: Sections 5.3 and 5.5

Unit III: Chapter 5 : Section 5.6

Unit IV: Chapter 7: Sections 7.1 and 7.2 (Theorem 7.2.1 only)

Unit V: Chapter 5: Section 5.7 (omit Lemma 5.7.1, Lemma 5.7.2 and Theorem 5.7.1)

Chapter 7 : Sections 7.3 and 7.4

Reference Books:

1. M.Artin, *Algebra,* Prentice Hall of India, 1991.
2. P.B.Bhattacharya, S.K.Jain, and S.R.Nagpaul, *Basic Abstract Algebra* (II Edition) Cambridge University Press, 1997. (Indian Edition)

Course Outcomes

CO	Upon completion of the course, the students will be able to:	PSOs Addressed	Cognitive Level
CO-1	Find the extension of a given field and show the irrationality of the number *e.*	1,2,5	K2
CO-2	Identify the degree of the extension fields.	1,2,5	K3
CO-3	Examine the Galois field of the irreducible polynomial.	1,5	K4
CO-4	Determine the finite fields for a given order.	1,2 3,4,5	K4
CO-5	Discuss Frobenius theorem and Four - Square theorem	1,2,5	K5

K1-Remembering; K2 – Understanding; K3 - Applying; K4 - Analyzing; K5 – Evaluating; K6 - Creating

Relationship Matrix

Semester	Course Code	Title of the Course	Hours	Credit
II	24PCMA21	Advanced Algebra	90	5

Course Outcomes (COS)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)				
	PO1	PO2	PO 3	PO4	PO5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1	3	3	3	3	3	3	3	1	2	3
CO-2	3	3	3	3	3	3	3	1	1	3
CO-3	3	3	3	3	3	3	2	1	2	3
CO-4	3	3	3	3	3	3	3	3	3	3
CO-5	3	3	3	3	3	3	3	2	1	3

STRONG (3), MEDIUM (2) and LOW (1)

Prepared by Name: Checked by

Signature: Head of the Department

Semester - II	Real Analysis II		24PCMA22			
Core – VI			L	T	P	C
Hrs./Week: 6	Hrs./Semester : 90	Marks :100	4	2		5

General Objective:

- To introduce measure on the real line, Lebesgue measurability and integrability, Fourier Series and Integrals, in-depth study in multivariable calculus. To recognize the basic properties of monotonic functions.
- To formulate the proofs and structures of Riemann - Stieltjes integral and Lebesgue integral.
- .To combine different definitions, theorems and techniques of Fourier Series and integrals.

Learning Objectives:

LO	The learners will be able to:
LO-1	understand the Measure on the Real line.
LO-2	study about the Integration of Functions of a Real variable.
LO-3	apply the integral concepts in Fourier Series and Fourier Integrals.
LO-4	gain the knowledge about the total derivative.
LO-5	know the significance of Implicit Functions and Extremes Problems.

UNIT I: Measure on the Real line : Lebesgue Outer Measure - Measurable sets - Regularity - Measurable Functions - Borel and Lebesgue Measurability

UNIT II: Integration of Functions of a Real variable - Integration of Non-negative functions - The General Integral - Riemann and Lebesgue Integrals

UNIT III: Fourier Series and Fourier Integrals - Introduction - Orthogonal system of functions - The theorem on best approximation - The Fourier series of a function relative to an orthonormal system - Properties of Fourier Coefficients - The Riesz-Fischer Thorem - The convergence and representation problems in for trigonometric series - The Riemann - Lebesgue Lemma - The Dirichlet Integrals - An integral representation for the partial sums of Fourier series - Riemann's localization theorem - Sufficient conditions for convergence of a Fourier series at a particular point –Cesarosummability of Fourier series- Consequences of Fejes's theorem - The Weierstrass approximation theorem

UNIT IV: Multivariable Differential Calculus - Introduction - The Directional derivative - Directional derivative and continuity - The total derivative - The total derivative expressed in terms of partial derivatives - The matrix of linear function - The Jacobian matrix - The chain rule - Matrix form of chain rule - The mean - value theorem for differentiable functions -

A sufficient condition for differentiability - A sufficient condition for equality of mixed partial derivatives - Taylor's theorem for functions of R^n to R^1

UNIT V: Implicit Functions and Extremum Problems : Functions with non-zero Jacobian determinants – The inverse function theorem-The Implicit function theorem-Extrema of real valued functions of severable variables-Extremum problems with side conditions.

TEXTBOOK:

1. G. de Barra, *Measure Theory and Integration*, Wiley Eastern Ltd., New Delhi, 1981. (for Units I and II)
2. Tom M.Apostol : *Mathematical Analysis*, 2nd Edition, Addison-Wesley Publishing Company Inc. New York, 1974. (for Units III, IV and V)

Unit I: **TB-1:**Chapter 2 (section 2.1-2.5)

Unit II: **TB-1:**Chapter 3 (section 3.1,3.2 & 3.4)

Unit III: **TB-2**Chapter 11 (section 11.1-11.15)

Unit IV: **TB-2**Chapter 12 (section 12.1-12.14)

Unit V: **TB-2**Chapter 13 (section13.1-13.7)

REFERENCE BOOK:

1. Burkill,J.C.*The Lebesgue Integral*, Cambridge University Press, 1951.
2. Munroe,M.E.*Measure and Integration*. Addison-Wesley, Mass.1971.
3. Roydon,H.L.*Real Analysis*, Macmillan Pub. Company, New York, 1988.
4. Rudin, W. *Principles of Mathematical Analysis*, McGraw Hill Company, New York,1979.
5. Malik,S.C. and Savita Arora. *Mathematical Analysis,* Wiley Eastern Limited. New Delhi, 1991.
6. Sanjay Arora and Bansi Lal, *Introduction to Real Analysis*, Satya Prakashan, New Delhi, 1991

Course Outcomes

CO	Upon completion of the course, the students will be able to:	PSOs Addressed	Cognitive Level
CO-1	Understand and describe the basic concepts of Fourier series and Fourier integrals with respect to orthogonal system.	1,2,3	K2
CO-2	Analyze the representation and convergence problems of Fourier series.	2,3,4,5	K4
CO-3	Analyze and evaluate the difference between transforms of various functions.	2,3,4,5	K4
CO-4	Formulate and evaluate complex contour integrals directly and by the fundamental theorem.	2,4,5	K6
CO-5	Apply the Cauchy integral theorem in its various versions to compute contour integration.	1,2,3,4	K3

K1-Remembering; K2 – Understanding; K3 - Applying; K4 - Analyzing; K5 – Evaluating; K6 – Creating

Relationship Matrix

Semester	Course Code	Title of the Course				Hours		Credit		
II	24PCMA22	Real Analysis – II				90		5		
Course Outcomes (COS)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)				
	PO1	PO2	PO3	PO4	PO5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1	3	3	2	2	1	3	3	3	1	2
CO-2	3	3	3	3	1	2	3	3	3	3
CO-3	1	3	3	3	2	1	3	3	3	3
CO-4	3	3	3	3	3	2	3	1	3	3
CO-5	3	3	3	3	3	3	3	3	3	1

STRONG (3), MEDIUM (2) and LOW (1)

Prepared by Name: Checked by

Signature: Head of the Department

Semester - II	Partial Differential Equations		24PCMA23			
Core – VII			L	T	P	C
Hrs./Week: 5	Hrs./Semester : 75	Marks :100	3	2	-	4

General Objective:

To classify the second order partial differential equations and to study Cauchy problem, method of separation of variables, boundary value problems.

Learning Objectives:

LO	The learners will be able to:
LO-1	Remember the concept of Second order equations in two independent variables.
LO-2	Classify the homogeneous and non-homogeneous wave equation.
LO-3	Identify and solve Laplace and beam equations.
LO-4	Evaluate Dirichlet, Neumann problems for various boundary condition.
LO-5	Understand the concept of Green Function and to apply Helmholtz operation and to solve Higher dimensional problem.

UNIT I : Mathematical Models and Classification of second order equation : Classical equations-Vibrating string – Vibrating membrane – waves in elastic medium – Conduction of heat in solids – Gravitational potential – Second order equations in two independent variables – canonical forms – equations with constant coefficients – general solution.

UNIT II: Cauchy Problem : The Cauchy problem – Cauchy-Kowalewsky theorem – Homogeneous wave equation – Initial Boundary value problem- Non-homogeneous boundary conditions – Finite string with fixed ends – Non-homogeneous wave equation – Riemann method – Goursat problem – spherical wave equation – cylindrical wave equation.

UNIT III: Method of separation of variables: Separation of variable- Vibrating string problem – Existence and uniqueness of solution of vibrating string problem - Heat conduction problem – Existence and uniqueness of solution of heat conduction problem – Laplace and beam equations.

UNIT IV: Boundary Value Problems : Boundary value problems – Maximum and minimum principles – Uniqueness and continuity theorem – Dirichlet Problem for a circle , a circular annulus, a rectangle – Dirichlet problem involving Poisson equation – Neumann problem for a circle and a rectangle.

UNIT V: Green's Function: The Delta function – Green's function – Method of Green's function – Dirichlet Problem for the Laplace and Helmholtz operators – Method of images and eigen functions – Higher dimensional problem – Neumann Problem.

Text Book:

TynMyint-U and Lokenath Debnath, *Partial Differential Equations for Scientists and Engineers* (Third Edition), North Hollan, New York, 1987.

Unit I: Chapter 2: Sections 2.1 to 2.6 Chapter 3 : Sections 3.1 to 3.4 (Omit 3.5)

Unit II: Chapter 4: Sections 4.1 to 4.11

Unit III: Chapter 6: Sections 6.1 to 6.6 (Omit section 6.7)

Unit IV: Chapter 8: Sections 8.1 to 8.9

Unit V: Chapter 10: Section 10.1 to 10.9

Reference Books:

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

Course Outcomes

CO	Upon completion of the course, the students will be able to:	PSOs Addressed	Cognitive Level
CO-1	To understand and classify second order equations and find general solutions	1,2,4	K2
CO-2	To analyse and solve wave equations in different polar coordinates	2,3	K4
CO-3	To solve Vibrating string problem, Heat conduction problem, to identify and solve Laplace and beam equations	1,2,4	K5
CO-4	To apply maximum and minimum principle's and solve Dirichlet, Neumann problems for various boundary condition.	1,3,4	K3
CO-5	To apply Green's function and solve Dirichlet, Laplace problems, to apply Helmholtz operation and to solve Higher dimensional problem.	1,3,5	K3

K1-Remembering; K2 – Understanding; K3 - Applying; K4 - Analyzing; K5 – Evaluating; K6 - Creating

Relationship Matrix

Semester	Course Code	Title of the Course				Hours		Credit		
II	24PCMA23	Partial Differential Equations				75		4		
Course Outcomes (COS)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)				
	PO1	PO2	PO3	PO4	PO5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1	3	3	3	2	3	3	3	1	3	1
CO-2	3	3	3	1	3	1	3	3	1	2
CO-3	3	3	3	3	2	3	3	2	3	2
CO-4	3	3	3	3	1	3	2	3	3	1
CO-5	3	3	3	3	2	3	1	3	2	3

STRONG (3), MEDIUM (2) and LOW (1)

Prepared by Name: Checked by

Signature: Head of the Department

Semester - II	Statistical Data Analysis Using R-Programming		24PEMA21A			
Elective– IIIA			L	T	P	C
Hrs./Week: 4	Hrs./Semester : 60	Marks :100	3	1	-	3

General Objective:

To create the R-studio, identify the console and scripts in an easiest way. Using the API, the learner can type his own R code and remember the R Syntax easily.

Learning Objectives:

LO	The learners will be able to:
LO-1	Understand the data types in R-Programming.
LO-2	Create, find and remove data in R-Programming.
LO-3	Study about the operators like mathematical and logical.
LO-4	Acquire knowledge to create the loops for vectors in their own way.
LO-5	Gain knowledge in creating data as a list using loops.

Unit–I: Introduction: Introducing to R – R Data Structures – Help functions in R – Vectors – Scalars – Declarations – recycling – Common Vector operations – Using all() and any() – Vectorized operations – NA and NULL values – Filtering – Vectorised if-then else – Vector Equality – Vector Element names.

Unit–II: Matrices and arrays: Creating matrices – Matrix operations – Applying Functions to Matrix Rows and Columns – Adding and deleting rows and columns – Vector/Matrix Distinction – Avoiding Dimension Reduction – Higher Dimensional arrays.

Unit–III: Lists – Creating lists – General list operations – Accessing list components and values – applying functions to lists – recursive lists. Creating Data Frames – Matrix-like operations in frames – Merging Data Frames – Applying functions to Data frames.

Unit–IV: Factors and Tables – factors and levels – Common functions used with factors – Working with tables - Other factors and table related functions.

Unit–V: Control statements – Arithmetic and Boolean operators and values – Default values for arguments - Returning Boolean values – functions are objects– Environment and Scope issues – Writing Upstairs - Recursion – Replacement functions – Tools for composing function code.

Text Book:

The Art of R Programming: A Tour of Statistical Software Design, Norman Matloff, No Starch Press, 2011.

Unit I : Chapter 1 & 2

Unit II : Chapter 3

Unit III : Chapter 4 & 5

Unit IV : Chapter 6

Unit V : Chapter 7 (Section 7.1 - 7.11)

Reference Book:

Introduction to statistical data analysis with R Introduction to statistical data analysis with R, Mathias Kohl, The e-Book company 2011, First Edition.

Course Outcomes

CO	Upon completion of the course, the students will be able to:	PSOs Addressed	Cognitive Level
CO-1	Understand the concept as to how to download and install R-studio to work with data structures.	1,4,5	K1
CO-2	Understand the data sets using matrices and arrays.	1,3,5	K2
CO-3	Remember and apply the main R data structures – vector and data frames.	1,2,4	K3
CO-4	Analyze the basics in R–Programming to form a factors and tables.	1,3,5	K4
CO-5	Evaluate the external data into R for statistical analysis and recursion.	1,2	K5

K1-Remembering; K2 – Understanding; K3 - Applying; K4 - Analyzing; K5 – Evaluating; K6 - Creating

Relationship Matrix

Semester	Course Code	Title of the Course				Hours		Credit		
II	24PEMA21A	Statistical Data Analysis Using R-Programming				60		4		
Course Outcomes (COS)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)				
	PO1	PO2	PO3	PO4	PO5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1	3	3	3	3	3	3	2	1	3	3
CO-2	3	3	3	3	3	3	1	3	2	3
CO-3	3	3	3	3	3	3	3	1	3	2
CO-4	3	3	3	3	3	3	1	3	2	3
CO-5	3	3	3	3	1	3	3	2	1	2

STRONG (3), MEDIUM (2) and LOW (1)

Prepared by Name: Checked by

Signature: Head of the Department

Semester - II	Neural Networks		24PEMA21B			
Elective– IIIB			L	T	P	C
Hrs./Week: 4	Hrs./Semester : 60	Marks :100	3	1	-	3

General Objective:

- To survey the application of artificial neural networks.
- To learn about Boolean functions.
- To know about the Hopfield model.

Learning Objectives:

LO	The learners will be able to:
LO-1	Understand the basic concepts of neural computations.
LO-2	Study about Harmonic Analysis of Logical Functions.
LO-3	Apply the Learning Algorithms for Neural Networks.
LO-4	Gain the knowledge in Synchronous and Asynchronous networks.
LO-5	Know about Variations of the Hopfield model.

UNIT - I: Neural Computation – Artificial Neural Networks - Networks of Functions.

UNIT-II: Synthesis of Boolean functions – Equivalent Networks - Recurrent Networks – Harmonic Analysis of Logical Functions.

UNIT - III: Perceptron and Parallel Processing – Implementation of Logical Functions - Learning Algorithms for Neural Networks.

UNIT - IV: Synchronous and Asynchronous networks - Definition of Hopfield networks - Converge to stable states - Equivalence of Hopfield and Preceptron learning - ParallelCombinatorics.

UNIT - V: Variations of the Hopfield model - Stochastic systems - Learning algorithms andapplications.

Text Book:

R. Rojas, Neural Networks, A Systamatic Introduction, Springer-Verlag Berlin Heidelberg New York, 1996

Unit I : Chapter 1: 1.1, 1.3 and Chapter 2: 2.1.
Unit II : Chapter 2: 2.2 - 2.5
Unit III : Chapter 3: 3.1- 3.2, Chapter 4: 4.1
Unit IV : Chapter 13: 13.1 -13.5
Unit V : Chapter 14: 14.1 -14.3

Reference Books:

1. Simon Haykin, Neural Networks and learning machines, third edition.
2. Laurene Fausett, Fundamentals of neural network, 2004.

Course Outcomes

CO	Upon completion of the course, the students will be able to:	PSOs Addressed	Cognitive Level
CO-1	Discuss the important concepts and theories of artificial neural networks	1,2,5	K1
CO-2	Apply simpler models as a component to build up feed forward neural network architectures	2,3,4,5	K2
CO-3	Analyse how ANNs can be designed and trained	2,4,5	K3
CO-4	Evaluate simple examples of ANNs	1,2,3,4,5	K5
CO-5	Compare real-valued states and continuous dynamics	1,2	K6

K1-Remembering; K2 – Understanding; K3 - Applying; K4 - Analyzing; K5 – Evaluating; K6 - Creating

Relationship Matrix

Semester	Course Code	Title of the Course				Hours		Credit		
II	24PEMA21B	Neural Network				60		3		
Course Outcomes (COS)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)				
	PO1	PO2	PO3	PO4	PO5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1	3	3	2	1	2	3	3	1	2	3
CO-2	3	3	3	3	1	2	3	3	3	3
CO-3	1	3	3	3	2	1	3	1	3	3
CO-4	3	3	3	3	3	3	3	3	3	3
CO-5	3	3	3	3	3	3	3	2	2	1

STRONG (3), MEDIUM (2) and LOW (1)

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Semester - II	Mathematical Statistics		24PEMA21C			
Elective– IIIC			L	T	P	C
Hrs./Week: 4	Hrs./Semester : 60	Marks :100	3	1	-	3

General Objectives:

Demonstrate knowledge of probability, fixed sample and large sample statistical properties and the standard statistical distributions.

Learning Objectives:

LO	The learner will be able to
LO-1	Understand the concept of stochastic processes model of a system.
LO-2	Know about the parameters and statistics in distribution.
LO-3	Optimize analytical measurement problem in sampling theory.
LO-4	Estimate the location and scale parameters of a distribution in order statistics.
LO-5	Evaluate the distribution of random variables in a limiting distribution.

UNIT I: Conditional Probability and Stochastic Independence: Conditional Probability –Marginal and Conditional distributions – The correlation coefficient – Stochastic Independence.

UNIT II: Some Special Distributions: The Binomial, The Poisson distribution - The Gamma distribution & chi-square distribution –The normal distribution –The Bivariate distribution.

UNIT III: Distributions of functions of Random variables: Sampling Theory – Transformation of variables of the discrete type – Transformation of variables of the continuous type-The t and F distribution.

UNIT IV: Extensions of the Change of variable Technique – Distribution of order statistics –The moment generating function technique – Distributions of and nS^2/σ^2 and $\overline{X}$.

UNIT V: Limiting Distributions: Limiting Distributions – Stochastic convergence – Limiting moment generating functions – The central limit theorem – Some theorems on Limiting Distributions.

Textbook:

Robert V. Hogg and Allen T. Craig – Introduction to Mathematical Statistics **-** Pearson Education Asia, Chapters2, 3, 4 and 5.

Unit I: Chapter2 (Section 2.1to2.3)

Unit II: Chapter 3(Section 3.1, 3.2, 3.3, 3.4)

Unit III: Chapter4 (Section 4.1to 4.4)

Unit IV: Chapter 4 (Section 4.5 to 4.8)

Unit V: Chapter5 (Section5.1 to 5.5)

Reference Books:

1. Lee. J. Bain, Max Engel-Hardt– Introduction to probability and Mathematical Statistics. Duxbury Learning, Second Edition

2. Richard J Larsen, Morris L. Marx- Introduction to Mathematical statistics and its Applications, fifth Edition, Prentice Hall.

Course Outcomes

CO	Upon completion of the course, the students will be able to:	PSOs Addressed	Cognitive Level
CO-1	Understand the concept of conditional probability to estimate the number of possible outcomes with different conditions	1, 2, 4	K2
CO-2	Remember the basic distribution theory to learn about special distributions.	1, 2	K1
CO-3	Analyse the change in transformations of variables in discrete and continuous type.	2, 4	K4
CO-4	Evaluate the distributions of $\overline{X}$ and $\frac{nS^2}{\sigma^2}$ by applying moment generating function technique.	3, 4	K5
CO-5	Apply the concept of central limit theorem to find the value of the probability.	3	K3

K1-Remembering; K2 – Understanding; K3 - Applying; K4 - Analyzing; K5 – Evaluating; K6 - Creating

Relationship Matrix

Semester	Course Code	Title of the Course				Hours		Credit		
II	24PEMA21C	Mathematical Statistics				60		4		
Course Outcomes (COS)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)				
	PO1	PO2	PO3	PO4	PO5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1	3	3	3	2	3	3	3	1	3	3
CO-2	3	3	3	1	3	3	3	2	1	1
CO-3	3	3	3	1	3	2	3	1	3	2
CO-4	3	3	3	2	3	1	1	3	3	1
CO-5	3	3	2	1	3	1	2	3	2	2

STRONG (3), MEDIUM (2) and LOW (1)

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Semester - II	Discrete Structure-II		24PIMA21			
Elective–IV-IDC			L	T	P	C
Hrs./Week: 2	Hrs./Semester : 30	Marks :50	2	-	-	2

General Objective:

To solve the counting problems by using counting principles and to understand thefundamental concept of probability.

Learning Objective:

LO	The learners will be able to:
LO-1	Discuss the two basic counting principles and the pigeonhole principle.
LO-2	Understand the selection and arrangement of objects of a set of particular size.
LO-3	Explain the fundamental concepts of probability.
LO-4	Understand the Baye's theorem.
LO-5	Understand the Karnaugh maps for the sum-of-product expansion.

Unit I: Basics of Counting –Pigeonhole Principle

Unit II: Permutations and Combinations - Inclusion and Exclusion Principle

Unit III: Probability - Baye's Theorem .

Unit IV: Boolean Functions and its Representation.

Unit V : Simplifications of boolean Functions.

Text book:

1. Kennath H Rosen, Discrete Mathematics & its Applications with Combinatorics and Graph Theory, Tata McGraw- Hill Publishing Company Limited, sixth Edition
2. S.Arumugam and A.Thangapandi Issac, Statistics, New Gamma Publishing House, 2015.

Unit I : TB1 Chapter 5 (5.1,5.2)

Unit II: TB1 Chapter 5 (5.3) and Chapter 6 (6.5)

Unit III: TB2 Chapter 11

Unit IV: TB1 Chapter 10 (10.1, 10.2)

Unit V : TB1 Chapter 10 (10.4)

Reference Books:

1. Susanna S. Epp, Discrete Mathematics with Applications, Brooks/Cole, Fourth Edition, 2011.

Course Outcomes

CO	Upon completion of the course, the students will be able to:	PSOs Addressed	Cognitive Level
CO-1	Define the concept of pigeonhole principle.	1,2,3,4	K1
CO-2	Demonstrate the solution for problem related with permutation and combination.	1,2,3	K2
CO-3	Illustrate the varies example for Inclusion and Exclusion principle.	1,2,3	K3
CO-4	Evaluate the solution for Baye's theorem.	1,2,5	K5
CO-5	Discuss K-maps to simplify sum-of-products expansions.	1,2	K6

K1-Remembering; K2 – Understanding; K3 - Applying; K4 - Analyzing; K5 – Evaluating; K6 - Creating

Relationship Matrix

Semester	Course Code	Title of the Course				Hours		Credit		
II	24PIMA21	Discrete Structure -II				30		2		
Course Outcomes (COS)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)				
	PO1	PO2	PO3	PO4	PO5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1	3	3	3	3	3	3	3	3	3	2
CO-2	3	3	3	3	2	3	3	3	1	1
CO-3	3	3	3	3	1	3	3	3	2	1
CO-4	3	3	3	3	3	3	3	1	1	3
CO-5	3	3	3	3	1	3	3	1	1	2

STRONG (3), MEDIUM (2) and LOW (1)

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Semester - II	Statistical Using R-Programming Practical		24PSMA21			
SEC-I			L	T	P	C
Hrs./Week: 4	Hrs./Semester : 60	Marks :100	-	-	4	2

General Objective:

To obtain the knowledge for downloading the R-studio and install it and be able to work in a workspace containing an R data frame. Also gain knowledge to Run, edit and save the script from R studio.

Learning Objectives:

LO	The learners will be able to:
LO-1	Compose R data into external files.
LO-2	Study about basic math functions like sum(), Avg(), etc.
LO-3	Display the results using graphs.
LO-4	Create and change the data in vectors, matrices and arrays using loops.
LO-5	Save the customize graphs in different ways.

1. Introduction to R
2. Identifying Types of Variables: Level of Measurement.
3. Univariate Statistics
4. Introduction to Probability.
5. The Normal curve.
6. Measures of Central Tendency and Dispersion.
7. Standard Deviations, Standard Scores and the Normal Distribution
8. Sampling
9. Hypothesis Testing: Testing the Significance of the difference between two means.
10. Hypothesis Testing: One and Two tailed Tests.
11. Bivariate Statistics for Normal Data.
12. Bivariate Statistics for Ordinal Data.
13. Bivariate Statistics for Interval / Ratio Data.
14. OLS Regression – Modelling Continuous Outcomes.

Course Outcomes

CO	Upon completion of the course, the students will be able to:	PSOs Addressed	Cognitive Level
CO-1	Understand the programming language for statistical analysis.	1,2,5	K2
CO-2	Evaluate the problems in probability and statistics.	1,2,3	K5
CO-3	Analyze and explore data sets to create test table.	1,2,4	K4
CO-4	Analyze as to how to find the regression values using R-Programming.	1,2,3	K4
CO-5	Estimate the program and find the value for sampling.	1,2,5	K6

K1-Remembering; K2 – Understanding; K3 - Applying; K4 - Analyzing; K5 – Evaluating; K6 - Creating

Relationship Matrix

Semester	Course Code	Title of the Course	Hours	Credit
II	24PSMA21	Statistical Using R-Programming Practical	60	2

Course Outcomes (COS)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)				
	PO1	PO2	PO3	PO4	PO5	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO-1	3	3	3	3	3	3	3	1	1	3
CO-2	3	3	3	3	2	3	3	3	2	1
CO-3	3	3	3	3	3	3	3	2	3	2
CO-4	3	3	3	3	1	3	3	3	2	1
CO-5	3	3	3	3	3	3	3	1	1	3

STRONG (3), MEDIUM (2) and LOW (1)

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