ST. MARY'S COLLEGE (Autonomous)

(Re-accredited with 'A$^+$' Grade by NAAC)

Thoothukudi-628001, Tamil Nadu

(Affiliated to Manonmaniam Sundaranar University)

Syllabus

M.Sc. Mathematics

School of Computing Sciences

Outcome Based Curriculum

(w.e.f.2023)

Preamble

Mathematics is the most beautiful and powerful tool, there's math all over the Universe and factors into every aspect of life. Many professions, such as engineering, medicine, physics, pharmacy, computer science and actuarial science, require math proficiency. Virtually all fields benefit from the analytical and problem-solving skills that students learn in mathematics. There is a remarkable correlation between mathematics that is beautiful, and mathematics that is important. Indeed, discovering surprising connections is one of the greatest joys of mathematics. The program has been designed to provide the opportunity to learn and refresh mathematical skills and ability.

Vision:

Contribute to the development of students as mathematical thinkers, enabling them to become lifelong learners, to continue to grow in the chosen professions, and to function as productive citizens.

Mission:

To provide an environment where students can learn and become competent users of mathematics and mathematical applications.

Program Outcome

PO No.	**After completion of the Postgraduate programme the students of St. Mary's College will be able to**
PO 1	acquire expertise knowledge in their respective disciplines and become professionals.
PO 2	develop critical/logical thinking skills, managerial skills and become locally, nationally & globally competent and be a lifelong learner
PO 3	pursue research / higher learning programme & apply their experiment and research skills to analyse and solve complex problems.
PO 4	compete in the job market by applying the knowledge acquired in Arts, Science, Economics, Commerce and Management studies
PO 5	be an empowered and economically independent woman with efficient leadership qualities and develop the themselves as a holistic person

Course Structure 2023 - 2025

Semester – I

Course	Course Code	Course Title	Contact Hours / Week	Credits	Max Marks		
					CIA	ESE	Total
Core I	23PMAC11	Algebraic Structures	7	5	25	75	100
Core II	23PMAC12	Real Analysis I	7	5	25	75	100
Core III	23PMAC13	Ordinary Differential Equations	6	4	25	75	100
Elective I	23PMAE11	Number Theory and Cryptography	5	3	25	75	100
Elective II	23PMAE12	Mathematical Programming	5	3	25	75	100
		Total	**30**	**20**			

Semester – II

Course	Course Code	Course Title	Contact Hours / Week	Credits	Max Marks		
					CIA	ESE	Total
Core IV	23PMAC21	Advanced Algebra	6	5	25	75	100
Core V	23PMAC22	Real Analysis II	6	5	25	75	100
Core VI	23PMAC23	Partial Differential Equations	6	4	25	75	100
Elective III	23PMAE21	Mathematical Statistics	4	3	25	75	100
Elective IV	23PMAE22	Graph Theory	4	3	25	75	100
Skill Enhancement Course I	23PMASE1	Statistics Using R Programming	4	2	25	75	100
		Total	**30**	**22**			

Semester – III

Course	Course Code	Course Title	Contact Hours / Week	Credits	Max Marks		
					CIA	ESE	Total
Core VII	23PMAC31	Complex Analysis	6	5	25	75	100
Core VIII	23PMAC32	Probability Theory	6	5	25	75	100
Core IX	23PMAC33	Topology	5	4	25	75	100
Core X	23PMAC34	Research Methodology	5	4	25	75	100
Discipline Specific Elective V	23PMAE31	Stochastic Processes	4	3	25	75	100
Skill Enhancement Course II	23PMASE2	Fluid Mechanics	4	3	25	75	100
Internship/ Self Study (Compulsory)				+2			
		Total	**30**	**24+2**			

Semester – IV

Course	Course Code	Course Title	Contact Hours / Week	Credits	Max Marks		
					CIA	ESE	Total
Core XI	23PMAC41	Functional Analysis	6	5	25	75	100
Core XII	23PMAC42	Differential Geometry	6	5	25	75	100
Core XIII	23PMAC43	Mechanics	6	5	25	75	100
Core XIV	23PMAC44	Operations Research	6	5	25	75	100
Core XV	23PMAP41	Project	6	4	25	75	100
		Total	**30**	**24**			

Master of Science (Mathematics)

Components	No. of Courses	No. of Hours	Credits	Extra Credits
Core	14	84	66	
Elective	5	22	15	
Project	1	6	4	
Skill Enhancement Course	2	8	5	
MOOC	1			+2
Self Study Course/MOOC/Internship				+2
	23	120	90	+4

Program Specific Outcome

PSO No.	Students of M.Sc. Mathematics will be able to	PO addressed to
PSO-1	acquire good knowledge and understanding, to solve specific theoretical & applied problems in different area of mathematics & applied statistics.	PO 1 , PO 4
PSO-2	understand, formulate, develop mathematical arguments, logically and use quantitative models to address issues arising in social sciences, business and other context /fields.	PO 2
PSO-3	prepare the students who will demonstrate respectful engagement with other's ideas, behaviors, beliefs and apply diverse frames of references to decisions and actions.	PO 4 , PO 5
PSO-4	provide systematic understanding of the concepts and theories of mathematics and their applications in the real world to an advanced level, and enhance career prospects in a huge array of fields	PO 4
PSO-5	encourage practices grounded in research that comply with employment laws, leading the organization towards growth and development.	PO 3

Semester I			
Core I	**Algebraic Structures**		
CourseCode:23PMAC11	**Hrs/Week:7**	**Hrs/Sem:105**	**Credits:5**

Course Objectives

- To provide an introduction of Normal Subgroups, permutation groups concept and to develop working knowledge of class equation for finite groups and Sylow's theorems.
- To enrich the students with the knowledge of Linear transformations.

Course Outcome

CO.NO.	Upon completion of this course, students will be able to	Cognitive Level
CO-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.	K1
CO-2	Define Solvable groups, define direct products, examine the properties of finite abelian groups, define modules.	K2
CO-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.	K3
CO-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.	K4
CO-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 .	K5

PSO Relation Matrix–Table

Course Outcomes	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)				
	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1	**3**	**2**	**1**	**2**	**1**	**3**	**2**	**1**	**2**	**1**
CO-2	**3**	**2**	**2**	**2**	**1**	**2**	**2**	**2**	**2**	**1**
CO-3	**3**	**2**	**1**	**2**	**1**	**3**	**2**	**2**	**2**	**2**
CO-4	**3**	**2**	**2**	**2**	**1**	**3**	**2**	**2**	**2**	**2**
CO-5	**1**	**1**	**3**	**2**	**1**	**3**	**2**	**2**	**2**	**2**
Ave.	**2.6**	**1.8**	**1.8**	**2**	**1**	**2.8**	**2**	**1.8**	**2**	**1.6**

Semester I			
Core I	**Algebraic Structures**		
CourseCode:23PMAC11	**Hrs/Week:7**	**Hrs/Sem:105**	**Credits:5**

UNIT I

Counting Principle - Class equation for finite groups and its applications - Sylow's Theorems (Fortheorem2.12.1, First proof only).

Chapter 2: Sections 2.11 and 2.12 (Omit Lemma2.12.5)

UNIT II

Solvable groups - Direct products - Finite abelian groups - Modules

Chapter 5: Section5.7 (Lemma5.7.1, Lemma 5.7.2, Theorem5.7.1)

Chapter 2: Section 2.13and 2.14 (Theorem2.14.1only)

Chapter 4: Section 4.5

UNIT III

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

Chapter 6: Sections 6.4, 6.5

UNIT IV

Jordan form - Rational canonical form

Chapter 6: Sections 6.6, 6.7

UNIT V

Trace and transpose - Hermitian, unitary, normal transformations, real quadratic form.

Chapter 6: Sections 6.8, 6.10 and 6.11

Text Book

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

Books for Reference

1. M.Artin, *Algebra,* Prentice Hall of India, 1991.
2. P.B.Bhattacharya,S.K.Jain, and S.R.Nagpaul, *Basic Abstract Algebra* (IIEdition)Cambridge University Press, 1997. (Indian Edition)
3. I.S.LutherandI.B.S.Passi, *Algebra,* Vol.I–Groups(1996);Vol.II Rings, Narosa Publishing House, NewDelhi, 1999

Semester I			
Core II	**Real Analysis I**		
Course Code: 23PMAC12	**Hrs/Week: 7**	**Hrs/Sem: 105**	**Credits: 5**

Course Objectives

- To work comfortably with functions of bounded variation, Riemann-Stieltjes Integration, convergence of infinite series, infinite product and uniform convergence and its interplay between various limiting operations.
- To acquire thorough knowledge about real functions, limit functions and their properties

Course Outcome

CO.NO.	Upon completion of this course, students will be able to	Cognitive Level
CO-1	Define and describe functions of bounded variation and Rectifiable Curves.	K1
CO-2	Explain the concept of Riemann-Stieltjes integral and its properties	K2
CO-3	Demonstrate the concept of step function, upper function, Lebesgue function and their integrals.	K3
CO-4	Construct various mathematical proofs using the properties of Lebesgue integrals and establish the Levi monotone convergence theorem.	K4
CO-5	Formulate the concept and properties of inner products, norms and measurable functions.	K5

PSO Relation Matrix–Table

Course Outcomes	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)				
	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1	**3**	**2**	**2**	**1**	**2**	**3**	**2**	**2**	**1**	**2**
CO-2	**2**	**3**	**2**	**1**	**2**	**3**	**2**	**1**	**2**	**1**
CO-3	**2**	**2**	**2**	**3**	**2**	**2**	**2**	**3**	3	**2**
CO-4	**2**	**2**	**3**	**2**	**2**	**2**	**3**	**2**	2	**2**
CO-5	**3**	2	**2**	**2**	**2**	**3**	**2**	**2**	**2**	**3**
Ave.	**2.4**	**2.2**	**2.2**	**1.8**	**2**	**2.6**	**2.2**	**2**	**2**	**2**

Semester I			
Core II	**Real Analysis I**		
Course Code: 23PMAC12	**Hrs/Week: 7**	**Hrs/Sem: 105**	**Credits: 5**

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.

Chapter – 6: Sections 6.1 to 6.8

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

Chapter 8: Sections 8.8, 8.15, 8.17, 8.18

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.

Chapter - 7: Sections 7.1 to 7.14

UNIT III

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

Chapter - 7: 7.15 to 7.26

UNIT IV

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

Chapter - 8 Sec, 8.20, 8.21 to 8.26

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

Chapter 9: Sections 9.14, 9.15, 9.19, 9.20, 9.22, 9.23

UNIT V

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

Chapter -9 Sec 9.1 to 9.6, 9.8, 9.9, 9.10, 9.11, 9.13

Text Book

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

Books for Reference

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

Semester I			
Core III	**Ordinary Differential Equations**		
Course Code: 23PMAC13	**Hrs/Week: 6**	**Hrs/Sem: 90**	**Credits: 4**

Course Objectives

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

Course Outcome

CO.NO.	Upon completion of this course, students will be able to	Cognitive Level
CO-1	Establish the qualitative behavior of solutions of systems of differential equations.	K1
CO-2	Recognize the physical phenomena modeled by differential equations and dynamical systems.	K2
CO-3	Analyze solutions using appropriate methods and give examples.	K3
CO-4	Evaluate the ordinary differential equations using variation of parameters, undetermined coefficients and by numerical technique.	K4
CO-5	Formulate and use various theoretical ideas and results that underlie the mathematics in this course.	K5

PSO Relation Matrix–Table

Course Outcomes	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)				
	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1	**3**	**3**	**2**	**2**	**2**	**3**	**2**	**3**	**2**	**2**
CO-2	**2**	**2**	**3**	**2**	**2**	**2**	**3**	**2**	**3**	**2**
CO-3	**3**	2	**2**	**3**	**2**	**3**	**2**	**2**	**2**	**2**
CO-4	**3**	**2**	**2**	**2**	**2**	**3**	**3**	**2**	**2**	**2**
CO-5	**2**	**3**	**2**	**2**	**2**	**3**	**2**	**1**	**3**	**2**
Ave.	**2.6**	**2.4**	**2.2**	**2.2**	**2**	**2.8**	**2.4**	**2**	**2.4**	**2**

Semester I			
Core III	**Ordinary Differential Equations**		
Course Code: 23PMAC13	**Hrs/Week: 6**	**Hrs/Sem: 90**	**Credits: 4**

UNIT I

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

Chapter 2: Sections 1 to 6

UNIT II

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

Chapter 2: Sections 7 to 12

UNIT III

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

Chapter: 3 Sections 1 to 8

UNIT IV

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

Chapter 4: Sections 1 to 4 and 6 to 8

UNIT V

Existence and uniqueness of solutions to first order equations: Equation with variable separated – Exact equation – Method of successive approximations – The Lipschitz condition – Convergence of the successive approximations and the existence theorem.

Chapter 5: Sections 1 to 6

Text Book

1. E.A.Coddington, *An Introduction To Ordinary Differential Equations* (3rd Printing) Prentice - Hall of India Ltd., New Delhi, 1987.

Books for Reference

1. Williams E. Boyce and Richard C. DI Prima, *Elementary differential equations and boundary value problems,* John Wiley and sons, New York, 1967.
2. George F Simmons, *Differential equations with applications and historical notes,* Tata McGraw Hill, New Delhi, 1974.
3. N.N. Lebedev, *Special functions and their applications*, Prentice Hall of India, New Delhi, 1965.

Semester I			
Elective I	**Number Theory and Cryptography**		
Code: 23PMAE11	**Hrs/Week: 5**	**Hrs/Sem: 75**	**Credits: 3**

Course Objectives

- To give elementary ideas from number theory which will have applications in cryptology
- To impart the knowledge of encryption and decryption techniques and their applications in managing the security of data.

Course Outcome

CO.NO.	Upon completion of this course, students will be able to	Cognitive Level
CO-1	give an account of fundamental theorems of the course and apply them in specific cases	K1
CO-2	apply Euler-Fermat's theorem to prove relations involving prime numbers	K2
CO-3	understand the definitions of congruence, residue classes and least residue	K3
CO-4	develop a deeper conceptual understanding of the theoretical basis of number theory and cryptography.	K4
CO-5	understand the concept of security, cryptography and defenses against them	K5

PSO Relation Matrix–Table

Course Outcomes	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)				
	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1	**3**	**2**	**2**	**3**	**2**	**3**	**3**	**3**	**3**	**3**
CO-2	**2**	**3**	**2**	**2**	**2**	**2**	**3**	**2**	**2**	**2**
CO-3	**3**	**3**	**2**	**2**	2	**3**	**3**	2	**3**	**3**
CO-4	**3**	**3**	3	**2**	**2**	**3**	**3**	**2**	3	**3**
CO-5	**3**	**3**	**3**	**2**	**2**	**3**	**3**	**2**	**3**	**3**
Ave.	**2.8**	**2.8**	**2.4**	**2.2**	**2**	**2.8**	**3**	**2.2**	**2.8**	**2.8**

Semester I			
Elective I	**Number Theory and Cryptography**		
Code: 23PMAE11	**Hrs/Week: 5**	**Hrs/Sem: 75**	**Credits: 3**

UNIT I

The Fundamental Theorem of Arithmetic: Divisibility – Greatest Common Divisor – Prime numbers – The Fundamental theorem of arithmetic – The series of reciprocals of the primes – The Euclidean algorithm – The greatest common divisor of more than two numbers.

Text Book 1: Chapter 1

UNIT II

Congruences: Definition and basic properties of congruences – Residue classes and complete residue systems – Linear congruences – Reduced residue systems and the Euler Fermat Theorem – Polynomial congruences modulo p. Lagrange's Theorem – Applications of Lagrange's Theorem – Simultaneous linear congruences. The Chinese remainder Theorem.

Text Book 1: Chapter 5: Sections 5.1 to 5.7

UNIT III

Arithmetic Functions and Dirichlet Multiplication: The Mobius function $\mu(n)$ – The Euler totient function $\varphi(n)$ – A relation connecting φ and μ – A product formula for φ(n) – The Dirichlet product of arithmetical functions – Dirichlet inverses and the Mobius inversion formula – The Mangoldt function – Multiplicative functions – Multiplicative functions and Dirichlet multiplication – The inverse of a completely multiplicative function – Liouville's function – The divisor functions – Generalized convolutions – Formal power series – The Bell series of an arithmetical function – Bell series and Dirichlet multiplication – Derivatives of arithmetical functions – The Selberg identity

Text Book 1: Chapter 2

UNIT IV

Cryptography: Some simple cryptosystems – Enciphering matrices

Text Book 2: Chapter 3

UNIT V

Public Key: The idea of public key cryptography – RSA – Discrete log – Knapsack

Text Book 2: Chapter 4: Sections 4.1 to 4.4

Text Book

1. Tom.M.Apostol ,*Introduction to Analytic Number Theory*, Narosa Publishing house, New Delhi.
2. Neal Koblitz, *A Course in Number Theory and Cryptography*, Springer-Verlag, New York

Books for Reference

1. David M Burton, *Elementary Number Theory*, Sixth Edition, Tat McGraw Hill Publishing House, Print Wade Trappe, Lawrence C Washington, New Delhi.
2. Ivan Niven and Herbert S. Zuckerman, *An Introduction to the Theory of numbers*, Wiley Eastern Ltd, Third Edition, 1976.
3. Harriet Griffin, *Elementary Theory of Numbers*. McGraw – Hall Book Company, INC 1954.

Website and e-Learning Sources

1.https://youtu.be/IWV6tLpqJ3w
2. https://youtu.be/sr0LDJI98sY
3.https://youtu.be/eL9AmU5afR0

Semester I			
Elective II	**Mathematical Programming**		
Course Code: 23PMAE12	**Hrs/Week: 5**	**Hrs/Sem: 75**	**Credits: 3**

Course Objectives

- To enable the use of optimization techniques.
- To acquire proper understanding of programming problems in real life.

Course Outcome

CO.NO.	Upon completion of this course, students will be able to	Cognitive Level
CO-1	understand integer programming problem and solve these problem using branch and bound method.	K1
CO-2	solve the optimal control problem for dynamic system using Bellman's principle of optimality.	K2
CO-3	learn classical optimization techniques and numerical methods of optimization.	K3
CO-4	construct linear programming models and explain the applications of linear programming problem.	K4
CO-5	construct the required resources to achieve a desired set of objectives using goal programming.	K5

PSO Relation Matrix–Table

Course Outcomes	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)				
	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1	**3**	**2**	**3**	**3**	**2**	**3**	**3**	**2**	**2**	**3**
CO-2	**3**	**3**	**3**	**3**	**1**	**2**	**3**	**2**	**3**	**2**
CO-3	**3**	**2**	**2**	**2**	**2**	**3**	**2**	**2**	**3**	**3**
CO-4	**3**	**3**	**2**	**2**	**1**	**3**	**2**	**2**	**2**	**2**
CO-5	**2**	**3**	**2**	**3**	**2**	**3**	**2**	**2**	**2**	**3**
Ave.	**2.8**	**2.6**	**2.4**	**2.6**	**1.6**	**2.8**	**2.4**	**2**	**2.4**	**2.6**

Semester I			
Elective II	**Mathematical Programming**		
Course Code: 23PMAE12	**Hrs/Week: 5**	**Hrs/Sem: 75**	**Credits: 3**

UNIT I

Integer Linear Programming: Types of integer linear programming problems – Concept of cutting plane- Gomory's all integer cutting plane method – Gomory's mixed integer cutting plane method – Branch and Bound Method

Chapter 7

UNIT II

Dynamic Programming: Characteristics of Dynamic Programming Problem-Developing Optimal Decision Policy – Dynamic Programming under certainty – DP approach to solve LPP

Chapter 22

UNIT III

Classical Optimization Method: Unconstraint Optimization – Constraint Multi- Variable optimization with equality constraints- Constraint Multi- Variable optimization with inequality constraints

Non-Linear Programming Methods: Examples of NLPP – General NLPP – Graphical Solutions – Quadratic Programming- Wolfe's Modified Simplex Method

Chapter 23 and Chapter 24: Sections 24.1 to 24.4 (omit Beale's Method)

UNIT IV

Linear Programming Problems: Simple Problems.

Parametric Linear Programming: Variation in the coefficients c_j , Variation in the Right Hand Side b_i..

Chapter 4: Sections 4.1 to 4.3 and Chapter 29

UNIT V

Goal Programming: Difference between LP and GP approach – Concepts of Goal Programming – Goal Programming Model Formulation – Graphical Solution Method of Goal Programming

Chapter 8: Sections 8.1 to 8.5

Text Book

1. K. Sharma, *Operation Research* (Fourth Edition) Macmillan, New Delhi, 2009.

Books for Reference

1. Hamdy A. Taha, *Operations Research* (Seventh Edition), Prentice – Hall of India Private Ltd, New Delhi, 1997.

2. F.S. Killer and J.Lieberman, *Introduction to Operations Research* (Seventh Edition) Tata Mc-Graw Hill Company , New Delhi 2001.

3. Beightier C, D. Phillips, B. Wilde, *Foundations of Optimization* (Second Edition), Prentice – Hall of India Private Ltd, New York, 1979.

Semester II			
Core IV	**Advanced Algebra**		
Course Code: 23PMAC21	**Hrs/Week: 6**	**Hrs/Sem: 90**	**Credits: 5**

Course Objectives

- To study field extension, roots of polynomials, Galois Theory, finite fields, division rings, and to develop computational skill in advanced algebra.
- Explain the fundamental concepts of advanced algebra and their role in modern mathematics and applied contexts.

Course Outcome

CO.NO.	Upon completion of this course, students will be able to	Cognitive Level
CO-1	write theorems applying algebraic ways of thinking.	K1
CO-2	Apply the knowledge of Algebra to attain a good mathematical maturity and enables to build mathematical thinking and reasoning.	K2
CO-3	compose clear and accurate proofs using the concepts of Galois Theory.	K3
CO-4	bring out insight into Abstract Algebra with focus on axiomatic theories.	K4
CO-5	demonstrate knowledge and understanding of fundamental concepts including extension fields, Algebraic extensions, Finite fields, Class equations and Sylow's theorem.	K5

PSO Relation Matrix–Table

Course Outcomes	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)				
	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1	**3**	**2**	**3**	**2**	**2**	**3**	**2**	**3**	**2**	**2**
CO-2	**3**	**3**	**2**	**2**	**3**	**3**	**3**	**2**	**2**	**2**
CO-3	**3**	**2**	**2**	**2**	**1**	**3**	**2**	**2**	**2**	**2**
CO-4	**3**	**3**	**2**	**2**	**2**	**2**	**2**	**2**	**1**	**1**
CO-5	**3**	**2**	**1**	**1**	**2**	**3**	**1**	**2**	**2**	**2**
Ave.	**3**	**2.4**	**2**	**1.8**	**2**	**2.8**	**2**	**2.2**	**1.8**	**1.8**

Semester II			
Core IV	**Advanced Algebra**		
Course Code: 23PMAC21	**Hrs/Week: 6**	**Hrs/Sem: 90**	**Credits: 5**

UNIT I

Extension fields – Transcendence of e.

Chapter 5: Section 5.1 and 5.2

UNIT II

Roots of Polynomials - More about roots

Chapter 5: Sections 5.3 and 5.5

UNIT III

Elements of Galois theory.

Chapter 5: Section 5.6

UNIT IV

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

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

UNIT V

A theorem of Frobenius - Integral Quaternions and the Four - Square theorem.

Chapter 7: Sections 7.3 and 7.4

Text Book

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

Books for Reference

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

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

3. I.S.Luther and I.B.S.Passi, *Algebra,* Vol. I –Groups(1996); Vol. II Rings, Narosa Publishing House , New Delhi, 1999

Semester II			
Core V	**Real Analysis II**		
Course Code: 23PMAC22	**Hrs/Week: 6**	**Hrs/Sem: 90**	**Credits: 5**

Course Objectives

- To introduce measure on the real line, Lebesgue measurability and integrability, in-depth study of multivariable calculus.
- To describe and analyze the convergence of Fourier Series and acquire knowledge on directional derivatives and partial derivatives.

Course Outcome

CO.NO.	Upon completion of this course, students will be able to	Cognitive Level
CO-1	Describe the basic concepts of Fourier series and Fourier integrals with respect to orthogonal system.	K1
CO-2	Interpret the representation and convergence problems of Fourier series.	K2
CO-3	Analyze and evaluate the difference between transforms of various functions.	K3
CO-4	Formulate and evaluate complex contour integrals directly and by the fundamental theorem.	K4
CO-5	Apply the Cauchy integral theorem in its various versions to compute contour integration.	K5

PSO Relation Matrix–Table

Course Outcomes	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)				
	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1	**3**	**2**	**1**	**2**	**1**	**3**	**2**	**2**	**1**	**1**
CO-2	**3**	**2**	**2**	**2**	**1**	**3**	**3**	**2**	**2**	**1**
CO-3	**3**	**2**	**1**	**2**	**1**	**3**	**2**	**2**	**2**	**2**
CO-4	**2**	**2**	**2**	**2**	**1**	**2**	**2**	**2**	**1**	**1**
CO-5	**3**	**2**	**2**	**2**	**1**	**3**	**2**	**2**	**2**	**1**
Ave.	**2.8**	**2**	**1.6**	**2**	**1**	**2.8**	**2.2**	**2**	**1.6**	**1.2**

Semester II			
Core V	**Real Analysis II**		
Course Code: 23PMAC22	**Hrs/Week: 6**	**Hrs/Sem: 90**	**Credits: 5**

UNIT I

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

Chapter - 2 Sec 2.1 to 2.5 (de Barra)

UNIT II

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

Chapter - 3 Sec 3.1, 3.2 and 3.4 (de Barra)

UNIT III

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

Chapter 11: Sections 11.1 to 11.15 (Apostol)

UNIT IV

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

Chapter 12: Section 12.1 to 12.12 (Apostol)

UNIT V

Implicit Functions: Functions with non-zero Jacobian determinants – The inverse function theorem-The Implicit function theorem

Chapter 13: Sections 13.1 to 13.4 (Apostol)

Text Book

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)

Books for Reference

1. Burkill,J.C.*The Lebesgue Integral*, Cambridge University Press, 1951.
2. Munroe,M.E.*Measure and Integration*. Addison-Wesley, Mass.1971.
3. Rudin, W. *Principles of Mathematical Analysis*, McGraw Hill Company, New York, 1979.

Semester II			
Core VI	**Partial Differential Equations**		
Course Code: 23PMAC23	**Hrs/Week: 6**	**Hrs/Sem: 90**	**Credits: 4**

Course Objectives

- To classify the second order partial differential equations and to study Cauchy problem, method of separation of variables, boundary value problems.
- To describe the behavior of physical systems such as heat conduction, fluid dynamics and electromagnetic fields.

Course Outcome

CO.NO.	Upon completion of this course, students will be able to	Cognitive Level
CO-1	understand and classify second order equations and find general solutions	K1
CO-2	analyse and solve wave equations in different polar coordinates	K2
CO-3	solve Vibrating string problem, Heat conduction problem, to identify and solve Laplace and beam equations	K3
CO-4	apply maximum and minimum principle's and solve Dirichlet, Neumann problems for various boundary conditions	K4
CO-5	apply Green's function and solve Dirichlet, Laplace problems, to apply Helmholtz operation and to solve Higher dimensional problem	K5

PSO Relation Matrix–Table

Course Outcomes	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)				
	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1	**3**	**3**	3	**3**	**2**	**3**	**2**	**3**	**3**	**3**
CO-2	**3**	3	3	3	**2**	**3**	**3**	**2**	**3**	**2**
CO-3	**3**	**3**	**3**	**2**	**2**	**3**	**3**	**2**	**3**	**3**
CO-4	**3**	**3**	**2**	**2**	**2**	**3**	**3**	**3**	**3**	**3**
CO-5	**3**	**3**	**3**	**2**	**2**	**3**	**3**	**3**	**3**	**3**
Ave.	**3**	**3**	**2.8**	**2.4**	**2**	**3**	**2.8**	**2.6**	**3**	**2.8**

Semester II			
Core VI	**Partial Differential Equations**		
Course Code: 23PMAC23	**Hrs/Week: 6**	**Hrs/Sem: 90**	**Credits: 4**

UNIT I

Mathematical Models and Classification of second order equation: Classical equations – Vibrating string – Vibrating membrane – Waves in elastic medium – Conduction of heat in solids – Gravitational potential – Second order equations in two independent variables – Canonical forms – Equations with constant coefficients – General solution

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

UNIT II

Cauchy Problem: The Cauchy problem – Cauchy Kowalewsky Theorem – Homogeneous wave equation – Initial Boundary value problem- Non-homogeneous boundary conditions – Finite string with fixed ends – Non-homogeneous wave equation – Riemann method – Goursat problem – Spherical wave equation – Cylindrical wave equation.

Chapter 4: Sections 4.1 to 4.11

UNIT III

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

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

UNIT IV

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

Chapter 8: Sections 8.1 to 8.9

UNIT V

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

Chapter 10: Section 10.1 to 10.9

Text Book

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

Books for Reference

1. M.M.Smirnov, *Second Order partial Differential Equations*, Leningrad, 1964.
2. I.N.Sneddon, *Elements of Partial Differential Equations*, McGraw Hill, New Delhi, 1983.
3. R. Dennemeyer, *Introduction to Partial Differential Equations and Boundary Value Problems*, McGraw Hill, New York, 1968.

Semester II			
Elective III	**Mathematical Statistics**		
Course Code: 23PMAE21	**Hrs/Week: 4**	**Hrs/Sem: 60**	**Credits: 3**

Course Objectives

- To enable the use of statistical techniques.
- To acquire proper understanding of statistical applications in real life.

Course Outcome

CO.NO.	Upon completion of this course, students will be able to	Cognitive Level
CO-1	understand the concepts of distributions and apply them.	K1
CO-2	compare the distribution with one another.	K2
CO-3	explain moment generating function and derive them.	K3
CO-4	learn the convergence in distribution of sequence of random variable	K4
CO-5	write the central limit theorem, and apply it.	K5

PSO Relation Matrix–Table

Course Outcomes	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)				
	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1	**3**	**2**	**2**	**2**	**2**	**3**	**2**	**3**	**2**	**3**
CO-2	**2**	**3**	**2**	**2**	**2**	**2**	**3**	**2**	**3**	**2**
CO-3	**3**	**2**	**2**	**2**	**2**	**3**	**2**	**3**	**2**	**3**
CO-4	**3**	**2**	**2**	**2**	**2**	**3**	**3**	**2**	**2**	**3**
CO-5	**2**	**3**	**3**	**2**	**2**	**3**	**2**	**2**	**2**	**2**
Ave.	**2.6**	**2.4**	**2.2**	**2**	**2**	**2.8**	**2.4**	**2.4**	**2.2**	**2.6**

Semester II			
Elective III	**Mathematical Statistics**		
Course Code:23PMAE21	**Hrs/Week: 4**	**Hrs/Sem: 60**	**Credits: 3**

UNIT I

Some special Distributions: The Binomial and Related Distributions – The Poisson Distribution - The Gamma and Chi-square Distributions – The Normal Distribution – The Bivariate Normal Distribution.

Chapter 3: Sections 3.1, 3.2, 3.3, 3.4, 3.5

UNIT II

Distributions of functions of Random variables: Sampling theory – Transformations of variables of the discrete type – Transformations of variables of the continuous type.

Chapter 4: Sections 4.1, 4.2, 4.3

UNIT III

The Beta, t, and F Distributions –Extensions of the Change of variable technique – Distributions of Order statistics

Chapter 4: Sections 4.4, 4.5, 4.6

UNIT IV

– The Moment generating function technique – The Distributions of$\bar{X}$ and nS^2/σ^2 – Expectations of functions of random variables.

Chapter 4: Sections, 4.7, 4.8, 4.9

UNIT V

Limiting Distributions: Convergence in Distribution – Convergence in Probability – Limiting Moment Generating Function – The central limit theorem – Some theorems on Limiting Distributions.

Chapter 5: Sections 5.1, 5.2, 5.3, 5.4, 5.5

Text Book

1. Robert V. Hogg and Allen T.Craig. *Introduction to Mathematical Statistics*. Pearson Education Asia. Fifth edition, 2004.

Books for Reference

1. J.N.Kapur, H.C. Saxena. *Mathematical Statistics,*S.Chand& Co, 2013.

2. Keith Knight. *Mathematical Statistics*. New York. Chapman & Hall/CRC, 2000.

3. S. C. Gupta, V.K.Kapoor, *Fundamentals of MathematicalStatistics,* Tenth Revised Edition, Sultan Chand and Sons, 2000

Semester II			
Elective IV	**Graph Theory**		
Course Code:23PMAE22	**Hrs/Week: 4**	**Hrs/Sem: 60**	**Credits: 3**

Course Objectives

- To understand and apply the fundamental concepts in Graph Theory.
- To apply Graph Theory based tools in solving practical problems.

Course Outcome

CO.NO.	Upon completion of this course, students will be able to	Cognitive Level
CO-1	demonstrate the concept of different structures and types about graphs and explain its applications.	K1
CO-2	determine the properties of tress and application in network and study the concepts of connection in graphs.	K2
CO-3	acquire the knowledge about Euler Tours, Hamilton Cycles and matchings in Graphs	K3
CO-4	analyze the concept of edge colouring, independent sets and cliques in Graphs.	K4
CO-5	explain the concept of vertex colouring.	K5

PSO Relation Matrix–Table

Course Outcomes	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)				
	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1	**2**	**2**	**2**	**2**	**1**	**3**	**2**	**2**	**2**	**1**
CO-2	**3**	**3**	**2**	**2**	**1**	**3**	**3**	**2**	**1**	**1**
CO-3	**3**	**2**	**1**	**1**	**1**	**3**	**2**	**2**	**2**	**1**
CO-4	**2**	**2**	**2**	**1**	**1**	**2**	**2**	**2**	**1**	**1**
CO-5	**2**	**2**	**2**	**2**	**1**	**2**	**2**	**2**	**1**	**1**
Ave.	**2.4**	**2.2**	**1.8**	**1.6**	**1**	**2.6**	**2.2**	**2**	**1.4**	**1**

Semester II			
Elective IV	**Graph Theory**		
Course Code:23PMAE22	**Hrs/Week: 4**	**Hrs/Sem: 60**	**Credits: 3**

UNIT I

Basic Concepts: Diagrammatic Representations – Subgraphs – Degrees of Vertices – Paths and Connectedness.

Chapter 1: Sections 1.1 – 1.5

UNIT II

Connectivity: Vertex cuts and Edge cuts – Connectivity and Edge connectivity - Blocks.

Chapter 3: Sections 3.1 – 3.4

UNIT III

Trees: Definition, characterization and simple properties – Centre and centroids – Counting the number of Spanning Trees – Cayley's formula

Chapter 4: Sections 4.1-4.5

UNIT IV

Independent Sets and Matchings: Vertex – Independent Sets and Vertex Coverings – Edge Independent Sets – Matchings and Factors – Matching in Bi-partite Graphs – Perfect Matching and the Tutte Matrix

Chapter 5: Sections 5.1- 5.6

UNIT V

Eulerian and Hamiltonian Graphs: Eulerian Graphs – Hamiltonian Graphs – Hamilton's "Around the World" Game Graph Colorings: Vertex colorings – Applications of Graph colorings – Critical Graphs – Brook's Theorem.

Chapter 6: Sections 6.1 – 6.3, Chapter 7: 7.1 – 7.3(7.3.1)

Text Book

1. R.Balakrishnan and K.Ranganathan, *Text Book of Graph Theory*, Springer Publications. 2012

Books for Reference

1. H.J.A Bondy and U.S.R.Murty. *Graph Theory with Applications.* North Holland, New York, Amsterdam, Oxford, 2008.

2. NarsingDeo, *Graph Theory with Applications to Engineering and Computer Science***,** Dover Publications, INC, Mineola, New York, Reprint 2016.

3. West, D. B., *Introduction to Graph Theory*, Pearson Education, 2011

Semester II			
Skill Enhancement Course I Statistics Using R Programming			
Course Code: 23PMASE1	**Hrs/Week: 4**	**Hrs/Sem: 60**	**Credits: 2**

Course Objectives

- To analysis data for the purpose of exploration using Descriptive and Inferential Statistics
- To learn the creative application of Linear Regression.

Course Outcome

CO.NO.	Upon completion of this course, students will be able to	Cognitive Level
CO-1	understand the fundamentals of R- Programming ,Math Functions	K1
CO-2	demonstrate simulation in R- Programming	K2
CO-3	know the principals of Graphics	K3
CO-4	develop application and performing T- Test and other relevant test	K4
CO-5	design and build Linear Model	K5

PSO Relation Matrix–Table

Course Outcomes	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)				
	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1	**3**	**2**	**3**	**3**	**2**	**3**	**2**	**3**	**2**	**3**
CO-2	**3**	**2**	**3**	**3**	**2**	**2**	**3**	**2**	**3**	**2**
CO-3	**3**	**2**	**3**	**3**	**2**	**3**	**2**	**2**	**3**	**3**
CO-4	**3**	**3**	**3**	**3**	**2**	**3**	**2**	**3**	**3**	**2**
CO-5	**3**	**2**	**3**	**2**	**2**	**3**	**3**	**2**	**2**	**3**
Ave.	3	2.2	3	2.8	2	2.8	2.4	2.4	2.6	2.6

Semester II			
Skill Enhancement Course I	**Statistics using R Programming**		
Course Code:23PMASE1	**Hrs/Week: 4**	**Hrs/Sem: 60**	**Credits: 2**

UNIT I:

Introduction, How to run R, Basic Math, Variables, Data Types, Vectors, Conclusion, Advanced Data Structures, Data Frames, Lists, Matrices, Arrays, Classes.

UNIT II:

Doing Math and Simulation in R, Math Function, Extended Example Calculating Probability Cumulative Sums and Products-Minima and Maxima- Calculus, Functions Fir Statistical Distribution, Sorting, Linear Algebra Operation on Vectors and Matrices, Reading and writer Files.

UNIT III:

Graphics, Creating Graphs, The Workhorse of R Base Graphics, the plot() Function – Customizing Graphs, Saving Graphs to Files.

UNIT IV:

Probability Distributions, Normal Distribution- Binomial Distribution- Poisson Distributions Other Distribution, Basic Statistics, Correlation and Covariance, T-Tests,-ANOVA.

UNITV:

Linear Models, Simple Linear Regression, -Multiple Regression Generalized Linear Models, Logistic Regression, - Poisson Regression- other Generalized Linear Models-Survival Analysis, Nonlinear Models, Splines- Decision- Random Forests.

Text Books

1. Jared P. Lander, *R for Everyone*, Pearson Education , 2014
2. The Art of R Programming, Norman Matloff, No starch Press , 2011

Books for Reference

1. Paul Teetor, *R Cookbook*, O'reilly, First Edition 2011.
2. Robert I.Kabacoff, *R in Action*, Manning Publication. 20 May 2015
3. KG Srinivasa, G.M. Siddesh,Chetan Shetty, B.J. Sowmya, *Statistical Programming in R* , 1st Edition , 5 June 2017

Semester III			
Core VII	**Complex Analysis**		
Course Code: 23PMAC31	**Hrs/Week: 6**	**Hrs/Sem: 90**	**Credits: 5**

Course Objectives

- To initiate the students to enjoy complex variables and to relate the problems with reallife problems.
- To introduce the fundamental ideas of the functions of complex variables and developing a clear understanding of the fundamental concepts of complex analysis such as analytic function, complex integrals and a range of skills which will allow students to work effectively with the concepts.

Course Outcome

CO.NO.	Upon completion of this course, students will be able to	Cognitive Level
CO-1	demonstrate the concept of the general form of cauchy's theorem	K1
CO-2	describe the concept of definite integral and harmonic functions.	K2
CO-3	analyze and evaluate local properties of analytical functions and definite integrals.	K3
CO-4	explain the infinite products, canonical products and jensen's formula.	K4
CO-5	Develop taylor's series and Laurent series.	K5

PSO Relation Matrix–Table

Course Outcomes	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)				
	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1	**3**	**2**	**3**	**3**	**2**	**3**	**2**	**3**	**2**	**3**
CO-2	**3**	**2**	**3**	**3**	**2**	**2**	**3**	**2**	**3**	**2**
CO-3	**3**	**2**	**3**	**3**	**2**	**3**	**2**	**2**	**3**	**3**
CO-4	**3**	**3**	**3**	**3**	**2**	**3**	**2**	**3**	**3**	**2**
CO-5	**3**	**2**	**3**	**2**	**2**	**3**	**3**	**2**	**2**	**3**
Ave.	**3**	**2.2**	**3**	**2.8**	**2**	**2.8**	**2.4**	**2.4**	**2.6**	**2.6**

Semester III			
Core VII	**Complex Analysis**		
Course Code: 23PMAC31	**Hrs/Week: 6**	**Hrs/Sem: 90**	**Credits: 5**

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 - The local Mapping - The Maximum Principle.

Chapter 4: Section 2: 2.1 to 2.3 and Section 3: 3.1 to 3.4

UNIT-II

The general form of Cauchy's Theorem: Chains and cycles - Simple Continuity - Homology - The General statement of Cauchy's Theorem - Proof of Cauchy's theorem - Locally exact differentials - Multiply connected regions - Residue theorem - The argument principle.

Chapter 4: Section 4: 4.1 to 4.7 and Section 5: 5.1 and 5.2

UNIT-III

Evaluation of Definite Integrals and Harmonic Functions Evaluation of definite integrals - Definition of Harmonic function and basic properties - Mean value property - Poisson formula.

Chapter 4: Section 5: 5.3 and Sections 6: 6.1 to 6.3

UNIT-IV

Harmonic Functions and Power Series Expansions: Schwarz theorem - The reflection principle - Weierstrass theorem - Taylor's Series - Laurent series.

Chapter 4: Sections 6.4 and 6.5 and Chapter 5: Sections 1.1 to 1.3

UNIT-V

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

Chapter 5: Sections 2.1 to 2.4 and Sections 3.1 and 3.2

Text Book

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

Books for Reference

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
3. E. Hille, *Analytic function Thorey* (2 vols.), Gonm& Co, 1959.

Semester III			
Core VIII	**Probability Theory**		
Course Code: 23PMAC32	**Hrs/Week: 6**	**Hrs/Sem: 90**	**Credits: 5**

Course Objectives

- To introduce the fundamentals of probability theory and random processes and illustrate these concepts with engineering applications.
- To introduce the foundations of probabilistic and statistical analysis mostly used in varied applications in engineering and sciences. .

Course Outcome

CO.NO.	Upon completion of this course, students will be able to	Cognitive Level
CO-1	Describe the probability distributions of functions of random variables	K1
CO-2	Explain Expectation, Moments and Chebyshev inequality solve regression of first and second types.	K2
CO-3	Construct characteristic functions and probobilty generating functions to solve problems.	K3
CO-4	Analyze one point two point binomial distributions, hypergeometric and poisson distributions and solve problems	K4
CO-5	Interpret the bernouliis law of large numbers and elaborate the convergence of sequence of distribution functions.	K5

PSO Relation Matrix–Table

Course Outcomes	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)				
	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1	**3**	**2**	**3**	**2**	**3**	**3**	**3**	**2**	**2**	**3**
CO-2	**2**	**2**	**3**	**3**	**2**	**3**	**3**	**2**	**1**	**2**
CO-3	**3**	**2**	**3**	**3**	**2**	**3**	**3**	**2**	**3**	**3**
CO-4	**2**	**3**	**2**	**2**	**2**	**3**	**3**	**2**	**3**	**2**
CO-5	**3**	**2**	**3**	**2**	**2**	**3**	**3**	**2**	**2**	**3**
Ave.	**2.6**	**2.2**	**2.8**	**2.8**	**2.4**	**3**	**3**	**2**	**2.2**	**2.6**

Semester III			
Core VIII	**Probability Theory**		
Course Code: 23PMAC32	**Hrs/Week: 6**	**Hrs/Sem: 90**	**Credits: 5**

UNIT-I

Random Events and Random Variables: Random events - Probability axioms - Combinatorial formulae - conditional probability - Bayes Theorem - Independent events - Random Variables - Distribution Function – Joint Distribution - Marginal Distribution - Conditional Distribution - Independent random variables - Functions of random variables.

Chapter 1: Sections 1.1 to 1.7 and Chapter 2: Sections 2.1 to 2.9

UNIT-II

Parameters of the Distribution: Expectation - Moments - The Chebyshev Inequality - Absolute moments - Order parameters - Moments of random vectors - Regression of the first and second types.

Chapter 3: Sections 3.1 to 3.8

UNIT-III

Characteristic functions : Properties of characteristic functions - Characteristic functions and moments - semi invariants - characteristic function of the sum of the independent random variables - Determination of distribution function by the Characteristic function - Characteristic function of multidimensional random vectors - Probability generating functions.

Chapter 4: Sections 4.1 to 4.7

UNIT-IV

Some Probability distributions: One point , two point , Binomial - Polya - Hypergeometric -Poisson (discrete) distributions - Uniform - normal gamma - Beta - Cauchy and Laplace (continuous) distributions.

Chapter 5: Section 5.1 to 5.10

UNIT-V

Limit Theorems : Stochastic convergence - Bernaulli law of large numbers - Convergence of sequence of distribution functions - Levy-Cramer Theorems - de Moivre-Laplace Theorem - Poisson, Chebyshev, Khintchine Weak law of large numbers - Lindberg Theorem - Lapunov Theroem - Borel-Cantelli Lemma - Kolmogorov Inequality and Kolmogorov Strong Law of large numbers.

Chapter 6: Sections 6.1 to 6.4, 6.6 to 6.9, 6.11 and 6.12.

Text Book

1. M. Fisz, *Probability Theory and Mathematical Statistics,* John Wiley and Sons, New York, 1963.

Books for Reference

1. R.B. Ash, *Real Analysis and Probability*, Academic Press, New York, 1972
2. K.L.Chung, *A course in Probability*, Academic Press, New York, 1974.
3. R.Durrett, *Probability : Theory and Examples*, (2^{nd} Edition) Duxbury Press, New York, 1996.

Semester III			
Core IX	**Topology**		
Course Code: 23PMAC33	**Hrs/Week: 5**	**Hrs/Sem: 75**	**Credits: 4**

Course Objectives

- To concern with the properties of geometric object that are preserved under continuous deformations such as stretching, twisting, crumpling and bending but not tearing or gluing.
- To introduce the fundamental ideas of Topological spaces and developing a clear understanding of the fundamental concepts of connectedness, compactness, continuity, separation and countability axioms.

Course Outcome

CO.NO.	Upon completion of this course, students will be able to	Cognitive Level
CO-1	define and illustrate the concepts of topological spaces and related topologies.	K1
CO-2	explain how the topology on a space is determined by the collection of open sets, by the collection of closed sets, or by a basis of neighbourhoods at each point, and the conditions for a function to be continuous.	K2
CO-3	apply the knowledge general topology to formulate and solve problems of a topological nature in mathematics and other fields where topological issues arise.	K3
CO-4	use continuous functions and homeomorphisms to understand structure of topological spaces.	K4
CO-5	create new topological spaces by using subspaces, product and quotient topologies.	K5

PSO Relation Matrix–Table

Course Outcomes	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)				
	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1	**3**	**2**	**3**	**3**	**2**	**3**	**2**	**3**	**2**	**3**
CO-2	**3**	**2**	**3**	**3**	**2**	**2**	**3**	**2**	**3**	**2**
CO-3	**3**	**2**	**3**	**3**	**2**	**3**	**2**	**2**	**3**	**3**
CO-4	**3**	**3**	**3**	**3**	**2**	**3**	**2**	**3**	**3**	**2**
CO-5	**3**	**2**	**3**	**2**	**2**	**3**	**3**	**2**	**2**	**3**
Ave.	**3**	**2.2**	**3**	**2.8**	**2**	**2.8**	**2.4**	**2.4**	**2.6**	**2.6**

Semester III			
Core IX	**Topology**		
Course Code: 23PMAC33	**Hrs/Week: 5**	**Hrs/Sem: 75**	**Credits: 4**

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.

Chapter 2: Sections 12 to 17

UNIT-II

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

Chapter 2: Sections 18 to 21

UNIT-III

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

Chapter 3: Sections 23 to 25

UNIT-IV

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

Chapter 3: Sections 26 to 29

UNIT-V

Countability and Separation Axiom: The Countability Axioms - The separation Axioms - Normal spaces - The Urysohn Lemma - The Urysohn metrization Theorem - The Tietz extension theorem.

Chapter 4: Sections 30 to 35

Text Book

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

Books for Reference

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

Semester III			
Core X	**Research Methodology**		
Course Code: 23PMAC34	**Hrs/ week: 5**	**Hrs/Semester: 75**	**Credits: 4**

Course Objectives

- To contribute to the development of the new statistical methodology to address substantive problems and to promote the use of these methods through publications.
- To identify and discuss the complex issues inherent in selecting a research problem, selecting an appropriate research design and implementing a research projects.

Course Outcome

CO. No.	Upon completion of this course, students will be able to	Cognitive Level
CO-1	Recognize the nature of research, its objectives, methodologies, and significance in academia and beyond.	K1
CO-2	Identify and evaluate criteria for assessing the quality and validity of research studies, including relevance, reliability, validity, and ethical considerations.	K2
CO-3	Execute plan and write a thesis, from selecting a topic to producing a final product that meets academic standards and contributes knowledge in their field of study.	K3
CO-4	Support ethical and responsible research practices to uphold academic integrity and avoid plagiarism in academic writing.	K4
CO-5	Justify mathematical ideas effectively through written language, particularly in the context of theorem statements, proofs, and mathematical discourse in discrete mathematics.	K5

PSO Relation Matrix–Table

Course Outcomes	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)				
	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1	**3**	**3**	**3**	**2**	**2**	**3**	**2**	**3**	**3**	**3**
CO-2	**3**	**3**	**3**	**2**	**2**	**3**	**3**	**3**	**3**	**2**
CO-3	**3**	**3**	**2**	**3**	**2**	**3**	**3**	**2**	**2**	**2**
CO-4	**3**	**2**	**3**	**2**	**2**	**3**	**3**	**2**	**2**	**3**
CO-5	**3**	**3**	**2**	**2**	**2**	**3**	**3**	**3**	**2**	**2**
Ave.	**3**	**2.8**	**2.6**	**2.2**	**2**	**3**	**2.8**	**2.6**	**2.4**	**2.4**

Semester III			
Core X	**Research Methodology**		
Course Code: 23PMAC34	**Hrs/ week: 5**	**Hrs/Semester: 75**	**Credits: 4**

UNIT I

An Introduction: Meaning of Research - Objectives of Research - Motivation of Research - Types of Research - Research approaches - Significance of Research - Research methods versus Methodology - Research and scientific method - Importance of knowing how research is done - Research Process - Criteria of Good Research.

(Text Book: 1, Chapter: 1)

UNIT II

Computer Tools for writing and Publishing: Text tools - Publishing and Printing Tools - Management and Presentation Tools - An invaluable tool for assignment and thesis Writing. The computer as an information tool: Electronic Information resources – The internet and World WideWeb - Indispensable Research Tool.

(Text Book: 2, Chapter: 5 and 6)

UNIT III

Planning the Thesis: Selecting a topic-Criteria for selecting a topic -Reviewing the literature - Designing the study- Ethical Concerns - The chapter outline. Writing the Thesis: The General Format - The preliminaries - The text -The reference material - The final product.

(Text Book: 2, Chapter: 3 and 8)

UNIT IV

Page and Chapter Format - Chapter divisions and subdivisions – Formatting and Style - Sample Thesis page.Revising the Thesis: Editing the final draft-Evaluating the final draft - Proof reading the final printed copy - Plagiarism - What is Plagiarism - Types of Plagiarism- Preventing plagiarism when writing.

(Text Book: 2, Chapter: 9 and 15, http://www.plagiarism.org/plagiarism-101/what-is-plagiarism/)

UNIT V

Writing language of theorem: Introduction and Motivation - Mathematical style - Terminologyand notation (especially in discrete mathematics) - English usage inmathematical writing.

(Text Book: 3, Pages 1-31)

Text Books

1. C.R. Kothari. *Research Methodology Methods and Techniques*, New Age InternationalPublishers, Second Revised Edition, 2009.
2. Jonathan Anderson & Millicent Poole. A*ssignmentand Thesis Writing,* Wiley, Fourth Edition,2019.
3. Douglas B. West. *The Grammar According to West.*

Book for Reference

1. Leonie Elphinstone and Robert Schweitzer. *How to get a research degree*. A Surival Guide, Allen and Unwin Publication, 1998.
2. C.R. Kothari & Gaurav Garg, *Research Methodology Methods and Techniques*, New Age InternationalPublishers, Fourth Edition,2020.
3. Ranjit Kumar , *Research Methodology A Step by Step Guide for Beginners,* Pearson Education, Second Education 2005

Semester III			
Discipline Specific Elective V	**Stochastic Process**		
Course Code: 23PMAE31	**Hrs/week: 4**	**Hrs/Sem: 60**	**Credits: 3**

Course Objectives

- To acquire knowledge about stochastic process relying on the probability theoryand mathematical analysis.
- To develop comprehensive knowledge of Probability Distribution, TransitionProbabilities, Markov Chains, Birth – Death Process.

Course Outcome

CO.NO.	Upon completion of this course, students will be able to	Cognitive Level
CO-1	list the random walk associated with real life situation to solve.	K1
CO-2	understand the notions of stochastic process.	K2
CO-3	apply markov chains to practical problems	K3
CO-4	analyze the transition probabilities and its classifications	K4
CO-5	evaluate and illustrate the different stochastic models.	K5

PSO Relation Matrix–Table

Course Outcomes	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)				
	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1	**3**	**3**	**2**	**2**	**2**	**3**	**2**	**3**	**2**	**2**
CO-2	**2**	**2**	**3**	**2**	**2**	**2**	**3**	**2**	**3**	**2**
CO-3	**2**	2	**2**	**3**	**2**	**3**	**2**	**2**	**2**	**2**
CO-4	**3**	**2**	**2**	**2**	**2**	**3**	**3**	**2**	**2**	**2**
CO-5	**3**	**3**	**3**	**2**	**2**	**3**	**2**	**2**	**3**	**2**
Ave.	**2.6**	**2.4**	**2.4**	**2.2**	**2**	**2.8**	**2.4**	**2.2**	**2.4**	**2**

Semester III			
Discipline Specific Elective V	**Stochastic Process**		
Course Code: 23PMAE31	**Hrs/week: 4**	**Hrs/Sem: 60**	**Credits: 3**

UNIT I

Generating functions – Laplace Transforms – Laplace Transforms of a Probability Distribution or of a Random Variable – Difference Equations

Chapter 1: Sections: 1.1 - 1.4

UNIT II

Difference Equations in Probability Theory – Differential - Difference Equations – Notion of Stochastic Processes – Specification of Stochastic Processes – Stationary Processess

Chapter 1: Sections: 1.5, 1.6 and Chapter 2: Sections: 2.1 - 2.3

UNIT III

Markov Chains – Higher Transition Probabilities – Classification of States and Chains – Determination of Higher Transition Probabilities – Stability of a Markov System: Limiting Behaviour

Chapter 3: Sections: 3.1 - 3.5

UNIT IV

Birth and Death Process – Markov Processes with Discrete State Space – Erlang Process

Chapter 4: Sections: 4.4 - 4.6

UNIT V

Brownian Motion – Wiener Process – Differential Equations for a Wiener Process – Kolmogorov Equations

Chapter 5: Sections: 5.1 – 5.4

Text Book:

1. J. Medhi. *Stochastic Process*. Wiley Eastern Limited, 1982.

Books for Reference:

1. Srinivasan Mehata. *Stochastic Process*. New Delhi: Tata McGraw-Hill Publishing Company Limited, 1976.
2. Tapas Kumar Chandra and Sreela Gangopadhya. *Introduction to Stochastic Process*, Narosa Publishing House, 2018.
3. Peter W. Jones and Peter Smith, *Stochastic Processes An Introduction*, Third Edition, CRC Press, Taylor and Francis Group, 2018.

Semester III			
Skill Enhancement Course II	**Fluid Mechanics**		
Course Code: 23PMASE2	**Hrs/Week: 4**	**Hrs/Sem: 60**	**Credits: 3**

Course Objectives

- To introduce fundamental aspects of fluid flow behaviour and to develop steady state mechanical energy balance equation for fluid flow systems.
- To estimate pressure drop in fluid flow systems and determine performance characteristics of fluid machinery.

Course Outcome

CO.NO.	Upon completion of this course, students will be able to	Cognitive Level
CO-1	define and explain fundamentals of fluid mechanics, which is used in the applications of Hydraulics.	K1
CO-2	understand basic laws and equations used for analysis of staticand dynamic fluids.	K2
CO-3	apply Archimedes principle to solve numerical exampleson Buoyancy.	K3
CO-4	analyze stability of submerged and floating bodies.	K4
CO-5	evaluate and optimize operational parameters of hydraulic problems, systems and machines	K5

PSO Relation Matrix–Table

Course Outcomes	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)				
	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1	**3**	**3**	**2**	**2**	**2**	**3**	**2**	**3**	**2**	**2**
CO-2	**2**	**2**	**3**	**2**	**2**	**2**	**3**	**2**	**3**	**2**
CO-3	**2**	2	**2**	**3**	**2**	**3**	**2**	**2**	**2**	**2**
CO-4	**3**	**2**	**2**	**2**	**2**	**3**	**3**	**2**	**2**	**2**
CO-5	**3**	**3**	**3**	**2**	**2**	**3**	**2**	**2**	**3**	**2**
Ave.	**2.6**	**2.4**	**2.4**	**2.2**	**2**	**2.8**	**2.4**	**2.2**	**2.4**	**2**

Semester III			
Skill Enhancement Course II	**Fluid Mechanics**		
Course Code: 23PMASE2	**Hrs/Week: 4**	**Hrs/Sem: 60**	**Credits: 3**

UNIT I

Properties of Fluids: Viscosity – Thermodynamic properties – Compressibility and Bulk modulus – Surface Tension and Capillarity

Chapter 1: Sec 1.1 – 1.6

UNIT II

Pressure and its measurement: Fluid pressure of a point – Pascal's Law – Pressure variation in a fluid at rest – Absolute, Gauge, Atmospheric and Vacuum Pressure – Measurement of pressure – Simple manometer – Differential Manometer

Chapter 2: Sec 2.1 – 2.7

UNIT III

Hydrostatic forces on Surfaces: Total pressure and Centre of Pressure – Vertical Plane Surfaces submerged in liquid – Horizontal Plane Surfaces submerged in liquid – Inclined PlaneSurface submerged in liquid

Chapter 3: Sec 3.1-3.5

UNIT IV

Buoyancy and flotation: Buoyancy – Centre of Buoyancy – Meta-centre – Metacentric height – Conditions of Equilibrium of a Floating and Submerged bodies

Chapter 4: Sec 4.1 – 4.7

UNIT V

Dimensional and Model Analysis – Secondary or Derived Quantities – Dimensional Homogeneity – Methods of Dimensional Analysis – Model Analysis

Chapter 12: Sec 12.1 – 12.5

Text Book

1. Dr.R.K. Bansal. *A text book of Fluid Mechanics*. Laxmi Publication private limited,Tenth edition, 2019.

Books for Reference

1. Joseph H.Spurk, NuriAksel. *Fluid Mechanics*. Springer- Verlag Berlin Heidelberg,Second Edition, 2008.
2. Ranald V. Giles. *Fluid Mechanics and Hydraulics*. McGraw - Hill Book Company,Fourth Edition, 2013.
3. RK Rajput, A Textbook of Fluid Mechanics, S.Chand and Company Limited, New Delhi, 2019.

Semester IV			
Core XI	**Functional Analysis**		
Course Code: 23PMAC41	**Hrs/Week: 6**	**Hrs/Semester: 90**	**Credits: 5**

Course Objectives

- To provide a working knowledge of the basic properties of Banach spaces, Hilbert spaces, Banach Algebras and Functionals defined on a set of functions.
- To introduce the ideas and some of the fundamental theorems of Functional Analysis.

Course Outcome

CO.NO.	Upon completion of this course, students will be able to	Cognitive Level
CO-1	define and explain the concepts of different operators.	K1
CO-2	understand the various concepts of Banach Spaces.	K2
CO-3	apply the spectral theorem for compact self- adjoint operators and decide which properties an operator has.	K3
CO-4	analyze the clear ideas about the finite dimensional Spectral Theory.	K4
CO-5	evaluate the statements and proof of important theorems andexplain the key steps in proofs sometimes with variation	K5

PSO Relation Matrix–Table

Course Outcomes	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)				
	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1	**3**	**3**	**2**	**2**	**2**	**3**	**2**	**3**	**2**	**2**
CO-2	**2**	**2**	**3**	**2**	**2**	**2**	**3**	**2**	**3**	**2**
CO-3	**2**	2	**2**	**3**	**2**	**3**	**2**	**2**	**2**	**2**
CO-4	**3**	**2**	**2**	**2**	**2**	**3**	**3**	**2**	**2**	**2**
CO-5	**3**	**3**	**3**	**2**	**2**	**3**	**2**	**2**	**3**	**2**
Ave.	**2.6**	**2.4**	**2.4**	**2.2**	**2**	**2.8**	**2.4**	**2.2**	**2.4**	**2**

Semester IV			
Core XI	**Functional Analysis**		
Course Code: 23PMAC41	**Hrs/Week: 6**	**Hrs/Semester: 90**	**Credits: 5**

UNIT I

Banach spaces: Definition and Examples – Continuous linear transformation – The Hahn Banach theorem – The natural imbedding of N in N**

Chapter 9: Sections 46, 47, 48, 49

UNIT II

The open mapping theorem – The conjugate of an operator – Hilbert spaces: The Definition and some simple properties – Orthogonal complements – Orthonormal sets

Chapter 9: Sections 50, 51, Chapter 10: Sections 52, 53, 54

UNIT III

Conjugate space H* – The adjoint of an operator – Self adjoint operators – Normal andunitary operators

Chapter 10: Sections 55, 56, 57, 58

UNIT IV

Finite Dimensional spectral theory: Determinants and the spectrum of an operator – The spectral theorem – General Preliminaries: The Definition and some Examples – Regular and Singular points – Topological Divisors of Zero.

Chapter 11: Sections 61, 62 Chapter 12: Sections 64, 65, 66

UNIT V

The Structure of Commutative Banach Algebras: The Gelfand mapping – Application of the formula $r(x) = lim\|x^n\|^{1/n}$ – Involutions in Banach Algebras – The Gelfand-Neumark Theorem.

Chapter 13: Sections 70-73

Text Book

1. G.F.Simmons. *Topology and Modern Analysis*. McGraw Hill InternationalEditions.

Books for Reference

1. M.Thamban Nair. *Functional Analysis A first course*. Prentice Hall of India.
2. S. Ponnusamy. *Functional Analysis*. Narosa Publishing.
3. W. Rudin, Functional Analysis, McGraw Hill Education (India) Private Limited, New Delhi, 1973

Semester IV			
Core XII	**Differential Geometry**		
Course Code: 23PMAC42	**Hrs/Week: 6**	**Hrs/Sem: 90**	**Credits: 5**

Course Objectives

- To focus on the geometry of curves and surfaces in 3-dimensional Euclidean space.
- To find and use the shortest paths on a surface and explore the relationship between the length of a curve and the area bounded by it.

Course Outcome:

CO. No.	Upon completion of this course, students will be ableto	Cognitive Level
CO -1	understand and analyze the geometric properties and behaviors of curves in three-dimensional space.	K1
CO-2	understanding of the geometric relationships between curves and surfaces, enabling them to analyze and manipulate complex shapes and structures in three-dimensional space.	K2
CO-3	Apply the concepts learned in the course to solve problems involving surfaces, curves, and the metric, including computing distances, angles, and curvature on surfaces.	K3
CO-4	Apply the canonical geodesic equations to solve problems involving geodesic curves on surfaces, including computing geodesics, determining their properties, and analyzing their behavior.	K4
CO-5	analyze and characterize surfaces in three-dimensional space and apply their knowledge to various fields of study.	K5

PSO Relation Matrix–Table

Course Outcomes	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)				
	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1	**3**	**2**	**3**	**2**	**2**	**3**	**2**	**3**	**2**	**2**
CO-2	**3**	**3**	**3**	**2**	**2**	**3**	**3**	**2**	**3**	**2**
CO-3	**3**	3	**3**	**2**	**2**	**3**	**3**	**3**	**2**	**2**
CO-4	**3**	**3**	**2**	**2**	**2**	**3**	**3**	**2**	**2**	**2**
CO-5	**3**	**3**	**3**	**2**	**2**	**3**	**3**	**3**	**3**	**2**
Ave.	**3**	**2.8**	**2.8**	**2**	**2**	**5**	**2.8**	**2.6**	**2.4**	**2**

Semester IV			
Core XII	**Differential Geometry**		
Course Code: 23PMAC42	**Hrs/Week :6**	**Hrs/Sem: 90**	**Credits: 5**

UNIT I

The Theory of Space Curves: Introductory Remarks about Space Curves - Definitions - Arc Length - Tangent, Normal and Binormal - Curvature and Torsion of a curve given as the intersection of two Surfaces.

Chapter 1: Sections 1, 2, 3, 4, 5

UNIT II

Contact between Curves and surfaces - Tangent Surface, Involutes and Evolutes. Intrinsic Equations, Fundamental Existence Theorem for Space Curves - Helices.

Chapter 1: Sections 6, 7, 8, 9

UNIT III

The Metric: Local Intrinsic Properties of a Surface: Definition of a Surface - Curves on a Surface - Surfaces of Revolution - Helicoids - Metric - Direction Coefficients.

Chapter 2: Sections 1, 2, 3, 4, 5, 6

UNIT IV

Families of Curves - Geodesics - Canonical Geodesic Equations - Normal Property of Geodesics - Geodesic Parallels – Geodesic Curvature

Chapter 2: Sections 7, 10, 11, 12, 14, 15

UNIT V

The Second and Fundamental form: Local non – intrinsic properties of a surface: The Second Fundamental Form -Principal curvatures - Lines of Curvature – Developables – Developables Associated with Space Curves.

Chapter 3: Sections 1, 2, 3, 4, 5

Text Book

1. T.J.Wilmore. *An Introduction to Differential Geometry*. Oxford University Press, 2007.

Books for Reference

1. Dirk J.Struik. *Lectures on Classical Differential Geometry*. Addison Wesley Publishing House, Second Edition,
2. William C.Graustein. *Differential Geometry*. New York: Dover Publications, 1962.
3. D.Somasudaram, *Differential Geometry A First Course*, Alpha Science International Ltd, Harrow, UK,2005

Semester IV			
Core XIII	**Mechanics**		
Course Code: 23PMAC43	**Hrs/Week: 6**	**Hrs/Sem: 90**	**Credits: 5**

Course Objectives

- To study mechanical systems under generalized coordinate systems, virtual work, energy and momentum
- To study mechanics developed by Newton, Language, Hamiltonian Jacobi and Theory of relativity due to Einstein

Course Outcome

CO.NO.	Upon completion of this course, students will be able to	Cognitive Level
CO-1	understand the classical dynamics in a systematic way	K1
CO-2	describe and apply the concept of Angular momentum, Kinetic energy and Moment of inertia of a particle.	K2
CO-3	demonstrate the knowledge of core principles in Mechanics.	K3
CO-4	apply the variation principle for real physical situations.	K4
CO-5	explore different applications of these concepts in the mechanical fields.	K5

PSO Relation Matrix–Table

Course Outcomes	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)				
	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1	**3**	**3**	**2**	**2**	**2**	**3**	**2**	**3**	**2**	**2**
CO-2	**2**	**2**	**3**	**2**	**2**	**2**	**3**	**2**	**3**	**2**
CO-3	**3**	2	**2**	**3**	**2**	**3**	**2**	**2**	**2**	**2**
CO-4	**3**	**2**	**2**	**2**	**2**	**3**	**3**	**2**	**2**	**2**
CO-5	**2**	**3**	**2**	**2**	**2**	**3**	**2**	**1**	**3**	**2**
Ave.	**2.6**	**2.4**	**2.2**	**2.2**	**2**	**2.8**	**2.4**	**2**	**2.4**	**2**

Semester IV			
Core XIII	**Mechanics**		
Course Code: 23PMAC43	**Hrs/Week :6**	**Hrs/Sem: 90**	**Credits: 5**

UNIT I

Mechanical Systems: The Mechanical System – Generalised co-ordinates – constraints – Virtual work – Energy and Momentum

Chapter 1: Sections 1.1 to 1.5

UNIT II

Lagrnge's Equations: Derivation of Lagrange's equation – Examples – Integrals of Motion

Chapter 2: Sections 2.1 to 2.3

UNIT III

Hamilton's Equations: Hamilton's Principle – Hamilton's Equation – Other variational principle

Chapter 4: Sections 4.1 to 4.3

UNIT IV

Hamilton-Jacobi Theory: Hamilton Principle function – Hamilton – Jacobi Equation - Separability

Chapter 5: Sections 5.1 to 5.3

UNIT V

Canonical Transformation: Differential forms and generating functions – Special Transformations – Lagrange and Poisson brackets.

Chapter 6: Sections 6.1 to 6.3

Text Book

1. D. Greenwood, Classical Dyanamics, Prentice Hall of India, New Delhi, 1983

Books for Reference

1. H. Goldstein, Classical Mechanics, (2nd Edition), Narosa Publishing House, New Delhi
2. N.C. Rane and P.S.C Joag, Classical Mechanics, Tata McGraw Hill, 1991.
3. J.L. Synge and B.A. Griffth, Princiles of Mechanics (3rd Edition), McGraw Hill Book Co., New York, 1970.

Semester IV			
Core XIV	**Operations Research**		
Course Code: 23PMAC44	**Hrs/Week: 6**	**Hrs/Sem: 90**	**Credits: 5**

Course Objectives

- To use quantitative methods and techniques for effective decision –making; model formulation and applications that are applied to problems in business, industry and society.
- To provide a theoretical introduction and implementation of optimization techniques in order to get best results from a set of serial possible solution of different problems.

Course Outcome

CO.NO.	Upon completion of this course, students will be able to	Cognitive Level
CO-1	define probabilistic inventory models that accounts for all variations in real systems.	K1
CO-2	compare inventory models and other related models.	K2
CO-3	formulate and solve classical dynamic programmingproblems.	K3
CO-4	analyze a network of queues with Poisson external arrival, exponential service requirements and independent routing.	K4
CO-5	evaluate the concept of complementary slackness and its role in solving prime and dual problems	K5

PSO Relation Matrix–Table

Course Outcomes	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)				
	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1	**3**	**3**	**2**	**2**	**2**	**3**	**2**	**3**	**2**	**2**
CO-2	**2**	**2**	**3**	**2**	**2**	**2**	**3**	**2**	**3**	**2**
CO-3	**3**	2	**2**	**3**	**2**	**3**	**2**	**2**	**2**	**2**
CO-4	**3**	**2**	**2**	**2**	**2**	**3**	**3**	**2**	**2**	**2**
CO-5	**2**	**3**	**2**	**2**	**2**	**3**	**2**	**1**	**3**	**2**
Ave.	**2.6**	**2.4**	**2.2**	**2.2**	**2**	**2.8**	**2.4**	**2**	**2.4**	**2**

Semester IV			
Core XIV	**Operations Research**		
Course Code: 23PMAC44	**Hrs/Week: 6**	**Hrs/Sem: 90**	**Credits: 5**

UNIT I

Integer Programming: Some Applications of Integer Programming Solution Algorithms- Methods of Integer Programming - Cutting Plane Algorithm - Branch and Bound Algorithm.

Chapter 8: Sections 8.1, 8.2, 8.3, 8.4

UNIT II

Dynamic Programming: Elements of DP Model - The Capital Budgeting Example -Cargo-Loading Problem- Reliability Problem - Work Force Size Problem - Forward and Backward Recursive equations.

Chapter 9: Sections 9.1, 9.2, 9.3

UNIT III

Deterministic Inventory Models - Probabilistic Models: Continuous Review Model, Single Period Models: Instantaneous Demand, No Setup Cost and s-S Policy

Chapter 13: Sections 13.1, 13.2, 13.3, 13.4(13.4.1, 13.4.2)

UNIT IV

Decision Theory and Games: Decisions under Risk - Decision Trees - Decision under uncertainty- Game Theory.

Chapter 11: Sections 11.1, 11.2, 11.3, 11.4

UNIT V

Queuing Theory: Elements of Queuing model - Roles of the Poisson and Exponential Distributions - Arrivals Process- Departures Process- Queues with combined arrivals and departures.

Chapter 15: Sections 15.1, 15.2, 15.3

Text Book

1.Hamdy A. Taha: *Operations Research an Introduction*, Fourth Edition, Macmillan Publishing Company, New York, 1987.

Books for Reference

1. J.K.Sharma: *Operations Research*, Macmillan, Publishers, India Ltd, 2007.
2. KantiSwarup, P.K.Kupta and Man Mohan: *Operations Research*, Sultan Chand & Sons Publications, 2013.
3. J K Sharma , *Operations Research Problems and Solutions*,Macmillan Publication,Third Edition 2009.