M.Sc. MATHEMATICS

Course Structure and Syllabus

(For the candidates admitted from the academic year 2024 – 2025 onwards)

CHOICE BASED CREDIT SYSTEM – LEARNING OUTCOMES BASED CURRICULUM FRAMEWORK (CBCS - LOCF)

THANTHAI HANS ROEVER COLLEGE (AUTONOMOUS)

(Accredited with 'A' Grade by NAAC (3rd cycle) with CGPA 3.23 out of 4)

(Affiliated to Bharathidasan University, Tiruchirappalli)

ELAMBALUR, PERAMBALUR – 621 220

Vision

To blossom as an institution of excellence, enabling, empowering and enlightening the youth and shaping them as fully developed human beings with the capacity to unfold their full mental potentiality resulting in the attainment of the wisdom to live constructively and meaningfully.

Mission

- To provide Congenial and Stress- free Environment and opportunities for the enhancement of knowledge and acquisition skills through the best exposure and training possible.
- To offer multifaced and need-based academic programmes and to promote extension activities.
- To adopt technology-enabled new methods, approaches and techniques so that the teaching-learning process becomes learner-centred and learner-friendly approach.
- To maximize the participation of all the stakeholders in the development of the institution and the region.
- To sensitize the youth towards inclusive growth for socio-economic change, sustainable development, gender equality, eco-friendliness, etc.
- To enable the youth to experience the effects of globalization and facilitate them to grow as responsible citizens and leaders.
- To inspire them, through value-based education, to embrace the entire humanity while firmly rooted in the Indian ethos.
- To provide regular placement training and placement opportunities.
- To kindle the spirit of creativity and enhance research activities and enable them to attain international standards.

Programme Outcomes (POs)

Upon completion of the programme, the postgraduate will be able to

1. Gain advanced knowledge resulting in entrepreneurship; innovation and newer opportunities for being employable in public and private sectors, research and development organizations
2. Apply enhanced new techniques and adopt new technologies needed in the respective disciplines
3. Appreciate the diversity of behaviour in professional practice and act in accordance with the core values of chosen profession
4. Demonstrate the knowledge, values and skills to be critical consumer of research practice and possess investigative skills to evaluate the practice
5. Engage in lifelong learning process, have the ability to communicate the findings of Languages/ Commerce/ Management Studies/ Social Work/ Computing Sciences/ Physical Sciences/ Biological Sciences/ Life Sciences with the current knowledge

Program Specific Outcomes(PSOs)

1. Understanding of the fundamental axioms in Mathematics and capability of developing ideas based on them.
2. Ability to build and administrate the Mathematical models to solve real time problems.
3. Aptitude and Reasoning skills that will help to take up research in pure and applied mathematics.
4. Employability Skills that will enable the students to explore career in Teaching and Research in Mathematics.
5. Recognize the need to engage lifelong learning of Mathematics through continuing education and Research.

Thanthai Hans Roever College (Autonomous)Elambalur, Perambalur – 621 220

M.Sc., MATHEMATICS

CHIOCE BASED CREDIT SYSTEM – LEARNING OUTCOMES BASED CURRICULUM FRAMEWORK (CBCS – LOCF)

(For the candidates admitted from the academic year 2024 – 2025 onwards)

Semester	Course Code	Title of the Course	Ins. Hours/ Weeks	Credits	Exam Hours	CIA (Max)	ESE (Max)	Total (Max)
I	23PMA1CC1	Algebraic Structures	6	5	3	25	75	100
	23PMA1CC2	Real Analysis I	6	5	3	25	75	100
	23PMA1CC3	Ordinary Differential Equations	6	4	3	25	75	100
	23PMA1EC11 23PMA1EC12	1. Graph Theory and Applications (Or) 2. Formal Languages and Automata Theory	6	3	3	25	75	100
	23PMA1EC21 23PMA1EC22	1. Fuzzy Sets and Their Applications (Or) 2. Discrete Mathematics	6	3	3	25	75	100
		Value Added Course - 1*	-	2*	2	50	50	100*
		Total	**30**	**20**	**-**	**-**	**-**	**500**
II	23PMA2CC4	Advanced Algebra	6	5	3	25	75	100
	23PMA2CC5	Real Analysis II	6	5	3	25	75	100
	23PMA2CC6	Partial Differential Equations	6	4	3	25	75	100
	23PMA2EC31 23PMA2EC32	1. Mathematical Statistics (Or) 2. Tensor Analysis and Relativity	5	3	3	25	75	100
	23PMA2EC41 23PMA2EC42	1. Programming in C++ (Theory) (Or) 2. Stochastic Processes	5	3	3	25	75	100
	23PMA2NME11 23PMA2NME12	1. Mathematical Aptitude (Or) 2. Statistics	2	2	3	25	75	100
	23PMA2OC	SWAYAM / NPTEL Online Course		2**				
		Total	**30**	**22**	**-**	**-**	**-**	**600**
III	23PMA3CC7	Complex Analysis	6	5	3	25	75	100
	23PMA3CC8	Calculus of Variations, Integral Equations and Transforms	6	5	3	25	75	100
	23PMA3CC9	Topology	6	5	3	25	75	100

	23PMA3CC10	Algebraic Number Theory	5	4	3	25	75	100
	23PMA3EC51 23PMA3EC52	1. Programming in C++ (Practical) (Or) 2. Fluid Dynamics	5	3	3	40 25	60 75	100
	23PMA3NME21 23PMA3NME22	1. Analytical Reasoning & Mental Ability (Or) 2. Sage Math	2	2	3	25 40	75 60	100
		Internship/ Industrial Activity (Carried out in Summer Vacation at the end of I year – 30 hours)	-	2	-	-	-	100
		Value Added Course - 2*	-	2*	2	50	50	100*
		Total	**30**	**26**	-	-	-	**700**
IV	23PMA4CC11	Functional Analysis	6	5	3	25	75	100
	23PMA4CC12	Differential Geometry	6	5	3	25	75	100
	23PMA4PW	Core Project With Viva Voce	6	5	-	-	-	100
	23PMA4EC61 23PMA4EC62	1. Resource Management Techniques (Or) 2. Financial Mathematics	4	3	3	25	75	100
	23PMA4SE1	Numerical Analysis Using SCILAB	4	2		40	60	100
	23PMA4SE2	Soft Skill	4	2		25	75	100
		Extension Activity	-	1	-	-	-	-
		Total	**30**	**23**	-	-	-	**600**
		Grand Total	**120**	**91**	-	-	-	**2400**

*** Internship/Industrial Activity- Internship after 2nd semester during summer vacation -30 Hours and 2 credits will be included in the 3rd semester.

* The value added course credit will not be included in the total CGPA. These courses are extra-credit courses. Instruction hours for these courses is 30 hours

Extra Credit Course- SWAYAM / NPTEL Online Courses

List of Core Course:

S. No	Core Course	Course Name
1.	Core Course I	Algebraic Structures
2.	Core Course II	Real Analysis I
3.	Core Course III	Ordinary Differential Equations
4.	Core Course IV	Advanced Algebra
5.	Core Course V	Real Analysis II
6.	Core Course VI	Partial Differential Equations
7.	Core Course VII	Complex Analysis
8.	Core Course VIII	Calculus of Variations, Integral Equations and Transforms
9.	Core Course IX	Topology
10.	Core Course X	Algebraic Number Theory
11.	Core Course XI	Functional Analysis
12.	Core Course XII	Differential Geometry
13.	Core Course XIII	Core Project with viva voce

List of Elective Course:

S. No	Course	Course Name
1.	Elective Course I	Graph Theory and Applications
		Formal Languages and Automata Theory
2.	Elective Course II	Fuzzy Sets and Their Applications
		Discrete Mathematics
3.	Elective Course III	Mathematical Statistics
		Tensor Analysis and Relativity
4.	Elective Course IV	Programming in C++ (Theory)
		Stochastic Processes
5.	Elective Course V	Programming in C++ (Practical)
		Fluid Dynamics
6.	Elective Course VI	Research Management Techniques
		Financial Mathematics

List of Non – Major Elective Course:

S. No	Course	Course Name
1.	NME – I	Mathematical Aptitude
		Statistics
2.	NME – II	Analytical Reasoning & Mental Ability
		SAGE Math

List of Skill Enhancement Course:

S. No	Course	Course Name
1.	Skill Enhancement Course - 1	Numerical Analysis Using SCILAB
2.	Skill Enhancement Course - 2	Soft Skills

List of Value Added Course:

Value Added Courses	Course Code	Title of the Course
VAC – I	23PVAMA11	Vedic Mathematics
VAC – II	23PVAMA21	General Mental Ability

SEMESTER – I

Course Code: 23PMA1CC1 Exam Hours: 3
Instruction Hours: 6 Internal Marks: 25
Credits: 5 External Marks: 75

CORE COURSE - I - ALGEBRAIC STRUCTURES

OBJECTIVES:

- To introduce the concept of algebraic structure.
- To develop working knowledge on class equation, solvability of groups, finite abelian groups, linear transformations, real quadratic forms

Course Learning Outcome

Students will be able to

CLO 1: Recall basic counting principle, define class equations to solve problems, explain Sylow's theorems and apply the theorem to find number of Sylow subgroups

CLO 2: Define Solvable groups, define direct products, examine the properties of finite abelian groups, define modules

CLO 3: Define similar Transformations, define invariant subspace, explore the properties of triangular matrix, to find the index of nilpotence to decompose a space into invariant subspaces, to find invariants of linear transformation, to explore the properties of nilpotent transformation relating nilpotence with invariants.

CLO 4: Define Jordan, canonical form, Jordan blocks, define rational canonical form, define companion matrix of polynomial, find the elementary devices of transformation, apply the concepts to find characteristic polynomial of linear transformation.

CLO 5: Define trace, define transpose of a matrix, explain the properties of trace and transpose, to find trace, to find transpose of matrix, to prove Jacobson lemma using the triangular form, define symmetric matrix, skew symmetric matrix, adjoint, to define Hermitian, unitary, normal transformations and to verify whether the transformation in Hermitian, unitary and normal

UNIT – I

Another Counting Principle - Normalizer - Class equation for finite groups and its applications - Sylow's theorems (For theorem 2.12.1, First proof only).

UNIT – II

Solvability by Radicals - Direct products – Normal Subgroups - Finite abelian groups - Modules.

UNIT – III

Linear Transformations: Canonical forms –Triangular form - Nilpotent Transformations.

UNIT – IV

Canonical forms: A Decomposition of V: Jordan form - Canonical forms: Rational canonical form

UNIT – V

Trace and transpose – Hermitian, Unitary and Normal Transformations - Real quadratic form.

TEXT BOOK(S):

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

UNIT – I	Chapter - 2	Sections 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. P.B.Bhattacharya, S.K.Jain, and S.R.Nagpaul, *Basic Abstract Algebra* (II Edition) Cambridge University Press, 1997. (Indian Edition)
2. I.S.Luther and I.B.S.Passi, *Algebra*, Vol. I –Groups(1996); Vol. II Rings, Narosa Publishing House , New Delhi, 1999
3. D.S.Malik, J.N. Mordeson and M.K.Sen, *Fundamental of Abstract Algebra*, McGraw Hill (International Edition), New York. 1997.

WEB LINK:

1. http://mathforum.org, http://ocw.mit.edu/ocwweb/Mathematics,
2. http://www.opensource.org, www.algebra.com

Relationship Matrix for COs, POs and PSOs

Semester	**Code**		**Title of the Course**			**Hours**			**Credits**	
I	23PMA1CC1		ALGEBRAIC STRUCTURE			6			5	
Course Outcomes (COs)	**Programme Outcomes(POs)**					**Programme Specific Outcomes(PSOs)**				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	✓	✓	✓	✓	✓	✓	✓	✓	✓	
CO2		✓	✓	✓		✓	✓	✓	✓	✓
CO3		✓	✓		✓		✓		✓	✓
CO4	✓			✓		✓	✓	✓		✓
CO5	✓	✓	✓	✓	✓	✓		✓	✓	✓
Number of Matches(✓) = 38						Relationship: **HIGH**				

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very Poor	Poor	Moderate	High	Very High

SEMESTER – I

Course Code: 23PMA1CC2 Exam Hours: 3
Instruction Hours: 6 Internal Marks: 25
Credits: 5 External Marks: 75

CORE COURSE - II - REAL ANALYSIS – I

OBJECTIVES:

- To work comfortably with functions of bounded variation, Riemann-Stieltjes Integration, convergence of infinite series, infinite product and uniform convergence.
- To interplay between various limiting operations.

Course Learning Outcome

Students will be able to

CLO1: Analyze and evaluate functions of bounded variation and Abel's test.
CLO2: Describe the concept of Riemann-Stieltjes integral and its properties.
CLO3: Demonstrate the concept of Infinite series and infinite products.
CLO4: Construct various mathematical proofs using the properties of Sequences of functions
CLO5: Formulate the concept and properties of Power series.

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.

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

Infinite Series and infinite Products -Rearrangement of series - Riemann's theorem on conditionally convergent series - Subseries - Double sequences - Double series - Rearrangement theorem for double series - A sufficient condition for equality of iterated series - Multiplication of series – Cesaro summability - Infinite products.

UNIT – IV

Sequences of Functions – Pointwise convergence of sequences of functions - Examples of sequences of real - valued functions – Definition of Uniform convergence - Uniform convergence and continuity - Cauchy condition for uniform convergence - Uniform convergence of infinite series of functions - Uniform convergence and 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.

UNIT – V

Power series - Multiplication of power series – The substitution theorem- Reciprocal of a power series - The Taylor's series generated by a function - Bernstein's theorem - Abel's limit theorem - Tauber's theorem.

TEXT BOOK(S):

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

UNIT – I	Chapter – 6	Sections 6.1 to 6.8
	Chapter – 8	Sections 8.8, 8.15,
UNIT – II	Chapter – 7	Sections 7.1 to 7.7 & 7.10 to 7.14
UNIT – III	Chapter – 8	Sections 8.17 to 8.26
UNIT – IV	Chapter – 9	Sections 9.1 to 9.6, 9.8 - 9.11, 9.13
UNIT – V	Chapter – 9	Sections 9.14 to 9.17, 9.19, 9.20, 9.22, 9.23

REFERENCE BOOKS:

1. Rudin,W. *Principles of Mathematical Analysis*, 3rd Edition. McGraw Hill Company, New York, 1976.
2. Malik, S.C. and Savita Arora. *Mathematical Analysis*, Wiley Eastern Limited. New Delhi, 1991

WEB LINK:

1. http://mathforum.org, http://ocw.mit.edu/ocwweb/Mathematics,
2. http://www.opensource.org, www.mathpages.com

Relationship Matrix for COs, POs and PSOs

Semester	**Code**		**Title of the Course**			**Hours**			**Credits**	
I	23PMA1CC2		REAL ANALYSIS – I			6			5	
Course Outcomes (COs)	**Programme Outcomes(POs)**					**Programme Specific Outcomes(PSOs)**				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CO2	✓	✓		✓		✓	✓		✓	
CO3	✓	✓	✓		✓		✓	✓	✓	✓
CO4	✓		✓	✓		✓	✓	✓		✓
CO5		✓	✓	✓	✓	✓		✓	✓	✓
Number of Matches(✓) = 39						Relationship: **HIGH**				

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very Poor	Poor	Moderate	High	Very High

SEMESTER – I

Course Code: 23PMA1CC3 | Exam Hours: 3
Instruction Hours: 6 | Internal Marks: 25
Credits: 4 | External Marks: 75

CORE COURSE - III - ORDINARY DIFFERENTIAL EQUATIONS

OBJECTIVES:

- To develop strong background on finding solutions to Second order linear equations with constant and variable coefficients and also with singular points.
- to study existence and uniqueness of the solutions of Method of successive Approximations

Course Learning Outcome:

Students will be able to

CLO1: Establish the qualitative behavior of solutions of Second order linear equations.
CLO2: Recognize the physical phenomena modeled by Power series solutions and special functions.
CLO3: Analyze solutions using Some special functions of mathematical physics.
CLO4: Formulate Systems of first order equations and The Existence and Uniqueness of solutions.
CLO5: Understand and use various theoretical ideas in Qualitative properties of solutions & Partial differential equations and boundary value problems

UNIT-I: Second order linear equations

The general solution of the Homogeneous Equation-The use of a known solution to find another – The method of variation of parameters.

Power series solutions and special functions

Introduction - A Review of power series – Series solutions of first order equations.

UNIT-II: Power series solutions and special functions (continued)

Second order linear equation (Ordinary points)-Regular singular points -Regular singular points(Continued)-Gauss's hypergeometric equation.

UNIT-III: Some special functions of mathematical physics

Legendre polynomials-properties of Legendre Polynomials-Bessel functions (The gamma function)-Properties of Bessel Functions-Legendre polynomials and potential theory-Bessel functions and the vibrating Membrane-Additional properties of Bessel functions.

UNIT-IV: Systems of first order equations

Linear systems – Homogeneous linear systems with constant coefficients

The Existence and Uniqueness of solutions

The Method of successive Approximations-Picard's theorem.

UNIT-V: Qualitative properties of solutions

Oscillations and the sturm separation theorem- The sturm comparison theorem.

Partial differential equations and boundary value problems

Eigenvalues, Eigen functions, and the Vibrating String.

TEXT BOOK(S):

1. George F Simmons, Differential equations with applications and historical notes, Tata McGraw Hill, New Delhi, 1974.

UNIT – I	Chapter – 3	Sections 15,16,19
	Chapter – 5	Sections 26,27
UNIT – II	Chapter – 5	Sections 28,29,30,31
UNIT – III	Chapter – 8	Sections 44,45,46,47
UNIT – IV	Chapter – 10	Sections 55,56
	Chapter – 13	Sections 68,69
UNIT – V	Chapter – 4	Sections 24,25
	Chapter – 7	Sections 40

REFERENCE BOOKS:

1. E.A.Coddington, A introduction to ordinary differential equations (3rd Printing) Prentice-Hall of India Ltd., New Delhi, 1987.
2. M.D.Raisinghania, *Advanced Differential Equations*, S.Chand & Company Ltd. New Delhi 2001

WEB LINK:

1. http://mathforum.org, http://ocw.mit.edu/ocwweb/Mathematics
2. http://www.opensource.org, www.mathpages.com

Relationship Matrix for COs, POs and PSOs

Semester	**Code**		**Title of the Course**			**Hours**			**Credits**	
I	23PMA1CC3		ORDINARY DIFFERENTIAL EQUATIONS			6			4	
Course Outcomes (COs)	**Programme Outcomes(POs)**					**Programme Specific Outcomes(PSOs)**				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	✓	✓	✓	✓	✓	✓	✓	✓		✓
CO2	✓	✓		✓		✓	✓		✓	
CO3		✓	✓		✓		✓	✓	✓	✓
CO4	✓		✓	✓		✓	✓	✓	✓	
CO5	✓	✓		✓		✓		✓		✓
Number of Matches(✓) = 35 Relationship: **HIGH**										

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very Poor	Poor	Moderate	High	Very High

SEMESTER – I

Course Code: 23PMA1EC11 Exam Hours: 3
Instruction Hours: 6 Internal Marks: 25
Credits: 3 External Marks: 75

ELECTIVE COURSE – I – GRAPH THEORY AND ITS APPLICATIONS

OBJECTIVES:

- To understand various parameters of Graph Theory with algorithms.
- To acquire sufficient knowledge and skill in the subject that will make them competent in various areas of mathematics.

COURSE OUTCOMES:

CLO1: This helps students to understand various parameters of Graph Theory with algorithms.

CLO2: Explain connectivity and edge-connectivity, 2-connected graphs and prove Menger's theorem.

CLO3: DiscussHaval & Hakimi Algorithm

CLO4: Define and illustrate the matching, system of distinct representatives and Marriage problem, covering.

CLO5: Explain Independent sets and edge-colourings Prove Vizing's theorem.

UNIT – I

AN INTRODUCTION TO GRAPHS: Basic concepts – Isomorphism and Automorphism –The pigeonhole principle and Turan's theorem – Distance, Radius and Diameter – Subgraphs and Isometric subgraphs – Operations on Graphs – The Adjacency Matrices - Incidence and Path matrices –

UNIT – II

CONNECTIVITY: Connectivity and edge connectivity – 2-Connected graphs – Menger's Theorem – Separable graphs – 1-Isomorphism and 2-Isomorphism.

UNIT – III

GRAPHIC SEQUENCES: Degree sequences – Graphic sequences – Wang and Kleitman's Theorem – Haval & Hakimi Algorithm – Generalisation of Haval & Hakimi Algorithm

UNIT –IV

MATCHINGS: Matching – System of Distinct Representatives and Marriage Problem – Covering – Konig-Egervary Theorem - 1-Factor Tutte's Theorem – Stable Matchings – Application –The Hungarian Algorithm – Algorithm for Maximum Matching

UNIT – V

INDEPENDENCE: Independent Sets – Edge colourings – Application – Vizing's Theorem – Vertex Colouring – Uniquely Colourable Graphs – Critical Graphs.

TEXTBOOK:

1. M.Murugan, Graph Theory and Algorithms, Second Edition, Muthali Publishing House, Annanagar, Chennai, 2018.

UNIT – I	Chapter – 1	Sections 1.1, 1.4, 1.6, 1.8 to 1.11
UNIT – II	Chapter – 3	Sections 3.1 to 3.4
UNIT – III	Chapter – 4	Sections 4.1 to 4.4
UNIT – IV	Chapter – 6	Sections 6.1 to 6.7
UNIT – V	Chapter – 7	Sections 7.1 to 7.7

REFERENCE(S):

1. J.A. Bondy and U.S.R. Murthy, Graph Theory with applications, Macmillan Co., London, 1976.
2. R. Balakrishnan, K. Ranganathan, A Textbook of Graph Theory, Second Edition, Springer International Edition, New Delhi, 2008.

Web Link:

1. https://www.pdfdrive.com/bondy-ja-murty-usr-graph-theory-with-applications-d187652858.html
2. https://www.pdfdrive.com/a-textbook-of-graph-theory-r-balakrishnan-k-ranganathanpdf-d18830765.html

Relationship Matrix for COs, POs and PSOs

Semester	**Code**		**Title of the Course**			**Hours**			**Credits**	
I	23PMA1EC11		GRAPH THEORY AND ITS APPLICATIONS			6			3	
Course Outcomes (COs)	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CO2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CO3		✓	✓	✓		✓		✓	✓	
CO4		✓		✓			✓	✓		
CO5	✓	✓			✓	✓	✓		✓	✓
Number of Matches (✓) = 37						Relationship: **HIGH**				

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very Poor	Poor	Moderate	High	Very High

SEMESTER – I

Course Code: 23PMA1EC12 Exam Hours: 3
Instruction Hours: 6 Internal Marks: 25
Credits: 3 External Marks: 75

ELECTIVE COURSE – I – FORMAL LANGUAGE AND AUTOMATA THEORY

COURSE OBJECTIVE:

- Recognise the fundamental properties of formal languages and grammars, distinguish between regular, context-free, and recursively enumerable languages. Create grammars to generate strings in a specific language.
- Learn about the theory of computation and computational models.

COURSE OUTCOMES:

CLO1: List the languages and strings. Define finite automata.

CLO2: Explain the concepts of finite automation and Non-deterministic finite automaton.

CLO3: Illustrate the process of phrase- structure grammar. Apply methods of context sensitivity languages.

CLO4: Examine the decision algorithms for context free languages. Discriminate between kleene closure and positive closure.

CLO5: Evaluate the problems based on Chomsky's normal forms.

UNIT – I

FORMAL LANGUAGES: Finite Automaton-Definition of finite automaton - Representation of finite automaton- Acceptability of a string by a finite automaton- Languages accepted by a finite automaton.

UNIT – II

FINITE AUTOMATA: Non-deterministic finite automaton- Acceptability of a string by NFA- Equivalence of FA and NFA- Procedure for finding an FA equivalent to a given NFA- Properties of regular sets –Decision algorithm for regular sets.

UNIT – III

GRAMMARS: Phrase – Structure Grammar derivations - Phrase–Structure languages – Context-sensitive languages(CSL)- Context-free languages(CFL)- Chomskian Hierarchy.

UNIT – IV

PROPERTIES OF REGULAR LANGUAGE: Closure Operation- Kleene Closure- Substituitions- Homomorphism-Inverse Homomorphism-Context free language, Derivation trees- Ambiguity leftmost, rightmost derivations.

UNIT – V

MORE PROPERTIES OF REGULAR LANGUAGE: Normal forms- Chomsky's normal forms- Problems based on Chomsky's normal forms – uvwxy theorem- Problems based on uvwxy theorem.

TEXT BOOKS

1. Dr. M. Venkatraman, Dr. N. Sridharan, N. Chandrasekaran," Discrete Mathematics",
2. Rani Siromoney, Formal Languages and Automata, The Christian Literature Society, Chennai.

REFERENCE(S):

1. John E Hopcroft, Jeffery D, Ullman, Introduction to Automata Theory and Computations, Narosa Publishing House.
2. Ragade B.R, "Automata and Theoretical Computer Science", Pearson Education.
3. Bernard M. Moret, " The Theory of Computation", Pearson Education

Relationship Matrix for COs, POs and PSOs

Semester	**Code**		**Title of the Course**			**Hours**			**Credits**	
I	23PMA1EC12		FORMAL LANGUAGE & AUTOMATA THEORY			6			3	
Course Outcomes (COs)	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CO2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CO3		✓	✓	✓		✓		✓	✓	
CO4		✓		✓			✓	✓		
CO5	✓	✓			✓	✓	✓		✓	✓
Number of Matches (✓) = 37						Relationship: **HIGH**				

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very Poor	Poor	Moderate	High	Very High

SEMESTER – I

Course Code: 23PMA1EC21 Exam Hours: 3
Instruction Hours: 6 Internal Marks: 25
Credits: 3 External Marks: 75

ELECTIVE COURSE – II – FUZZY SETS AND THEIR APPLICATIONS

OBJECTIVES:

- To introduce the concept of fuzzy theory and study its application in real problems.
- To study the uncertainty environment through the fuzzy sets that incorporates imprecision and subjectivity into the model formulation and solution process.

COURSE OUTCOMES:

CLO1: Form Classical Sets to fuzzy sets and operator.

CLO2: Illustrate operation on fuzzy sets.

CLO3: Classify fuzzy relations and properties of fuzzy relations.

CLO4: Demonstrate the fuzzy decision making, fuzzy ranking methods and fuzzy linear programming.

CLO5: To mold the students in research/teaching or to find better placement in corporate sectors.

UNIT – I

CRISP SETS AND FUZZY SETS: Overview of Classical Sets- Membership Function- Height of a fuzzy set – Normal and sub normal fuzzy sets – Support- Level sets - fuzzy points- α–cuts – Decomposition Theorems- Extension Principle.

UNIT – II

OPERATION ON FUZZY SETS: Standard fuzzy operations – Union– intersection and complement – Properties De. Morgan's laws- Aggregation operations.

UNIT – III

FUZZY RELATIONS: Crisp and Fuzzy Relations – Projections and Cylindric Extensions – Binary Fuzzy Relations – Binary Relations on a single set – Fuzzy Equivalence Relations - Fuzzy Compatibility Relations – Fuzzy ordering Relations – Fuzzy Morphisms.

UNIT – IV

DECISION MAKING IN FUZZY ENVIRONMENTS: General Discussion – IndividualDecision making – Multi person decision making – Multi criteria decision making – Multi stage decision making – Fuzzy ranking methods – Fuzzy linear programming.

UNIT – V

APPLICATIONS: Medicine – Economics – Fuzzy Systems and Genetic Algorithms – Fuzzy Regression – Interpersonal Communication – Other Applications.

TEXT BOOK:

1. George J. Klir and Bo Yuan, Fuzzy Sets and Fuzzy Logic, Prentice Hall of India, New Delhi, 2004.

UNIT – I	Chapters – 1 & 2	Sections 1.2 to 1.4 & 2.1 to 2.3
UNIT – II	Chapter – 3	Sections 3.1 to 3.6
UNIT – III	Chapter – 5	Sections 5.1 to 5.8
UNIT – IV	Chapter – 15	Sections 15.1 to 15.7
UNIT – V	Chapter – 17	Sections17.2 to 17.7

REFERENCE BOOKS:

1. A. K. Bhargava; Fuzzy Set Theory, Fuzzy Logic and their Applications, published by S. Chand Pvt. Limited (2013).
2. K.Pundir and R.Pundir, Fuzzy sets and their application, Published by A Pragati edition (2012)
3. H.J.Zimmermann, Fuzzy set theory and its applications, Springer (2012).

Web Link:

1. https://cours.etsmtl.ca/sys843/REFS/Books/ZimmermannFuzzySetTheory2001.pdf
2. https://www.pdfdrive.com/an-introduction-to-fuzzy-logic-and-fuzzy-sets-e157643851.html
3. https://www.pdfdrive.com/introduction-to-fuzzy-sets-fuzzy-logic-and-fuzzy-control-systems-e156646351.html

Relationship Matrix for COs, POs and PSOs

Semester	**Code**		**Title of the Course**			**Hours**			**Credits**	
I	23PMA1EC21		FUZZY SETS AND THEIR APPLICATIONS			6			3	
Course Outcomes (COs)	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CO2	✓		✓	✓	✓		✓		✓	
CO3	✓	✓			✓	✓	✓	✓	✓	
CO4	✓	✓	✓	✓		✓		✓	✓	✓
CO5	✓	✓	✓	✓			✓	✓		✓
Number of Matches(✓) = 38						Relationship: **HIGH**				

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very Poor	Poor	Moderate	High	Very High

SEMESTER – II

Course Code: 23PMA1EC21 Exam Hours: 3
Instruction Hours: 6 Internal Marks: 25
Credits: 3 External Marks: 75

ELECTIVE COURSE – II – DISCRETE MATHEMATICS

OBJECTIVES:

- To achieve this goal, students will learn logic and proof, sets functions, as well as definition.
- To know the examples of partial order mathematical reasoning.

COURSE OUTCOMES:

CLO1: The concepts needed to test the logic of a Computability and Formal Languages
CLO2: Have an understand in identifying structures on many levels Finite State Machines.
CLO3: Use of Boolean Algebras, Lattices and Algebraic Systems Use logical notation.
CLO4: To define mathematically about Discrete Numeric Functions and Generating Functions.
CLO5: The concept of Recurrence Relations and Recursive Algorithms.

UNIT – I

Computability and Formal Languages: Introduction – Russell's paradox and Noncomputability - Ordered Sets – Languages – Phrase Structure Grammars - Types of Grammars and Languages.

UNIT – II

Finite State Machines: Introduction – Finite State Machines – Finite State Machine as Models of Physical Systems – Equivalent Machines – Finite State Machines as Languages Recognizers – Finite State Languages and Type-3 Languages.

UNIT – III

Boolean Algebras: Lattices and Algebraic Systems – Principle of Duality – Basic Properties of Algebraic Systems Defined by Lattices – Distributive and Complemented Lattices – Boolean Lattices and Boolean Algebras – Uniqueness of Finite Boolean Algebras – Boolean Functions and Boolean Expressions

UNIT – IV

Discrete Numeric Functions and Generating Functions: Introduction – Manipulation of Numeric Functions – Asymptotic Behavior of Numeric Functions – Generating Functions – Combinatorial Problems

UNIT – V

Recurrence Relations and Recursive Algorithms: Introduction - Recurrence Relations – Linear Recurrence relations with constant coefficients – Homogeneous Solutions – Particular Solutions – Total solutions – Solution by the Method of Generating Functions.

TEXT BOOK(S):

1. C.L.Liu, Elements of Discrete Mathematics, Tata McGrawHill Publishing company Limited, New Delhi, and Second Edition.

UNIT – I	Chapter 2	Sections 2.1 to 2.6
UNIT – II	Chapter 7	Sections 7.1 to 7.6
UNIT – III	Chapter 12	Sections 12.7 to 12.7
UNIT – IV	Chapter 9	Sections 9.1 to 9.5
UNIT – V	Chapter 10	Sections 10.1 to 10.7

REFERENCE:

1. L.R. Vermani and Shalini, A course in discrete Mathematical structures, ImperialCollege Press London (2011).

Relationship Matrix for COs, POs and PSOs

Semester	**Code**		**Title of the Course**			**Hours**		**Credits**	
I	23PMA1EC21		DISCRETE MATHEMATICS			6		3	
Course Outcomes (COs)	**Programme Outcomes(POs)**					**Programme Specific Outcomes(PSOs)**			
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	✓	✓		✓		✓	✓	✓		✓
CO2	✓		✓		✓	✓	✓		✓	✓
CO3		✓	✓	✓		✓		✓	✓	✓
CO4	✓	✓		✓	✓		✓		✓	✓
CO5		✓	✓	✓	✓	✓	✓	✓	✓	
Number of Matches (✓) = 35						Relationship: **HIGH**				

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very Poor	Poor	Moderate	High	Very High

SEMESTER – II

Course Code: 23PMA2CC4 Exam Hours: 3

Instruction Hours: 6 Internal Marks: 25

Credits: 5 External Marks: 75

CORE COURSE - IV – ADVANCED ALGEBRA

OBJECTIVES:

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

Course Learning Outcome

Students will be able to

CLO1: Prove theorems applying algebraic ways of thinking.

CLO2: Connect groups with graphs and understanding about Hamiltonian graphs.

CLO3: Compose clear and accurate proofs using the concepts of Galois Theory.

CLO4: Bring out insight into Abstract Algebra with focus on axiomatic theories.

CLO5: Demonstrate knowledge and understanding of fundamental concepts including extension fields, Algebraic extensions, Finite fields, Class equations and Sylow's theorem.

UNIT – I

Extension fields – Transcendence of e.

UNIT – II

Roots or 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(S):

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

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)

WEB LINK:

1. http://mathforum.org, http://ocw.mit.edu/ocwweb/Mathematics,
2. http://www.opensource.org, www.algebra.com

Relationship Matrix for COs, POs and PSOs

Semester	**Code**		**Title of the Course**			**Hours**			**Credits**	
II	23PMA2CC4		ADVANCED ALGEBRA			6			5	
Course Outcomes (COs)	**Programme Outcomes(POs)**					**Programme Specific Outcomes(PSOs)**				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CO2	✓		✓		✓	✓	✓	✓	✓	✓
CO3		✓	✓	✓		✓		✓		✓
CO4	✓	✓		✓	✓		✓		✓	✓
CO5		✓	✓	✓	✓	✓	✓	✓	✓	
Number of Matches (✓) = 39						Relationship: **HIGH**				

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very Poor	Poor	Moderate	High	Very High

SEMESTER – II

Course Code: 23PMA2CC5 Exam Hours: 3
Instruction Hours: 6 Internal Marks: 25
Credits: 5 External Marks: 75

CORE COURSE - V – REAL ANALYSIS – II

OBJECTIVES:

- To introduce measure on the real line, Lebesgue measurability and inerrability.
- To understand Fourier Series and Integrals, in-depth study in multivariable calculus.

Course Learning Outcome

Students will be able to

CLO1: Understand and describe the basic concepts of Fourier series and Fourier integrals with respect to orthogonal system.

CLO2: Analyze the representation and convergence problems of Fourier series.

CLO3: Analyze and evaluate the difference between transforms of various functions.

CLO4: Formulate and evaluate complex contour integrals directly and by the fundamental theorem.

CLO5: Apply the Cauchy integral theorem in its various versions to compute contour integration.

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 a 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 –An Application to complex – valued functions - The matrix of a linear function - The Jacobian matrix - The chain rule - Matrix form of the 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: Introduction - Functions with non-zero Jacobian determinants – The inverse function theorem-The Implicit function - Theorem-Extrema of real valued functions of one variables-Extremum problems with side conditions.

TEXT BOOK(S):

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	Chapter – 2	Sections 2.1 to 2.5 (de Barra)
UNIT – II	Chapter – 3	Sections 3.1,3.2 and 3.4 (de Barra)
UNIT – III	Chapter – 11	Sections 11.1 to 11.15 (Apostol)
UNIT – IV	Chapter – 12	Sections 12.1 to 12.14 (Apostol)
UNIT – V	Chapter – 13	Sections 13.1 to 13.7 (Apostol)

REFERENCE BOOKS:

1. Munroe, M.E.*Measure and Integration*. Addison-Wesley, Mass.1971.
2. Roydon, H.L.*Real Analysis*, Macmillan Pub. Company, New York, 1988.
3. Rudin, W. *Principles of Mathematical Analysis*, McGraw Hill Company, New York,1979.

WEB LINK:

1. http://mathforum.org, http://ocw.mit.edu/ocwweb/Mathematics,
2. http://www.opensource.org

Relationship Matrix for COs, POs and PSOs

Semester	**Code**		**Title of the Course**				**Hours**		**Credits**	
II	23PMA2CC5		REAL ANALYSIS – II				6		5	
Course Outcomes (COs)	**Programme Outcomes(POs)**					**Programme Specific Outcomes(PSOs)**				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CO2	✓	✓		✓		✓	✓		✓	
CO3	✓	✓	✓		✓		✓	✓	✓	✓
CO4	✓		✓	✓		✓	✓	✓		✓
CO5		✓	✓	✓	✓	✓		✓	✓	✓
Number of Matches(✓) = 39						Relationship: **HIGH**				

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very Poor	Poor	Moderate	High	Very High

SEMESTER – II

Course Code: 23PMA2CC6 Exam Hours: 3
Instruction Hours: 6 Internal Marks: 25
Credits: 4 External Marks: 75

CORE COURSE - VI - PARTIAL DIFFERENTIAL EQUATIONS

OBJECTIVES:

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

Course Learning Outcome

Students will be able to

CLO1: To understand and classify second order equations and find general solutions

CLO2: To analyse and solve wave equations in different polar coordinates

CLO3: To solve Vibrating string problem, Heat conduction problem, to identify and solve Laplace and beam equations

CLO4: To apply maximum and minimum principle's and solve Dirichlet, Neumann problems for various boundary conditions

CLO5: To apply Green's function and solve Dirichlet, Laplace problems, to apply Helmholtz operation and to solve Higher dimensional problem

UNIT – I

First order P.D.E: Curves and Surfaces – Genesis of First Order P.D.E. – Classification of Integrals – Linear Equations of the first order – Pfaffian Differential Equations – Compatible systems – Charpit's Method..

UNIT – II

First order P.D.E (Continued): Jocobi's Method - Integral Surfaces Through a given Curve – Quasi–Linear Equations – Non-Linear First order P.D.E.

UNIT – III

Second order P.D.E: Genesis of second order P.D.E. – Classification of Second order P.D.E. One Dimensional Wave equation – Vibrations of an infinite string – Vibrations of semi-infinite string – Vibrations of a String of Finite Length (Method of separation of variables)

UNIT – IV

Laplace's Equation: Boundary value Problems – Maximum and Minimum Principles –The Cauchy Problem – The Dirichlet problem for the Upper Half Plane – The Neumann Problem for the Upper Half Plane – The Dirichlet Interior Problem for a circle – The Dirichlet Exterior for a circle – The Neumann Problem for a circle – The Dirichlet Problem for a Rectangle – Harnack's Theorem – Laplace's Equation-Green's Function.

UNIT – V

Heat Conduction problem: Heat Conduction– Infinite Rod case - Heat Conduction finite Rod case.

Duhamel's Principle: Wave Equation – Heat Conduction Equation.

TEXT BOOK(S)

1. T. Amarnath, An Elementary course in Partial Differential Equations, Narosa Publishing house Pvt. Ltd. Second Edition Fourth Reprint 2009.

UNIT – I	Chapter – 1	Sections 1.1 to 1.7
UNIT – II	Chapter – 1	Sections 1.8 to 1.11.
UNIT – III	Chapter – 2	Sections 2.1 to 2.3.5 (omit section 2.3.4.)
UNIT – IV	Chapter – 2	Sections 2.4.1 to 2.4.11
UNIT – V	Chapter – 2	Sections 2.5.and 2.6

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. M.D.Raisinghania, *Advanced Differential Equations*, S.Chand & Company Ltd., New Delhi, 2001.

WEB LINK:

1. http://mathforum.org, http://ocw.mit.edu/ocwweb/Mathematics,
2. http://www.opensource.org, www.mathpages.com

Relationship Matrix for COs, POs and PSOs

Semester	**Code**		**Title of the Course**			**Hours**		**Credits**		
II	23PMA2CC6		PARTIAL DIFFERENTIAL EQUATIONS			6		4		
Course Outcomes (COs)	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	✓	✓	✓	✓	✓	✓		✓	✓	✓
CO2			✓	✓	✓		✓			
CO3	✓	✓			✓	✓	✓	✓	✓	
CO4	✓	✓	✓	✓		✓		✓	✓	✓
CO5	✓	✓	✓	✓			✓	✓		✓
Number of Matches(✓) = 35						Relationship: **HIGH**				

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very Poor	Poor	Moderate	High	Very High

SEMESTER – II

Course Code: 23PMA2EC31 Exam Hours: 3
Instruction Hours: 5 Internal Marks: 25
Credits: 3 External Marks: 75

ELECTIVE COURSE – III – MATHEMATICAL STATISTICS

OBJECTIVES:

- To introduce the concepts involved in basic statistics and learn them with plenty of demonstrating examples
- To emphasize the correct statistical tools required to analyze and understand the results based on them.

COURSE OUTCOMES:

CLO1: To know the basic concepts of some theorems on probability and Bayes' theorem.
CLO2: To study the concepts of Random variables and Distribution Functions.
CLO3: Understanding the concepts involved in Theory of Attributes.
CLO4: Analyzing the concepts of Applications of t and F Distributions.
CLO5: Understanding the concepts of Theory of Estimations.

UNIT – I

THEORY OF PROBABILITY – I

Some theorems on Probability – Conditional Probability – Multiplication Theorem of Probability – Independent Events.

UNIT – II

RANDOM VARIABLES AND DISTRIBUTION FUNCTIONS

Introduction - Distribution Function - Discrete Random Variable – Continuous Random Variable.

UNIT – III

THEORY OF ATTRIBUTES

Introduction –Notations and Terminology – Classes and Class Frequencies – Consistency of Data – Independence of Attributes – Association of Attributes.

UNIT – IV

LARGE SAMPLE THEORY

Test of significance - Procedure for testing of hypothesis – Tests of significance for large samples – Sampling of attributes - Sampling of variables.

UNIT – V

THEORY OF ESTIMATION

Introduction – Characteristics of Estimators – Methods of Estimation.

TEXT BOOK (S)

1. S. C Gupta and V.K. Kapoor Fundamentals of Mathematical Statistics, Sultan Chand & Sons – Twelfth Edition,

UNIT - I	Chapter – 3	Sections 3.9 to 3.12
UNIT - II	Chapter – 5	Sections 5.1 to 5.4
UNIT - III	Chapter – 13	Sections 13.1 to 13.7
UNIT - IV	Chapter – 14	Section 14.4 to 14.8.
UNIT - V	Chapter – 17	Section 17.1, 17.2.4,

REFERENCE BOOK[s]

1. D.r. Caze – Applied Statistics – Principle and Examples
2. B.n. Ashana – Applied Statistics

Relationship Matrix for COs, POs and PSOs

Semester	**Code**		**Title of the Course**			**Hours**		**Credits**	
II	23PMA2EC31		MATHEMATICAL STATISTICS			5		3	
Course Outcomes (COs)	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**			
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	✓	✓	✓	✓	✓	✓	✓	✓		✓
CO2	✓			✓	✓		✓		✓	
CO3		✓	✓		✓	✓	✓	✓	✓	✓
CO4	✓	✓	✓	✓		✓		✓	✓	✓
CO5	✓	✓	✓	✓			✓	✓	✓	✓
Number of Matches (✓) = 38 Relationship: **HIGH**										

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very Poor	Poor	Moderate	High	Very High

SEMESTER – II

Course Code: 23PMA2EC32 Exam Hours: 3
Instruction Hours: 5 Internal Marks: 25
Credits: 3 External Marks: 75

ELECTIVE COURSE – III – TENSOR ANALYSIS AND SPECIAL THEORY OF RELATIVITY

COURSE OUTCOMES:

This course will enable the students to:

CLO1: Explain the basic concepts of tensors.

CLO2: Learn various properties of Christoffel's symbols, Ricci Theorem - Riemann - Christoffel Tensor and their properties.

CLO3: Understand the concept of Einstein Tensor, Riemannian and Euclidean Spaces.

CLO4: Learn about Galilean Transformation and Lorentz Transformation equations.

CLO5: Analyse Lagrangian and Hamiltonian formulations and Accelerated systems.

UNIT – I

Invariance - Transformations of coordinates and its properties - Transformation by invariance - Transformation by covariance and contra variance - Covariance and contra variance - Tensor and Tensor character of their laws - Algebras of tensors - Quotient tensors - Symmetric and skew symmetric tensors – Relative tensors.

UNIT – II

Metric Tensor - The fundamental and associated tensors - Christoffel's symbols - Transformations of Chrisffel's symbols- Covariant Differentiation of Tensors - Formulas for covariant Differentiation- Ricci Theorem - Riemann - Christoffel Tensor and their properties.

UNIT – III

Einstein Tensor- Riemannian and Euclidean Spaces (Existence Theorem)-The e-systems and the generalized Kronecker deltas - Application of the e-systems.

UNIT – IV

Special Theory of Relativity: Galilean Transformation - Maxwell's equations - The ether Theory – The Principle of Relativity Relativistic Kinamatics : Lorentz Transformation equations - Events and simultaneity - Example Einstein Train - Time dilation - Longitudinal Contraction -Invariant Interval - Proper time and Proper distance – World line - Example - twin paradox - addition of velocities - Relativistic Doppler effect.

UNIT – V

Relativistic Dynamics: Momentum – energy – Momentum-energy four vector – Force – Conservation of Energy – Mass and energy – Example – inelastic collision – Principle of equivalence – Lagrangian and Hamiltonian formulations. **Accelerated Systems:** Rocket with constant acceleration – example – Rocket with constant thrust.

TEXT BOOK(S):

1. I.S. Sokolnikoff, Tensor Analysis, John Wiley and Sons, New York, 1964
2. D. Greenwood, Classical Dynamics, Prentice Hall of India, New Delhi, 1985

UNIT – I	Chapter – 2	Sections 18 to 28 of [1]
UNIT – II	Chapter – 2	Sections 29 to 37 of [1]
UNIT – III	Chapter – 2	Sections 38 to 41 of [1]
UNIT – IV	Chapter – 7	Sections 7.1 & 7.2 of [2]
UNIT – V	Chapter – 7	Sections 7.3 & 7.4 of [2]

REFERENCE(S):

1. J.L. Synge and A.Schild, Tensor Calculus, Toronto, 1949.
2. A.S. Eddington, The Mathematical Theory of Relativity, Cambridge University Press, 1930.
3. P.G. Bergman, An Introduction to Theory of Relativity, New York, 1942.
4. C.E. Weatherburn, Riemannian Geometry and Tensor Calculus, Cambridge, 1938.

Relationship Matrix for COs, POs and PSOs

Semester	**Code**		**Title of the Course**			**Hours**			**Credits**	
II	23PMA2EC32		TENSOR ANALYSIS AND SPECIAL THEORY OF RELATIVITY			5			3	
Course Outcomes (COs)	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	✓	✓	✓	✓		✓	✓	✓		✓
CO2	✓			✓	✓		✓		✓	
CO3	✓	✓			✓	✓	✓	✓	✓	
CO4		✓	✓	✓		✓		✓	✓	✓
CO5	✓	✓	✓	✓			✓	✓		✓
Number of Matches (✓) = 34 Relationship: **MODERATE**										

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very Poor	Poor	Moderate	High	Very High

SEMESTER – II

Course Code: 23PMA2EC41 Exam Hours: 3
Instruction Hours: 5 Internal Marks: 25
Credits: 3 External Marks: 75

ELECTIVE COURSE – IV – PROGRAMMING IN C++

OBJECTIVES:

- Describe the object-oriented programming paradigm.
- Explain functions in C++, function prototyping, return by reference, lnline functions and function overloading

COURSEOUTCOMES:

CLO1: The learner will become proficient in object oriented programming concept in C++ tokens, operators, class declaration and definition and its objects.

CLO2: Discuss the constructors and destructors.

CLO3: Understand the concept of operator overloading and the concept inheritance.

CLO4: Discuss the working with files and Exception Handling.

CLO5: Demonstrate Standard Template Library, Manipulating Strings and Object Oriented Systems Development.

UNIT – I

Principles of Object Oriented Programming – Beginning with C++ - Tokens – Expressions And Control Structures – Functions in C++

UNIT – II

Classes and Objects – Constructors and Destructors – New Operator – Operator Overloading and Type Conversions

UNIT – III

Inheritance- Extending Classes – Pointers- Virtual Functions and Polymorphism

UNIT – IV

Managing Console, I/O Operations – Working with Files – Templates – Exception Handling

UNIT – V

Standard Template Library – Manipulating Strings – Object Oriented Systems Development

TEXT BOOK:

1. Balagursamy E, Object Oriented Programming with C++, Tata McGraw Hill Publications, Sixth Edition, 2013

REFERENCE(S):

1. Ashok Kamthane, Programming in C++, Pearson Education, 2013.

Web Link:

1. https://www.pdfdrive.com/c-programming-language-for-beginners-with-easy-tips-d176516054.html
2. https://www.youtube.com/watch?v=McojvctVsUs
3. https://www.youtube.com/watch?v=55lEuBLBTB8

Relationship Matrix for COs, POs and PSOs

Semester	**Code**		**Title of the Course**			**Hours**		**Credits**	
II	23PMA2EC41		PROGRAMMING IN C++			5		3	
Course Outcomes (COs)	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**			
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	✓	✓	✓	✓	✓	✓	✓	✓		✓
CO2	✓			✓	✓		✓		✓	
CO3		✓			✓	✓	✓	✓	✓	✓
CO4	✓	✓	✓	✓		✓			✓	✓
CO5	✓	✓	✓	✓			✓	✓		✓
Number of Matches (✓) = 35						Relationship: **HIGH**				

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very Poor	Poor	Moderate	High	Very High

SEMESTER – II

Course Code: 23PMA2EC42 Exam Hours: 3
Instruction Hours: 5 Internal Marks: 25
Credits: 3 External Marks: 75

ELECTIVE COURSE – IV – STOCHASTIC PROCESSES

OBJECTIVES

- To enable every student to face the touch situation in the world.
- The study of stochastic process is precisely to give comparative knowledge to every student.

COURSEOUTCOMES:

CLO1: Describe stability of a Markov System and limiting behavior.

CLO2: Define Renewal process, Cumulative Process, Semi-Markov Process and Classify queuing processes.

CLO3: Demonstrate queuing systems, Birth and Death queues with Finite and Infinite Capacity.

CLO4: Illustrate M/G/1 and G/M/1 Queues

CLO5: Study Brownian motion to create analytical skills and to think practical level in the real life situation so that the students can sharpen their knowledge better.

UNIT – I

Continuous Time Markov Chain and Examples-Transient Analysis - Occupancy Times- Limiting Behaviour.

UNIT – II

Renewal Process – Cumulative Process – Semi-Markov Process – Examples and Long term Analysis.

UNIT – III

Queuing Systems – Single-Station Queues– Birth and Death queues with Finite and Infinite Capacity

UNIT – IV

M/G/1Queues- G/M/1 Queues -Network of Queues

UNIT – V

Standard Brownian Motion-Brownian motion and First Passage Times

TEXT BOOK:

1. V.G. Kulkarni, Introduction to Modelling and Analysis of Stochastic Systems, Second Edition, Springer (2011)

UNIT – I	Chapter – 4	Sections 4.1 to 4.6
UNIT – II	Chapter – 5	Sections 5.1 to 5.5
UNIT – III	Chapter – 6	Sections 6.1 to 6.4
UNIT – IV	Chapter – 6	Sections 6.5 to 6.7
UNIT – V	Chapter – 7	Sections 7.3 to 7.5

REFERENCE BOOKS:

1. J. Medhi, Stochastic Processes, NEW AGE (2009).

2. S. M. Ross, Stochastic Processes, Wiley Series in Probability and Statistics (1996).

Web Link:

1. https://www.pdfdrive.com/stochastic-processes-sheldon-m-ross-e96204984.html
2. https://galton.uchicago.edu/~lalley/Courses/313/BrownianMotionCurrent.pdf

Relationship Matrix for COs, POs and PSOs

Semester	**Code**		**Title of the Course**			**Hours**			**Credits**	
II	23PMA2EC42		STOCHASTIC PROCESSES			5			3	
Course Outcomes (COs)	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	✓	✓	✓		✓	✓	✓	✓	✓	✓
CO2	✓		✓	✓	✓		✓		✓	✓
CO3		✓			✓	✓	✓	✓	✓	
CO4	✓		✓	✓		✓		✓	✓	✓
CO5	✓	✓	✓	✓			✓	✓		✓
Number of Matches(✓) = 36						Relationship: **HIGH**				

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very Poor	Poor	Moderate	High	Very High

SEMESTER – III

Course Code: 23PMA3CC7 Exam Hours: 3
Instruction Hours: 6 Internal Marks: 25
Credits: 5 External Marks: 75

CORE COURSE - VII - COMPLEX ANALYSIS

OBJECTIVES:

- To Study Cauchy integral formula, local properties of analytic functions, general form of Cauchy's theorem and
- To know about Evaluation of definite integral and harmonic functions

COURSE LEARNING OUTCOME

Students will be able to

CLO1: Analyze and evaluate local properties of analytical functions and definite integrals.

CLO2: Describe the concept of definite integral and harmonic functions.

CLO3: Demonstrate the concept of the general form of Cauchy's theorem

CLO4: Develop Taylor and Laurent series.

CLO5 Explain the infinite products, canonical products and jensen's formula.

UNIT - I

Cauchy's Integral Formula: The Index of a point with respect to a closed curve – The Integral formula – Higher derivatives.

Local Properties of analytical Functions: Removable Singularities-Taylors's Theorem – Zeros and poles.

UNIT - II

The general form of Cauchy's Theorem: The local Mapping – The Maximum Principle - Chains and cycles- Simple Continuity - Homology - The General statement of Cauchy's Theorem - Proof of Cauchy's theorem.

UNIT - III

Residue theorem - The argument principle.

Evaluation of Definite Integrals and Harmonic Functions**:** Definition of Harmonic function and basic properties - Mean value property.

UNIT-IV

Harmonic Functions and Power Series Expansions:

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

UNIT-V

Partial Fractions and Entire Functions: Partial fractions - Infinite products – Canonical products – Gamma Function- Jensen's formula – Hadamard's Theorem

TEXT BOOK(S):

1. Lars V. Ahlfors, *Complex Analysis*, (3rd edition) McGraw Hill Co., New York, 1979

UNIT – I	Chapter – 4	Section 2: 2.1 to 2.3 & Section 3 : 3.1 to 3.2
UNIT – II	Chapter – 4	Section 3: 3.3 to 3.4 & Section 4: 4.1 to 4.5
UNIT – III	Chapter – 4	Section 5: 5.1 and 5.2 & Sections 6: 6.1 to 6.2
UNIT – IV	Chapter – 4	Sections 6: 6.4, 6.5
	Chapter – 5	Sections 1.1 to 1.3
UNIT – V	Chapter – 5	Sections 2.1 to 2.4
	Chapter – 5	Sections 3.1 and 3.2

REFERENCE BOOKS:

1. H.A. Presfly, *Introduction to complex Analysis*, Clarendon Press, oxford, 1990.
2. J.B. Conway, *Functions of one complex variables* Springer - Verlag, International student Edition, Naroser Publishing Co.1978

WEB LINK:

1. http://mathforum.org, http://ocw.mit.edu/ocwweb/Mathematics,
2. http://www.opensource.org , http://en.wikipedia.org

Relationship Matrix for COs, POs and PSOs

Semester	**Code**		**Title of the Course**			**Hours**			**Credits**	
III	23PMA3CC7		COMPLEX ANALYSIS			6			5	
Course Outcomes (COs)	**Programme Outcomes(POs)**					**Programme Specific Outcomes(PSOs)**				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CO2	✓	✓	✓	✓	✓		✓		✓	✓
CO3			✓	✓		✓		✓	✓	
CO4	✓	✓	✓		✓	✓	✓	✓		✓
CO5	✓	✓		✓	✓	✓		✓	✓	✓
Number of Matches(✓) = 39						Relationship: **HIGH**				

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very Poor	Poor	Moderate	High	Very High

SEMESTER – III

Course Code: 23PMA3CC8 | Exam Hours: 3
Instruction Hours: 6 | Internal Marks: 25
Credits: 5 | External Marks: 75

CORE COURSE - VIII - CALCULUS OF VARIATIONS, INTEGRAL EQUATIONS AND TRANSFORMS

OBJECTIVES:

- To introduce various types of Integral Equations and Integral Transforms and to solve these equations.
- To understand the concept of Calculus of variation and its applications.

COURSEOUTCOMES:

CLO1: Describe calculus of variations and applications.

CLO2: Discuss regularity conditions and prove Fredholmalternative and Describe method of successive approximations and Volterra Integral

CLO3: Explain applications to ordinary differential equationsof Initial value boundary value problems and discuss singular integral equations to Abelintegral equation.

CLO4: Gain the knowledge about Fourier transforms and Parseval's Theorems.

CLO5: Demonstrate Hankel transforms and its properties.

UNIT – I

CALCULUS OF VARIATIONS: Variation and its properties – Euler's (Euler Lagrange's) equation – functional dependent on the functions of several independent variables – Variational problems in parametric form – Applications

UNIT – II

INTEGRAL EQUATIONS WITH SEPERABLE KERNELS: Introduction – Reduction to a system of Algebraic Equations – Examples - Fredholm Alternative – Example - An Approximate method.

UNIT – III

METHOD OF SUCCESSIVE APPROXIMATION: Volterra integral equations – Examples

CLASSICAL FREDHOLM THEORY: The method of solution of Fredholm – Fredholm's First Theorem - Fredholm's Second Theorem – Fredholm's Third Theorem.

UNIT – IV

FOURIER TRANSFORMS: Fourier Transforms– Fourier sinetransforms–cosine transforms – Fourier transforms of derivatives –Convolution integral – Parseval's Theorem –Solution of Laplace Equations by Fourier transform.

UNIT – V

HANKEL TRANSFORMS: Properties of Hankel Transforms – Hankel transformation of derivatives of functions – The Parseval's relation.

TEXT BOOK(S):

1. L.Elsgolts, Differential Equations and Calculus of Variations, Mir Publishers, Moscow, 1970
2. R.P.Kanwal, Linear Integral Equations Theory and Technique, Academic Press, New York, 1971.
3. Vasishtha, Gupta, Integral Transforms, Krishna Prakashan Media Pvt Ltd, India, 2008.

UNIT – I	Chapter – 6	Sections 1, 2, 5 to 7of [1]
UNIT – II	Chapters –1 & 2	Sections 1.1 to 1.7 & 2.1 to 2.5 of [2]
UNIT – III	Chapters – 3 & 4	Sections 3.3 to 3.4 & 4.1 to 4.5 of [2]
UNIT – IV	Chapter – 6	Sections 6.1 to 6.21 of [3]

UNIT – V Chapter – 9 Sections 9.1 to 9.7 of [3]

REFERENCE(S):

1. Shanti Swarup, Integral Equations, Krishna Prakashan Media Ltd, Meerut,1982.
2. I.N. Snedden, Mixed Boundary Value Problems in Potential Theory, North Holland, 1966.

Web Link:

1. https://www.ams.org/journals/qam/1968-25-04/S0033-569X-1968-0226328-3/S0033-569X-1968-0226328-3.pdf
2. https://www.pdfdrive.com/calculus-of-variations-e187405674.html
3. https://ia600908.us.archive.org/2/items/ElsgoltsDifferentialEquationsAndTheCalculusOfVariations/Elsgolts-Differential-Equations-and-the-Calculus-of-Variations.pdf

Relationship Matrix for COs, POs and PSOs

Semester	**Code**		**Title of the Course**			**Hours**		**Credits**	
III	23PMA3CC8		CALCULUS OF VARIATIONS, INTEGRAL EQUATIONS AND TRSNSFORMS			6		5	
Course Outcomes (COs)	**Programme Outcomes(POs)**					**Programme Specific Outcomes(PSOs)**			
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CO2	✓	✓	✓	✓	✓		✓		✓	✓
CO3			✓	✓		✓		✓	✓	
CO4	✓	✓	✓		✓	✓	✓	✓		✓
CO5	✓	✓		✓	✓	✓		✓	✓	✓
Number of Matches(✓) = 39						Relationship: **HIGH**				

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very Poor	Poor	Moderate	High	Very High

SEMESTER – III

Course Code: 23PMA3CC9 Exam Hours: 3
Instruction Hours: 6 Internal Marks: 25
Credits: 5 External Marks: 75

CORE IX - TOPOLOGY

OBJECTIVES:

- To study topological spaces, continuous functions, connectedness, compactness.
- To understand countability and separation axioms.

Course Learning Outcome

Students will be able to

CLO1: Define and illustrate the concept of topological spaces and the basic definitions of open sets, neighbourhood, interior, exterior, closure and their axioms for defining topological space.

CLO2: Understand continuity, compactness, connectedness, homeomorphism and topological properties.

CLO3: Analyze and apply the topological concepts in Functional Analysis.

CLO4: Ability to determine that a given point in a topological space is either a limit point or not for a given subset of a topological space.

CLO5: Develop qualitative tools to characterize connectedness, compactness, second countable, Hausdorff and develop tools to identify when two are equivalent(homeomorphic).

UNIT-I

Topological spaces : Topological spaces – Basis for a topology – The order topology – The product topology on $X \times Y$ – The subspace topology – Closed sets and limit points.

UNIT-II

Continuous functions: Continuous functions – the product topology – The metric topology.

UNIT-III

Connectedness: Connected spaces- connected subspaces of the Real line – Components and local connectedness.

UNIT-IV

Compactness: Compact spaces – compact subspaces of the Real line – Limit Point Compactness – Local Compactness.

UNIT-V

Countability and Separation Axiom: The Countability Axioms – The separation Axioms – Normal spaces – The Urysohn Lemma – The Urysohnmetrization Theorem – The Tietzextension theorem.

TEXT BOOK(S):

1. James R. Munkres, *Topology* (2^{nd} Edition) Pearson Education Pve. Ltd., Delhi-2002 (Third Indian Reprint)

UNIT – I	Chapter – 2	Sections 12 to 17
UNIT – II	Chapter – 2	Sections 18 to 21
UNIT – III	Chapter – 3	Sections 23 to 25.
UNIT – IV	Chapter – 3	Sections 26 to 29.
UNIT – V	Chapter – 4	Sections 30 to 35.

REFERENCE BOOKS:

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

3. J.L. Kelly, *General Topology*, Van Nostrand, Reinhold Co., New York

WEB LINK:

1. http://mathforum.org, http://ocw.mit.edu/ocwweb/Mathematics,
2. http://www.opensource.org , http://en.wikipedia.org

Relationship Matrix for COs, POs and PSOs

Semester	**Code**		**Title of the Course**				**Hours**		**Credits**	
III	22PMA3CC9		TOPOLOGY				6		5	
Course Outcomes (COs)	**Programme Outcomes(POs)**					**Programme Specific Outcomes(PSOs)**				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CO2	✓		✓	✓	✓		✓		✓	
CO3	✓	✓			✓	✓	✓	✓	✓	✓
CO4	✓	✓	✓	✓		✓		✓	✓	✓
CO5	✓	✓	✓	✓	✓		✓	✓		✓
Number of Matches(✓) = 40						Relationship: **HIGH**				

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very Poor	Poor	Moderate	High	Very High

SEMESTER – III

Course Code: 23PMA3CC10 | Exam Hours: 3
Instruction Hours: 5 | Internal Marks: 25
Credits: 4 | External Marks: 75

COURSE – ALGEBRAIC NUMBER THEORY

COURSE OUTCOMES:

This course will enable the students to learn

CLO1: Demonstrate Algebraic congruence,Primitive roots and theory of Indicices.

CLO2: Prove Euler Function and its Properties.

CLO3: Understand the concept of Farey Sequence, Continued Fractions and Pell's Equation.

CLO4: Methods and techniques used in number theory

CLO5: Demonstrate Knowledge and understanding of topics including, but not limited to divisible the congruences quadratic reciprocity.

UNIT – I

ALGEBRAIC CONGRUENCE AND PRIMITIVE ROOTS: Algebraic Congruence - Primitive Roots - Theory of Indices.

UNIT – II

ARITHMETIC FUNCTIONS: Arithmetic Functions – Euler's Function – Divisor Function – The Function σ - The Function $\sigma_k(n)$

UNIT – III

Farey Sequence – Continued Fractions – Notion of Convergents and Infinite Continued Fractions.

UNIT – IV

Quadratic Irrationals – Pell's Equation – Fibbonaci Numbers.

UNIT – V

Quadratic Residues - Legendre's Symbol –QuadraticReciprocity Law - Quadratic Residue for Composite Modules: Jacobi's Symbol.

TEXTBOOK:

1. K.C. Chowdhury, A First Course in Theory of Numbers, Asian Books Pvt. Ltd., New Delhi, 2004.

UNIT – I	Chapter – 3	Sections 3.1, 3.3 & 3.4
UNIT – II	Chapter – 4	Sections 4.1 to 4.5
UNIT – III	Chapter – 5	Sections5.1 to 5.3
UNIT – IV	Chapter – 5	Sections5.5 to 5.7
UNIT – V	Chapter – 6	Sections 6.1 to 6.4

REFERENCE(S):

1. S.B.Malik, Basic Number Theory, Second Edition, Vikas Publishing House Pvt. Ltd., Noida,2009.
2. George E. Andrews, Number Theory, Courier Dover Publications, 1994.

WEB LINK

1. https://dudhnoicollege.ac.in/online/attendence/classnotes/files/1626791483.pdf
2. https://books.google.co.in/books/about/Basic_Number_Theory_2nd_Edition.html?id=kQKmqpWtYnQC&redir_esc=y

Relationship Matrix for COs, POs and PSOs

Semester	**Code**		**Title of the Course**			**Hours**		**Credits**	
III	23PMA3CC10		ALGEBARIC NUMBER THEORY			5		4	
Course Outcomes (COs)	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**			
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CO2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CO3		✓	✓	✓		✓		✓		
CO4		✓		✓	✓		✓	✓		
CO5	✓	✓			✓	✓	✓		✓	✓
Number of Matches (✓) = 37						Relationship: **HIGH**				

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very Poor	Poor	Moderate	High	Very High

SEMESTER – III

Course Code: 23PMA3EC51 Exam Hours: 3
Instruction Hours: 5 Internal Marks: 25
Credits: 3 External Marks: 75

ELECTIVE COURSE – V – PROGRAMMING IN C++ (PRACTICAL)

COURSE OUTCOMES:

On completion of the course, the student will be able to

CLO1: To familiarize the students with language environment.

CLO2: To implement various concepts related to language.

CLO3: Identify importance of object oriented programming and difference between structured oriented and object oriented programming features.

CLO4: Able to make use of objects and classes for developing programs.

CLO5: Able to use various object oriented concepts to solve different problems.

1. Classes

Write a Program using a class to represent a Bank Account with Data Members – Name of depositor - Account Number - Type of Account and Balance and Member Functions – Deposit Amount – Withdrawal Amount - Show name and balance - Check the program with own data.

2. Constructor & Destructor

Write a program to read an integer and find the sum of all the digits until it reduces to a single digit using constructor-destructor and default constructor.

3. Default & Reference Argument

Write a program using function overloading to read two matrices of different data types such as integers and floating point numbers - Find out the sum of the above matrices separately and display the total sum of these arrays individually.

4. Operator Overloading

a. Addition of Two Complex Numbers.

b. Matrix Multiplication

5. Inheritance

Prepare Pay Roll of an employee using Inheritance

6. Pointers

a. Write a Program to find the number of vowels in a given text

b. Write a Program to check for Palindrome

7. Files

a. Prepare Students Mark List in a file with Student Number, Mark in four subjects and Mark Total.

b. Write a program to arrange these records in the ascending order of Mark Total and write them in the same file overwriting the earlier records.

8. Exception Handling

Prepare Electricity Bill for customers generating and handling any two Exceptions.

Web Link:

1. https://www.youtube.com/watch?v=xE5WMhTle88

Relationship Matrix for COs, POs and PSOs

Semester	**Code**		**Title of the Course**			**Hours**			**Credits**	
III	22PMA3EC51		PROGRAMMING IN C++ (PRACTICAL)			5			3	
Course Outcomes (COs)	**Programme Outcomes(POs)**					**Programme Specific Outcomes(PSOs)**				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CO2	✓			✓	✓		✓		✓	
CO3		✓			✓	✓	✓	✓		✓
CO4	✓	✓	✓	✓		✓			✓	✓
CO5	✓	✓	✓	✓			✓	✓		✓
Number of Matches(✓) = 35 Relationship: **HIGH**										

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very Poor	Poor	Moderate	High	Very High

SEMESTER – III

Course Code: 23PMA3EC52 Exam Hours: 3
Instruction Hours: 5 Internal Marks: 25
Credits: 3 External Marks: 75

ELECTIVE COURSE – V – FLUID DYNAMICS

OBJECTIVES:

- To establish an understanding of the fundamental concepts of fluid dynamics
- To make students understand the importance of fluid dynamics in diverse real life applications

COURSE OUTCOMES:

On successful completion of the course, the students will be able to

CLO1: Analyze fluid flow problems with the application of the momentum and energy equations

CLO2: Understand modelling approximations in finding exact solutions.

CLO3: Apply basic principles of multi-variable calculus, differential equations and complex variables to fluid dynamic problems.

CLO4: Understood Laplace equation and Stoke's stream function.

CLO5: State and Prove the Navier-Stokes equations andsteady flow between parallel planes.

UNIT – I

INTRODUCTORY IDEAS: Quantities like velocity and density pressure and etc. – streamlines and pathlines - stream tubes and filaments – fluid body - Bernoulli's theorem - differentiation w.r.to time - equation of continuity – transport theorem - boundary conditions - rate of change of linear momentum.

UNIT – II

INVISCID THEORY: Euler's equation - conservative forces - Lagrangian form of the equation of motion - steady motion - energy equation - rate of change of circulation – Kelvin's theorem - vortex motion and its permanence.

UNIT – III

TWO DIMENSIONAL MOTION: examples – stream function and velocity potential - complex potentials and flows – the singularities source-doublet and vortex - mixed flow method of images - circle theorem - flow past a circular cylinder with circulation – Blasius's theorem-lift force.

UNIT – IV

IRROTATIONAL MOTION IN THREE DIMENSIONS: Laplace equation – spherical harmonics – axially symmetric field – Stoke's stream function – motion of a sphere – pressure distribution – drag force – axial distributions of sources and doublets – continuous distributions – flow near axis due to sources and doublets.

UNIT – V

VISCOUS THEORY: The Navier-Stokes equations - vorticity and circulation in a viscous fluid – some exact solutions – steady flow through an arbitrary cylinder with pressure – steady Couette flow between cylinders in relative motion – steady flow between parallel planes - Couette and plane Poiseuille flow.

REFERENCES:

1. L.M. Milne Thomson, Theoretical Hydrodynamics, Dover, 1996.
2. N. Curle and H.J. Davies, Modern Fluid Dynamics, D Van Nostrand Company Ltd., London, 1968.
3. S.W. Yuan, Foundations of Fluid Mechanics, Prentice- Hall of India, New Delhi, 1988.
4. F. Chorlton, Textbook of Fluid Dynamics, CBS Publishers, New Delhi, 2004.
5. A.J. Chorin and A. Marsden, A Mathematical Introduction to Fluid Dynamics, Springer-Verlag, New York, 1993.

Web Link

1. http://mdudde.net/pdf/study_material_DDE/M.Sc.MAthematics/Fluid_Dynamics_final.pdf
2. https://www.pdfdrive.com/fluid-dynamics-part-1-classical-fluid-dynamics-d158427109.html
3. https://www.youtube.com/watch?v=9m5-kPzixfU

Relationship Matrix for COs, POs and PSOs

Semester	**Code**		**Title of the Course**			**Hours**			**Credits**	
III	23PMA3EC52		FLUID DYNAMICS			5			3	
Course Outcomes (COs)	**Programme Outcomes(POs)**					**Programme Specific Outcomes(PSOs)**				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CO2	✓			✓	✓		✓		✓	
CO3		✓			✓	✓	✓	✓	✓	✓
CO4	✓	✓	✓	✓		✓			✓	✓
CO5	✓	✓	✓	✓	✓		✓	✓		✓
Number of Matches(✓) = 37 Relationship: **HIGH**										

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very Poor	Poor	Moderate	High	Very High

SEMESTER – IV

Course Code: 23PMA4CC11 Exam Hours: 3
Instruction Hours: 6 Internal Marks: 25
Credits: 5 External Marks: 75

CORE COURSE - XI - FUNCTIONAL ANALYSIS

OBJECTIVES:

- To provide students with a strong foundation in functional analysis, focusing on spaces, operators and fundamental theorems.
- To develop student's skills and confidence in mathematical analysis and proof techniques.

Course Learning Outcome

Students will be able to

CLO1: Understand the Banach spaces and Transformations on Banach Spaces.

CLO2: Prove open mapping theorem.

CLO3: Describe Hilbert Spaces.

CLO4: Validate normal and unitary operators.

CLO5: Analyze and establish the spectral theorem.

UNIT – I

Banach Spaces: The definition and some examples – Continuous linear transformations – The Hahn-Banach theorem

UNIT – II

Banach Spaces (Continued): – The natural imbedding of N in N^{**}- The open mapping theorem – The conjugate of an Operator.

UNIT – III

Hilbert Spaces: The definition and some simple properties – Orthogonal complements – Ortho normal sets – The conjugate space H^*.

UNIT – IV

Hilbert Spaces (Continued): The adjoint of an operator–self-adjoint operators - Normal and unitary operators – Projections.

UNIT – V

Finite-Dimensional Spectral Theory: Matrices – Determinants and the spectrum of an operator – The spectral theorem.

TEXT BOOK(S):

1. F.Simmons, Introduction to Topology and Modern Analysis, McGraw Hill Education (India)Private Limited, New Delhi, 1963

UNIT – I	Chapter – 9	Sections 46 to 48
UNIT – II	Chapter – 9	Sections 49 to 51
UNIT – III	Chapter – 10	Sections 52 to 55
UNIT – IV	Chapter – 10	Sections 56 to 59
UNIT – V	Chapter – 11	Sections 60 to 62

REFERENCE BOOKS:

1. W.Rudin, Functional Analysis, McGraw Hill Education (India) Private Limited, New Delhi, 1973.
2. B.V. Limaye, Functional Analysis, New Age International,1996.
3. C. Goffman and G. Pedrick, First course in Functional Analysis, Prentice Hall of India, NewDelhi,1987.

WEB LINK:

1. http://mathforum.org, http://ocw.mit.edu/ocwweb/Mathematics,
2. http://www.opensource.org, http://en.wikiepedia.org

Relationship Matrix for COs, POs and PSOs

Semester	**Code**		**Title of the Course**			**Hours**		**Credits**	
IV	23PMA4CC11		FUNCTIONAL ANALYSIS			6		5	
Course Outcomes (COs)	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**			
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CO2	✓		✓	✓	✓		✓		✓	
CO3	✓	✓			✓	✓	✓	✓	✓	
CO4		✓	✓	✓		✓		✓	✓	✓
CO5	✓	✓	✓	✓			✓	✓		✓
Number of Matches (✓) = 37						Relationship: **HIGH**				

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very Poor	Poor	Moderate	High	Very High

SEMESTER – IV

Course Code: 23PMA1CC12 Exam Hours: 3
Instruction Hours: 6 Internal Marks: 25
Credits: 5 External Marks: 75

CORE COURSE - XII - DIFFERENTIAL GEOMETRY

OBJECTIVES:

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

Course Learning Outcome

Students will be able to

CLO1: Explain space curves, Curves between surfaces, metrics on a surface, fundamental form of a surface and Geodesics.

CLO2: Evaluate these concepts with related examples.

CLO3: Compose problems on geodesics.

CLO4: Recognize applicability of developable.

CLO5: Construct and analyze the problems on curvature and minimal surfaces

UNIT-I

Space curves: Definition of a space curve – Arc length – tangent – normal and binormal – curvature and torsion – contact between curves and surfaces- tangent surface- involutes and evolutes- Intrinsic equations – Fundamental Existence Theorem for space curves- Helices.

UNIT-II

Intrinsic properties of a surface: Definition of a surface – curves on a surface – Surface of revolution – Helicoids – Metric- Direction coefficients – families of curves- Isometric correspondence- Intrinsic properties

UNIT-III

Geodesics: Geodesics – Canonical geodesic equations – Normal property of geodesics- Existence Theorems – Geodesic parallels – Geodesics curvature- Gauss- Bonnet Theorem – Gaussian curvature- surface of constant curvature

UNIT-IV

Non Intrinsic properties of a surface: The second fundamental form- Principle curvature – Lines of curvature – Developable - Developable associated with space curves and with curves on surface - Minimal surfaces – Ruled surfaces.

UNIT-V

Differential Geometry of Surfaces: Compact surfaces whose points are umblics- Hilbert's lemma – Compact surface of constant curvature – Complete surface and their characterization – Hilbert's Theorem – Conjugate points on geodesics.

TEXT BOOK(S):

1. T.J.Willmore, An Introduction to Differential Geometry, Oxford University Press,(17^{th} Impression) New Delhi 2002. (Indian Print)

UNIT – I	Chapter – 1	Sections 1 to 9
UNIT – II	Chapter – 2	Sections 1 to 9
UNIT – III	Chapter – 2	Sections 10 to 18
UNIT – IV	Chapter – 3	Sections 1 to 8
UNIT – V	Chapter – 4	Sections 1 to 8

REFERENCE BOOKS:

1. Struik, D.T. *Lectures on Classical Differential Geometry*, Addison – Wesley, Mass. 1950.
2. Kobayashi. S. and Nomizu. K. *Foundations of Differential Geometry*, Inter science Publishers, 1963.
3. Wilhelm Klingenberg: *A course in Differential Geometry*, Graduate Texts in Mathematics, Springer-Verlag 1978.

WEB LINK:

1. http://mathforum.org, http://ocw.mit.edu/ocwweb/Mathematics,
2. http://www.opensource.org, www.physicsforum.com

Relationship Matrix for COs, POs and PSOs

Semester	**Code**		**Title of the Course**			**Hours**			**Credits**	
IV	23PMA4CC12		DIFFERENTIAL GEOMETRY			6			5	
Course Outcomes (COs)	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	✓	✓		✓	✓	✓	✓	✓	✓	✓
CO2	✓		✓	✓	✓		✓		✓	✓
CO3		✓	✓		✓	✓	✓	✓	✓	
CO4	✓	✓	✓	✓		✓		✓	✓	✓
CO5	✓	✓	✓	✓			✓	✓		✓
Number of Matches (✓) = 38						Relationship: **HIGH**				

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very Poor	Poor	Moderate	High	Very High

SEMESTER – IV

Course Code: 23PMA4EC61 Exam Hours: 3

Instruction Hours: 4 Internal Marks: 25

Credits: 3 External Marks: 75

ELECTIVE COURSE - VI – RESOURCE MANAGEMENT TECHNIQUES

OBJECTIVES

- To understand the concept of the Integer Programming and Dynamic Programming.
- To know about Nonlinear programming, Inventory and Queuing System.

COURSEOUTCOMES:

CLO1: Describe Integer Linear Programming and Gomory's all integer cutting plane method.

CLO2: The learner will befall skillful in decision making, markov process, integer programming, enumeration algorithm, dynamic programming, Stage coach and cargo leading problem.

CLO3: Acquire essential concepts in nonlinear programming.

CLO4: Explain EOQ, EOQ with Price Breaks and Inventory Problems with Uncertain Demand.

CLO5: Understand the concept of queuing theory andits Characteristics.

UNIT - I

INTEGER PROGRAMMING: Introduction – Integer Programming Formulations – Gomory's construction–The Cutting Plane Algorithm - Fractional cut method (all integer) – Branch and Bound Technique – Zero–One Implicit Enumeration Algorithm.

UNIT – II

DYNAMIC PROGRAMMING: Introduction – Application of Dynamic Programming: Capital Budgeting Problem – Reliability Improvement Problem – Stage–coach Problem – Cargo Leading Problem – Minimizing Total Tardiness in Single Machine Scheduling Problem.

UNIT – III

NON LINEAR PROGRAMMING: Introduction – Lagrangean Method - Kuhn–Tucker Method – Quadratic Programming – Separable Programming.

UNIT – IV

INVENTORY: Introduction – Types of Inventory – Cost Associated -with Inventories – Concept of Economic Order Quantity – Deterministic Inventory Problems with No Shortages – Deterministic inventory Models with shortages – EOQ with Price Breaks.

UNIT – V

QUEUING THEORY: Introduction – Queuing System – Elements Of Queuing System – Operating Characteristics of Queuing System – Classification of Queuing Models – Model–I(M/M/1):(∞/FIFO), Model – II (M/M/1) : (N/FIFO), Model–III (M/M/C):(∞/FIFO), Model – IV(M/M/C):(N/FIFO) - Problems in above four models.

TEXT BOOK:

1. Panneerselvam.R, Operations Research, 2nd Edition, PHI Learning Private Limited, Delhi, 2015
2. KantiSwarup, P.K. Gupta, Man Mohan, Operations Research, Sultan Chand & Sons, Educational Publishers, New Delhi.

UNIT – I	Chapter – 6	Sections 6.1 to 6.5 of [1]
UNIT – II	Chapter – 8	Sections 8.1 to 8.2.5 of [1]
UNIT – III	Chapter – 17	Sections 17.1 – 17.5 of [1]
UNIT – IV	Chapter – 19	Sections 19.2, 19.6, 19.9 to 19.12 [2]
UNIT – V	Chapter – 21	Sections 21.1 – 21.4, 21.7, 21.9 of [2]

REFERENCE BOOKS:

1. Hamdy A. Taha, Operations Research, (sixth edition) Prentice–Hall of India private Limited, New Delhi,1997.
2. Hiller.F.S & Lieberman.J Introduction to Operation Research,7th Edition, Tata – MCGraw Hill Publishing Company, New Delhi, 2001.
3. Prem Kumar Gupta.Er, Hira.D.S. Operations Research,7th Edition, S. Chand & Company Pvt. Ltd. 2014.

Relationship Matrix for COs, POs and PSOs

Semester	**Code**		**Title of the Course**			**Hours**			**Credits**	
IV	23PMA4EC61		RESOURCE MANAGEMENT TECHNIQUES			4			3	
Course Outcomes (COs)	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	✓	✓	✓	✓	✓	✓	✓	✓		✓
CO2	✓			✓	✓		✓		✓	
CO3	✓	✓			✓	✓	✓	✓	✓	
CO4	✓	✓	✓	✓		✓		✓	✓	✓
CO5	✓	✓	✓	✓			✓	✓		✓
Number of Matches (✓) = 36						Relationship: **HIGH**				

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very Poor	Poor	Moderate	High	Very High

SEMESTER – IV

Course Code: 23PMA4EC62 Exam Hours: 3
Instruction Hours: 4 Internal Marks: 25
Credits: 3 External Marks: 75

ELECTIVE COURSE – VI – FINANCIAL MATHEMATICS

OBJECTIVES:

- To know the financial mathematics through various models.
- To apply the various aspects of financial mathematics.

COURSE OUTCOMES:

This course will enable the students to

CLO1: Understand financial markets and derivatives including options and futures.

CLO2: Appreciate pricing and hedging of options, interest rate swaps and no-arbitrage pricing concepts.

CLO3: Study and use Hedging parameters, trading strategies and currency swaps.

CLO4: Understood Levy's Construction of Brownian motion and Martingales in Continuous time.

CLO5: Learn stochastic analysis, Ito's formula, Ito integral and the Black−Scholes model.

UNIT – I

SINGLE PERIOD MODELS: Definitions from Finance - Pricing a forward - One-step Binary Model - a ternary Model - Characterization of no arbitrage - Risk-Neutral Probability Measure.

UNIT – II

BINOMIAL TREES AND DISCRETE PARAMETER MARTINGALES: Multi-period Binary model - American Options - Discrete parameter martingales and Markov processes - Martingale Theorems - Binomial Representation Theorem - Overturn to Continuous models.

UNIT – III

BROWNIAN MOTION: Definition of the process - Levy's Construction of Brownian Motion - The Reflection Principle and Scaling - Martingales in Continuous time.

UNIT – IV

STOCHASTIC CALCULUS: Non-differentiability of Stock prices - Stochastic Integration - Ito's formula - Integration by parts and Stochastic Fubini Theorem - Girsanov Theorem - Brownian Martingale Representation Theorem - Geometric Brownian Motion - The FeynmanKac Representation.

UNIT – V

BLOCK-SCHOLES MODEL: Basic Block Scholes Model – Block Scholes price and hedge for European Options - Foreign Exchange - Dividends - Bonds - Market price of risk.

TEXT BOOK:

1. Alison Etheridge,A Course in Financial Calculus, Cambridge University Press, Cambridge, 2002.

REFERENCE(S):

1. Martin Boxter and Andrew Rennie, Financial Calculus: An Introduction to Derivatives Pricing, Cambridge University Press, Cambridge, 1996.
2. Damien Lamberton and Bernard Lapeyre, (Translated by Nicolas Rabeau and FarancoisMantion), Introduction to Stochastic Calculus Applied to Finance, Chapman and Hall, 1996.
3. MarekMusiela and MarekRutkowski, Martingale Methods in Financial Modeling, Springer Verlag, New York, 1988.
4. Robert J.Elliott and P.Ekkehard Kopp, Mathematics of Financial Markets, Springer Verlag, New York, 2001 (3rd Printing).

Web Link:

1. https://www.pdfdrive.com/financial-calculus-d85508935.html
2. https://www.pdfdrive.com/introduction-to-stochastic-calculus-applied-to-finance-second-edition-e189575436.html

Relationship Matrix for COs, POs and PSOs

Semester	**Code**		**Title of the Course**			**Hours**		**Credits**	
IV	23PMA4EC62		FINANCIAL MATHEMATICS			4		3	
Course Outcomes (COs)	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**			
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CO2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CO3		✓	✓	✓		✓		✓		
CO4		✓		✓	✓		✓	✓		
CO5	✓	✓			✓	✓	✓		✓	✓
Number of Matches (✓) = 37						Relationship: **HIGH**				

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very Poor	Poor	Moderate	High	Very High

SEMESTER – IV

Course Code: 23PMA4SE2 Exam Hours: 3
Instruction Hours: 2 Internal Marks: 25
Credits: 2 External Marks: 75

SKILL ENHANCEMENT COURSES II – SOFT SKILLS

Objective:

- Understand how soft skills complement technical expertise in mathematics-related careers.
- Enable students to work effectively as part of a team on mathematical projects and interdisciplinary collaborations.

Course Learning Outcome

CLO1: Develop self-awareness, confidence, and a growth mindset.
CLO2: Preparing for Positive Thinking and Motivation
CLO3: Gain advanced communication skills for effectively interacting in academic, industrial, and interdisciplinary settings.
CLO4: Foster creativity and innovation in applying mathematical theories to real-world problems.
CLO5: Build strong professional networks and explore diverse career paths in mathematics.

UNIT – I

Self-Awareness and Personal Growth: Individual strengths and weaknesses - Improvement in both mathematical and personal development - Embracing challenges, learning from mistakes, and celebrating progress in mathematics - Efficiently managing study time, deadlines, and balancing multiple tasks.

UNIT – II

Positive Thinking and Motivation: Building resilience in facing challenging mathematical problems - The role of motivation in consistent study habits - Developing a positive outlook on tackling complex mathematical concepts.

UNIT – III

Communication Skills: Mathematical Writing - Oral Communication - Active Listening and Feedback.
Teamwork and Collaboration: Effective Collaboration - Conflict Resolution - Leadership in Groups.

UNIT – IV

Problem-Solving and Critical Thinking: Analytical Thinking - Creative Problem-Solving - Decision-Making - Questioning assumptions and validating results - Identifying patterns and generalizing mathematical results - Comparing different methods to solve a problem.

UNIT – V

Networking and Interpersonal Skills: Building professional relationships with professors, mentors, and peers - Attending mathematical conferences and networking events effectively - Joining and contributing to academic or professional mathematics communities.

Reference Books:

1. Marshall B. Rosenberg, Nonviolent Communication: A Language of Life".
2. Patrick Lencioni "The Five Dysfunctions of a Team: A Leadership Fable".
3. Daniel Goleman, Emotional Intelligence: Why It Can Matter More Than IQ".

https://chatgpt.com/share/67516366-0658-8011-86a0-40edd218e678
https://chatgpt.com/share/6751605c-a9d8-8011-a0fc-8722f5c7271c

Relationship Matrix for COs, POs and PSOs

Semester	**Code**		**Title of the Course**			**Hours**			**Credits**	
IV	23PMA4SE2		Soft Skills			4			2	
Course Outcomes (COs)	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	✓	✓	✓	✓		✓	✓	✓	✓	✓
CO2	✓		✓	✓	✓	✓	✓		✓	✓
CO3		✓	✓	✓		✓		✓		
CO4		✓		✓	✓		✓	✓		
CO5	✓	✓			✓	✓	✓		✓	✓
Number of Matches (✓) = 34						Relationship: **MODERATE**				

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very Poor	Poor	Moderate	High	Very High

SEMESTER – IV

Course Code: 23PMA4SE1 Exam Hours: 3
Instruction Hours: 4 Internal Marks: 40
Credits: 2 External Marks: 60

SKILL ENHANCEMENT COURSES - NUMERICAL ANALYSIS USING SCILAB

OBJECTIVES:

- To make the students aware of SCILAB programming environment.
- Students will understand the basics of SCILAB software and code development.

COURSE OUTCOMRS:

CLO1: To introduce the exciting world of programming to the students through numerical methods.

CLO2: To introduce the techniques of SCILAB programming.

CLO3: To solve numerical problems using SCILAB programming.

CLO4: To solve Gauss eliminations method.

CLO5: To introduce R.K fourth order method.

LIST OF PRACTICALS:

1. Solving to the equations by Bisection method
2. Solving to the equations by Newton – Raphson method.
3. Solving to the equations by Gauss – Siedel method.
4. Solving to the equations by Gauss eliminations method.
5. Solving to the Integral equations by Trapezoidal rule.
6. Solving to the Integral equations by Simpson's rule.
7. Solving to the ODE by fourth order Range – Kutta method.

TEXT BOOK(S):

1. Scilab Textbook Companion for Numerical Methods for Scientific and Engineering Computation by M. K. Jain, S. R. K. Iyengar and R. K. Jain.

REFERENCE:

1. Programming using Scilab theory & practical, Akhilesh Kumar.

WEB LINK:

1. http://www.aagasc.edu.in/Scilab-Book-Akhilesh.pdf
2. https://mars.uta.edu/mae3183/simulation/introscilab_baudin.pdf

Relationship Matrix for COs, POs and PSOs

Semester	**Code**		**Title of the Course**			**Hours**			**Credits**	
IV	23PMA4SE1		NUMERICAL ANALYSIS USING SCILAB			4			2	
Course Outcomes (COs)	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	✓	✓	✓	✓		✓	✓	✓	✓	✓
CO2	✓	✓	✓	✓	✓	✓	✓		✓	✓
CO3		✓	✓	✓		✓		✓		
CO4		✓		✓	✓		✓	✓		
CO5	✓	✓			✓	✓	✓		✓	✓
Number of Matches (✓) = 35						Relationship: **HIGH**				

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very Poor	Poor	Moderate	High	Very High

SEMESTER – II

Course Code: 23PMA2NME11 Exam Hours: 3
Instruction Hours: 2 Internal Marks: 25
Credits: 2 External Marks: 75

NON – MAJOR ELECTIVE – I – MATHEMATICAL APTITUDE

OBJECTIVES:

- To learn the problem solving techniques for aptitude problems.
- To enable the students prepare themselves for various competitive examinations.

COURSE OUTCOMES:

CLO1: Describe the problems based on Mixture.

CLO2: Understand the techniques of Races and games of skills.

CLO3: Solve the problems based on Calendar and clocks.

CLO4: Using the concept of Stocks and Shares.

CLO5: Solve the problems Permutation & Combinations.

UNIT – I

Alligation or Mixture.

UNIT – II

Races & games of skills

UNIT III

Calendar & Clocks

UNIT - IV

Stocks & Shares

UNIT - V

Permutation & Combinations

TEXT BOOK:

1. Scope and treatment as in "Quantitative Aptitude" by R.S.Aggarwal, S.Chand & Company Ltd., Ram Nagar, New Delhi (2007)

UNIT – I	Chapter – 20
UNIT – II	Chapter – 26
UNIT – III	Chapters – 27 & 28
UNIT – IV	Chapter – 29
UNIT – V	Chapter – 30

REFERENCE(S):

1. R.V.Praveen, Quantitative Aptitude and Reasoning, Phi Learning, New Delhi, 2nd Edition-2013.

WEB LINK:

1. https://www.youtube.com/watch?v=CSxKH5zUvDQ
2. https://www.youtube.com/watch?v=xgXzcBqfy_I
3. https://www.youtube.com/watch?v=0NAASclUm4k

Relationship Matrix for COs, POs and PSOs

Semester	**Code**		**Title of the Course**			**Hours**		**Credits**		
II	23PMA2NME11		MATHEMATICAL APTITUDE			2		2		
Course Outcomes (COs)	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	✓	✓		✓		✓	✓	✓		✓
CO2	✓		✓		✓	✓	✓		✓	✓
CO3		✓	✓	✓		✓		✓	✓	✓
CO4	✓	✓		✓	✓		✓		✓	✓
CO5		✓	✓	✓	✓	✓	✓	✓	✓	
Number of Matches (✓) = 35						Relationship: **HIGH**				

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very Poor	Poor	Moderate	High	Very High

SEMESTER – II

Course Code: 23PMA2NME12 Exam Hours: 3
Instruction Hours: 3 Internal Marks: 25
Credits: 2 External Marks: 75

NON - MAJOR ELECTIVE – I – STATISTICS

COURSE OBJECTIVES:

- To introduce the concepts involved in basic statistics and learn them with plenty of demonstrating examples.
- To emphasize the correct statistical tools required to analyze and understand the results based on them.

COURSE OUTCOMES:

At the end of the course, students will be able to:

CLO1: Collect, classify and tabulate a given data and study graphical and diagrammatic representations through Bar diagrams, Pie diagram, Histogram, Frequency polygon

CLO2: Understand measures of central tendency, viz., Mean, Median and Mode in series of individual observations.

CLO3: Analyze measures of dispersion namely range, quartile deviation, Mean deviation about mean, standard deviation and co-efficient of variation for individual, discrete and continuous type data.

CLO4: Distinguish different types of correlation Calculate Karl Pearson's correlation coefficient for a lot of problems

CLO5: Compute partial and multiple regression coefficients for a plenty of problems.

UNIT – I

Collection- classification and tabulation of data - graphical and diagrammatic - Bar diagrams - Pie diagram – Histogram - Frequency polygon - frequency curve and Ogive.

UNIT – II

Measures of central tendency: Mean - Median - Mode – Geometric Mean – Harmonic Mean – Selection of an average – Partition Values.

UNIT – III

Measures of dispersion: Range - Quartile deviation - Mean deviation about an average - Standard deviation - co-efficient of variation for individual - discrete and continuous type data.

UNIT – IV

Correlation: Different types of correlation – Positive – Negative – Simple - Partial - Multiple - Linear and non-Linear correlation - Methods of correlation – Karl Pearson's Spearman's correlations and Concurrent deviation.

UNIT – V

Regression: Regression types and method of analysis - Regression line -Regression equations - Deviation taken from arithmetic mean of X and Y - Deviation taken from assumed mean - Partial and multiple regression coefficients - Applications

REFERENCES:

1. Gupta S.C. and Kapoor V.K., Fundamentals of Mathematical Statistics, Sultan Chand & Sons, 1994.
2. Freund J.E.(2001); Mathematical Statistics, Prentice Hall of India.
3. Goon, A.M., Gupta M.K., Dos Gupta, B, (1991), Fundamentals of Statistics, Vol. I, World Press, Calcutta.

Web Link:

1. https://books.google.co.in/books?id=FmuH3IcYIRYC&printsec=frontcover&source=gbs_ge_summary_r&cad=0#v=onepage&q&f=true
2. https://www.pdfdrive.com/statistics-601-advanced-statistical-methods-e387419.html
3. https://www.pdfdrive.com/mathematicsprobability-and-statisticsapplied-mathematics-e16657497.html

Relationship Matrix for COs, POs and PSOs

Semester	**Code**		**Title of the Course**			**Hours**		**Credits**	
II	23PMA2NME12		STATISTICS			2		2	
Course Outcomes (COs)	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**			
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	✓	✓		✓		✓	✓	✓		✓
CO2	✓		✓		✓	✓	✓		✓	✓
CO3		✓	✓	✓		✓		✓		✓
CO4	✓	✓		✓	✓		✓		✓	✓
CO5		✓	✓	✓	✓	✓	✓	✓	✓	
Number of Matches (✓)= 35						Relationship: **HIGH**				

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very Poor	Poor	Moderate	High	Very High

SEMESTER – III

Course Code: 23PMA3NME21 Exam Hours: 3
Instruction Hours: 2 Internal Marks: 25
Credits: 2 External Marks: 75

NON - MAJOR ELECTIVE – II – ANALYTICAL REASONING & MENTAL ABILITY

OBJECTIVES

- To comprehend complex ideas, solve problems, and apply learned skills through questions based on abstract reasoning, numeric reasoning, and verbal reasoning.
- To develop the thinking capacity.

COURSE OUTCOMES

CLO1: Understand the concept ofcoding and decoding test.

CLO2: Solve the problems based on blood relations.

CLO3: Illustrate the concept of direction sense test.

CLO4: Finding the problems oflogical diagram.

CLO5: Identify the short cuts of finding the missing one.

UNIT – I

Coding Decoding Test.

UNIT – II

Blood Relation.

UNIT – III

Direction sense Test

UNIT – IV

Logical Venn Diagram.

UNIT – V

Inserting the missing one

TEXT BOOK:

1. R.V.Praveen, Quantitative Aptitude and Reasoning, Phi Learning, New Delhi, 2nd Edition-2013.

Part – II Reasoning (Section – A)

UNIT – I	Chapter – 4
UNIT – II	Chapter – 5
UNIT – III	Chapter – 7
UNIT – IV	Chapter – 8
UNIT – V	Chapter –14

REFERENCE(S):

1. Scope and treatment as in "Quantitative Aptitude" by R.S.Aggarwal, S.Chand & Company Ltd., Ram Nagar, New Delhi (2007)

Web Link

1. https://3.imimg.com/data3/GR/OF/MY-1056081/quantitative-aptitude-and-reasoning.pdf
2. https://www.youtube.com/watch?v=Z3V2m7gtiLg

3. https://www.indiabix.com/non-verbal-reasoning/analytical-reasoning/

Relationship Matrix for COs, POs and PSOs

Semester	**Code**		**Title of the Course**			**Hours**		**Credits**	
III	23PMA3NME21		ANALYTICAL REASONING & MENTAL ABILITY			2		2	
Course Outcomes (COs)	**Programme Outcomes(POs)**					**Programme Specific Outcomes(PSOs)**			
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	✓	✓		✓		✓	✓	✓		✓
CO2	✓		✓		✓	✓	✓		✓	✓
CO3		✓	✓	✓		✓		✓	✓	✓
CO4	✓	✓		✓	✓		✓		✓	✓
CO5		✓	✓		✓	✓	✓	✓	✓	
Number of Matches (✓) = 34						Relationship: **Moderate**				

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very Poor	Poor	Moderate	High	Very High

SEMESTER – III

Course Code: 23PMA3NME22 Exam Hours: 3
Instruction Hours: 2 Internal Marks: 40
Credits: 2 External Marks: 60

NON - MAJOR ELECTIVE – II – SAGEMATH

OBJECTIVES

- To "create a viable free open source alternative to Magma, Maple, Mathematica and Matlab.
- SageMath is built upon open-source software and it is fully open-source by itself. It is free to use worldwide for private, commercial, governmental, etc..

COURSE OUTCOMES

CLO1: Using SageMath as a calculator.

CLO2: Implement and illustrate 2-D graphs and 3-D graphs.

CLO3: Solving mathematical problems and to plot using SageMath.

CLO4: Implement SageMath using templates and exceptional and handling concepts.

CLO5: Make use of theoretical concepts to solve problems and visualize the output.

List of Practical

1. Finding all local extrema and inflection points of a function.
2. Creating and plotting 2-D graphs and 3-D graphs.
3. Finding the surface area of given surface using package.
4. Finding the approximate roots using Newton's method.
5. Plotting and finding area between curves using integrals.
6. Finding the average of a function.
7. Finding the volume of solid of revolution.
8. Finding the solution for a system of linear equations.
9. Finding the divergence and curl of vector valued functions.
10. Using differential calculus to analyse a quintic polynomials features, for finding the optimal graphing window.

Books for Reference:

1. Razvan A. Mezei, An Introduction to SAGE Programming: With Applications to SAGE, Wiley, 2016
2. https://doc.sagemath.org/pdf/en/ttorial/SageTutorial.pdf

Web Link

1. https://www.perlego.com/book/996725/an-introduction-to-sage-programming-with-applications-to-sage-interacts-for-numerical-methods-pdf
2. https://www.pdfdrive.com/an-introduction-to-sage-programming-with-applications-to-sage-interacts-for-mathematics-d188174981.html

Relationship Matrix for COs, POs and PSOs

Semester	**Code**		**Title of the Course**			**Hours**		**Credits**	
III	23PMA3NME22		SAGEMATH			2		2	
Course Outcomes (COs)	**Programme Outcomes(POs)**					**Programme Specific Outcomes(PSOs)**			
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	✓	✓		✓		✓	✓	✓		✓
CO2	✓		✓		✓	✓	✓		✓	✓
CO3		✓	✓	✓		✓		✓	✓	✓
CO4	✓	✓		✓	✓		✓		✓	✓
CO5		✓	✓		✓	✓	✓	✓	✓	
Number of Matches (✓) = 34						Relationship: **Moderate**				

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very Poor	Poor	Moderate	High	Very High

SEMESTER – I

Course Code: 23PMAVA1 Exam Hours: 2
Credits: 2

VALUE ADDED COURSE – II – VEDIC MATHEMATICS

OBJECTIVES

- To develop the thinking capacity.
- To inquire many short tricks to solve problems
- Facilitate the habit of analytical thinking and measured approach towards any.

COURSE OUTCOMES

On completion of the course the student will be able:

1. To acquire basic knowledge of finding imperfect squares.
2. Compute the short cut methods of finding Cubes.
3. Solve the division problems with base methods.
4. Understand the concept of higher powers.
5. To gain the knowledge of Pythagorean values.

UNIT – I

Square Roots of Imperfect Squares- Characteristics - Method– Simple Problems.

UNIT – II

Cubing Numbers - Method One: Formula Method – Method Two: The Anurupya Sutra - The Rule of Zeros - Simple Problems.

UNIT – III

Base Method ofDivision – Format - Bigger Divisors - Simple Problems.

UNIT – IV

Division (Part Two)- Substitution Method - Divisibility Tests - Raising to fourth and higher powers.

UNIT – V

Pythagorean Values - Co-ordinate Geometry - Traditional Method One & Two - Vedic Mathematics Method.

TEXT BOOK:

1. Dhaval.Bathia , Vedic Mathematics Made Easy, Jaico Publishing House, Mumbai, 2006.

REFERENCE BOOK:

1. BharatiKrsnaTirthaji Maharaja, Vedic Mathematics, Motilal Banarsidass Publishers Private Ltd, Delhi, Re-Print 2004.
2. Ronak Bajaj, Vedic Mathematics, Black Rose Publications, 2005.

Web Link

1. https://www.researchgate.net/profile/Hazim-Tahir/post/How-can-I-find-the-coefficient-for-fitting-a-curve-in-MATLAB/attachment/59d61dd179197b807797a400/AS%3A273591222898691%401442240638234/download/MATLAB_+An+Introduction+with+Ap+-+Amos+Gilat.pdf
2. http://www.uop.edu.pk/ocontents/A%20Guide%20to%20MATALB.pdf

Relationship Matrix for COs, POs and PSOs

Semester	**Code**		**Title of the Course**			**Hours**			**Credits**	
I	23PMAVA1		VEDIC MATHEMATICS						2	
Course Outcomes (COs)	**Programme Outcomes(POs)**					**Programme Specific Outcomes(PSOs)**				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	✓	✓	✓	✓	✓	✓	✓		✓	✓
CO2	✓		✓		✓	✓		✓	✓	
CO3		✓	✓	✓				✓		✓
CO4	✓			✓	✓		✓		✓	✓
CO5		✓	✓		✓	✓	✓	✓	✓	
Number of Matches (✓)= 33						Relationship: **MODERATE**				

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very Poor	Poor	Moderate	High	Very High

SEMESTER – III

Course Code: 23PMAVA2 Exam Hours: 2
Credits: 2

VALUE ADDED COURSE – II – GENERAL MENTAL ABILITY
(Offered to students of Mathematics)

OBJECTIVES

- To comprehend complex ideas, solve problems, and apply learned skills through questions based on abstract reasoning, numeric reasoning, and verbal reasoning.
- To develop the thinking capacity.

COURSE OUTCOMES

1. Illustrate the concept of ranking and time sequence.
2. Describe the problems on assertion & reason.
3. Explain the tricks to find situation reaction.
4. Identify the short cuts of mathematical operations.
5. Understand the concept of finding the missing one.

UNIT I

Number Ranking and Time sequence test

UNIT II

Assertion and Reason

UNIT III

Situation Reaction Test

UNIT IV

Mathematical Operations

UNIT V

Inserting the missing one

TEXT BOOK:

1. R.V.Praveen, Quantitative Aptitude and Reasoning, Phi Learning, New Delhi, 2nd Edition-2013.
   Part – II Reasoning (Section – A)

UNIT – I	Chapter – 9
UNIT – II	Chapter – 11
UNIT – III	Chapter – 12
UNIT – IV	Chapter – 13
UNIT – V	Chapter – 14

Relationship Matrix for COs, POs and PSOs

Semester	**Code**		**Title of the Course**			**Hours**			**Credits**	
III	23PMAVA2		GENERAL MENTAL ABILITY						2	
Course Outcomes (COs)	**Programme Outcomes(POs)**					**Programme Specific Outcomes(PSOs)**				
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	✓	✓	✓	✓	✓	✓	✓		✓	✓
CO2	✓		✓		✓	✓		✓	✓	
CO3		✓	✓	✓				✓		✓
CO4	✓			✓	✓		✓		✓	✓
CO5		✓	✓		✓	✓	✓	✓	✓	
Number of Matches (✓) = 33						Relationship: **MODERATE**				

Mapping	1-29%	30-59%	60-69%	70-89%	90-100%
Matches	1-14	15-29	30-34	35-44	45-50
Relationship	Very Poor	Poor	Moderate	High	Very High