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.2019)

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.	At the end of the M.Sc. Program, the students will be able to
PO-1	obtain in-depth and detailed functional knowledge of the fundamental theoretical concepts and experimental methods in Science
PO-2	understand their subject areas more clearly and develop skills to critically reflect upon the theory they learn.
PO-3	adopt the scientific methods and hypothesis testing in designing and execution of experiments.
PO-4	think critically, work independently and focus in research oriented activities.
PO- 5	inculcate an ability to engage in life-long learning to improve professional competency.
PO-6	extend and understand the impact of science on society.
PO-7	apply their professional ability for entrepreneurship and self employment.
PO-8	understand and commit to professional ethics and social responsibility.

Course Structure (w.e.f. June 2019)
Semester - I

Subject	Subject Code	Title of the Paper	Contact Hours / Week	Credits	Max. Marks		
					CIA	ESE	Total
Core I	19PMAC11	Groups and Rings	6	4	40	60	100
Core II	19PMAC12	Real Analysis	6	4	40	60	100
Core III	19PMAC13	Ordinary differential Equations	6	4	40	60	100
Core IV	19PMAC14	Mathematical Statistics	6	4	40	60	100
Core V	19PMAC15	Operations Research	6	4	40	60	100
			30	**20**			

Semester - II

Subject	Subject Code	Title of the Paper	Contact Hours / Week	Credits	Max. Marks		
					CIA	ESE	Total
Core VI	19PMAC21	Linear Algebra	6	4	40	60	100
Core VII	19PMAC22	Mathematical Analysis	6	4	40	60	100
Core VIII	19PMAC23	Classical Mechanics	6	4	40	60	100
Core IX	19PMAC24	Calculus of Variations and Integral Equations	4	4	40	60	100
Core X	19PMAC25	Fuzzy Algebra	4	4	40	60	100
Elective I	19PMAE21	A. Combinatorics B. Stochastic Processes	4	3	40	60	100
			30	**23+2**			

It is mandatory for students to complete one MOOC during the first year of study. (19PMAM21) 2 Credits.

Semester - III

Subject	Subject Code	Title of the Paper	Contact Hours / Week	Credits	Max. Marks		
					CIA	ESE	Total
Core XI	19PMAC31	Topology	6	4	40	60	100
Core XII	19PMAC32	Graph Theory	6	4	40	60	100
Core XIII	19PMAC33	Measure Theory	5	4	40	60	100
Core XIV	19PMAC34	Partial Differential Equations	5	4	40	60	100
Core XV	19PMAC35	Research Methodology	4	4	40	60	100
Elective II	19PMAE31	A. Fluid Mechanics B. Wavelet Analysis	4	3	40	60	100
Self Study Course / MOOC	19PMASS1 19PMAM31	Discrete Mathematics		2		(50)	(50)
			30	**23 + 2**			

Semester - IV

Subject	Subject Code	Title of the Paper	Contact Hours / Week	Credits	Max. Marks		
					CIA	ESE	Total
Core XVI	19PMAC41	Complex Analysis	6	4	40	60	100
Core XVII	19PMAC42	Functional Analysis	6	4	40	60	100
Core XVIII	19PMAC43	Number Theory	5	4	40	60	100
Core XIX	19PMAC44	Differential Geometry	5	4	40	60	100
Project	19PMAP41	Project	8	8	40	60	100
			30	**24**			
Total			**120**	**90+2+2**			

Master of Science (Mathematics)

Components	Credit per Semester	No. of Courses	Credits	Extra Credits
Core	20+20+20+16	19	76	
Elective	3	2	6	
Project	8	1	8	
MOOC	2	1		+2
Self Study Course/MOOC	2	1		+2
		Total	90	+4

Program Specific Outcome

PSO No.	Students of M.Sc. Mathematics will be able to
PSO-1	formulate and analyze mathematical and statistical problems, precisely define the key terms and draw clear and responsible conclusion.
PSO-2	develop problem solving skills and apply them independently to problems in pure and applied mathematics.
PSO-3	utilize number theory in the field of cryptography that helps in hiding information and maintaining secrecy in military information.
PSO-4	set up and solve linear systems and linear inequalities.
PSO-5	explore current research problems in mathematical sciences.
PSO-6	formulate and analyze complex problems reaching substantiated conclusions using principles of Mathematics.
PSO-7	represent and statistically analyze data both graphically and numerically
PSO-8	apply statistical method in engineering and use of statistical software in modern data analysis

Semester I			
Core I	**Groups and Rings**		
Code: 19PMAC11	**Hrs/Week: 6**	**Hrs/Sem: 90**	**Credits: 4**

Vision

To develop and apply the concepts of algebra to investigate and describe situations.

Mission

To acquire knowledge about algebraic concepts like Groups, Rings, Vector Spaces, Dual spaces, Polynomials and Matrices.

Course Outcome

CO. No.	Upon completion of this course, students will be able to	PSO addressed	CL
CO-1	determine the orbit for a set and make use of the counting principle technique to find algebraic descriptions for the size of each equivalence class.	2	Ev
CO-2	explain Sylow's theorem for all finite groups.	5	Ev
CO-3	describe all abelian groups generated by a finite set of elements and to find the root of unity for each element of a group.	1,2	Un
CO-4	analyze and demonstrate the examples of Ideals and Quotient Rings.	5	An
CO-5	assess properties implied by the definition of Euclidean Rings and to illustrate and apply the concepts of Polynomial Rings.	6	Ev
CO-6	determine and use orthogonality and matrices	2	Ev
CO-7	show procedural fluency with polynomial expressions including basic factoring.	4	Un
CO-8	apply the definitions of matrix multiplication that corresponds to composition of linear transformations.	2	Ap

Semester I			
Core I	**Groups and Rings**		
Code: 19PMAC11	**Hrs/Week: 6**	**Hrs/Sem: 90**	**Credits: 4**

Unit I

Cayley's Theorem - Permutation Groups - Another Counting Principle.

(Chapter 2: Sections 2.9, 2.10, 2.11)

Unit II

First part of Sylow's Theorem- Second part of Sylow's Theorem- Third part of Sylow's Theorem.

(Chapter 2: Sections 2.12)

Unit III

Direct Products - Internal direct product- Finite Abelian Groups-Invariants - Solvable.

(Chapter 2: Sections 2.13, 2.14)

Unit IV

Ring Theory– Homomorphisms- Ideals and Quotient Rings – More Ideals and Quotient Rings -The Fields of Quotients of an Integral Domain.

(Chapter 3: Sections 3.3, 3.4, 3.5, 3.6)

Unit V

Euclidean Rings - A Particular Euclidean Ring - Polynomial Rings -Polynomial over the Rational Field.

(Chapter 3: Sections 3.7, 3.8, 3.9, 3.10)

Text Book

1. I. N. Herstein: Topics in Algebra, Second Edition ,Wiley Eastern Ltd, New Delhi, 2013.

Books for Reference

1. Gavvett Birkhoff and Thomas C. Bartee: Modern Applied Algebra, CSS Publishers and Distributors, Delhi, 1987.
2. P.B Bhattacharya, S.K. Jain and S.R. Nagpaul: Basic abstract algebra, Cambridge University Press, 1987.

Semester I			
Core II	**Real Analysis**		
Code: 19PMAC12	**Hrs/Week: 6**	**Hrs/Sem: 90**	**Credits: 4**

Vision

To equip the students with the concept analysis in problem solving and enable the students to take a prominent role in research.

Mission

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	PSO addressed	CL
CO-1	determine the basic properties of real numbers.	5,6	Ev
CO-2	demonstrate the knowledge of real functions, limit of functions and their properties	2,5	Ap
CO-3	analyze the concept of differentiability of real functions and related theorems	6	Un
CO-4	determine the continuity, differentiability and integrability of functions defined on the real line.	2,5	Ev
CO-5	analyse the concepts of continuous functions and their properties	6	Ap
CO-6	explain the concepts of axioms of real number systems, uniform convergence of sequences and series of functions, equicontinuity, compact and complete metric spaces, the Stone-Weierstrass theorem.	1,5	Un
CO-7	apply the concept of the series of real numbers and convergence.	2,5	Ap
CO-8	describe fundamental properties of the real numbers that lead to the formal development of real analysis.	2	Un

Semester I			
Core II	**Real Analysis**		
Code: 19PMAC12	**Hrs/Week: 6**	**Hrs/Sem: 90**	**Credits: 4**

Unit I

Metric Spaces- Compact sets- Perfect sets- Connected sets.

(Chapter 2)

Unit II

Convergent Sequences – Subsequences - Cauchy Sequences - Upper and Lower Limits - Some Special Sequences- Series of nonnegative terms - The Number e.

(Chapter 3)

Unit III

The Root and Ratio Tests - Power Series - Summation by parts - Absolute Convergence - Addition and Multiplication of series - Rearrangements.

(Chapter 3)

Unit IV

Limits of functions - Continuous functions - Continuity and Compactness - Continuity and Connectedness - Discontinuities - Monotone functions - Infinite limits and limits at infinity.

(Chapter 4)

Unit V

The Derivative of a real function - Mean value Theorems - The continuity of derivatives - L'Hospital's Rule - Derivatives of Higher order - Taylor's Theorem.

(Chapter 5)

Text Book

1. Walter Rudin: Principles of Mathematical Analysis, Third Edition, McGraw-Hill International Editions, 1953.

Books for Reference

1. Apostol: Mathematical Analysis, Addition Wesley Publishing Company, London, 1971.
2. Goldberg: Methods of Real Analysis, Oxford & IBH Publishing Company, 1970.

Semester I			
Core III	**Ordinary Differential Equations**		
Code:19PMAC13	**Hrs/Week:6**	**Hrs/Sem: 90**	**Credits: 4**

Vision

To provoke the students to develop mathematical skills and knowledge of standard concepts in ordinary differential equations.

Mission

To identify and get optimal solutions for any higher order differential equations and also to solve dynamical problems of practical interest.

Course Outcome

CO. No.	Upon completion of this course, students will be able to	PSO addressed	CL
CO-1	find the solution of second order differential equations by variation of parameters.	2	Re
CO-2	use power series methods to solve differential equations about ordinary points.	6	Ap
CO-3	use the method of Frobenius to solve differential equations about regular singular points.	5	Ap
CO-4	Approximate polynomials in terms of Legendre and Bessel equations.	2	Un
CO-5	understand the importance of Picard's Theorem.	2	Un
CO-6	solve scientific and engineering problems	8	Ap
CO-7	comprehend the Euler equation, Bessel equation and Regular singular points.	2	An
CO-8	solve the Homogenous linear system with constant co-efficient	2,5	Un

Semester I			
Core III	**Ordinary Differential Equations**		
Code: 19PMAC13	**Hrs/Week: 6**	**Hrs/Sem: 90**	**Credits: 4**

Unit I

Second order linear equations - The general solution of a homogeneous equation - The use of a known solution to find another - The method of variation of parameters.

(Chapter 3: Sections 14, 15, 16, 19)

Unit II

Power series solution - A review of power series solution - series solution of first order equations - Second order linear equations.

(Chapter 5: Sections 25, 26, 27)

Unit III

Ordinary points - Regular singular points - Frobenius series - Hermite Polynomials.

(Chapter 5: Sections 28, 29, Appendix B)

Unit IV

Legendre polynomial – Bessel functions and Gamma functions.

(Chapter 6: Sections 32, 33, 34, 35)

Unit V

Linear systems - Homogeneous linear systems with constant coefficients - The methods successive approximation - Picard's theorem.

(Chapter 7: Sections 37, 38, Chapter 11: Sections 55, 56)

Text Book

1. G.F.Simmons: Differential equations with application and historical notes, Tata McGraw Hill, 1997.

Books for Reference

1. Richard Bronson: Differential Equations, Second Edition, Schaum's Outlines, Tata McGraw Hill, 1989.
2. Shepley L.Ross: Differential Equations,Third Edition,John Wiley &Sons Publications, 1980.

Semester I			
Core IV	**Mathematical Statistics**		
Code: 19PMAC14	**Hrs/Week: 6**	**Hrs/Sem: 90**	**Credits: 4**

Vision

To provide students with a solid grounding in probability theory and mathematical statistics.

Mission

To teach the main principles and methods of mathematical solutions and develop the students ability to analyze and think logically.

Course Outcome

CO.NO.	Upon completion of this course, students will be able to	PSO addressed	CL
CO-1	explain the concepts of distributions and apply them.	2,8	Un
CO-2	provide a description of the method used for analysis, including a discussion of advantages, disadvantages and necessary assumptions.	1,2	An
CO-3	apply discrete and continuous probability to evaluate the probability of real world events.	2,7	Ap
CO-4	provide a conclusion to the study including a discussion of limitations of the analysis.	2,8	An
CO-5	test statistical hypothesis.	2	Cr
CO-6	explain the concepts of random variable, probability distribution, distribution function, expected value, variance and higher moments, and calculate expected values and probabilities associated with the distributions of random variables	2,7,8	Un
CO-7	define a probability generating function, a moment generating function and derive them in simple cases.	5,8	Re
CO-8	state the central limit theorem, and apply it.	1,5	Ap

Semester I			
Core IV	**Mathematical Statistics**		
Code: 19PMAC14	**Hrs/Week: 6**	**Hrs/Sem: 90**	**Credits: 4**

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 – The Beta, t, and F Distributions. **(Chapter 4: Sections 4.1, 4.2, 4.3, 4.4)**

Unit III

Extensions of the Change of variable technique – Distributions of Order statistics – The Moment generating function technique – The Distributions of$\bar{X}$ and nS^2/σ^2 – Expectations of functions of random variables. **(Chapter 4: Sections 4.5, 4.6, 4.7, 4.8, 4.9)**

Unit IV

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)**

Unit V

Theory of statistical tests: Certain best tests - Uniformly most powerful tests-Likelihood ratio test. (**Chapter 8 and 9, Sections 8.1, 9.1, 9.2, 9.3)**

Text Book

1. Robert V.Hogg and AllenT.Craig: Introduction to Mathematical Statistics, fifth edition, Pearson Education Asia, 2004.

Books for Reference

1. J.N.kapur, H.C. Saxena: Mathematical Statistics, S.Chand & Co, 2013.
2. Keith Knight: Mathematical Statistics, Chapman & Hall/CRC, New York, 2000.

Semester I			
Core V	**Operations Research**		
Code: 19PMAC15	**Hrs/Week: 6**	**Hrs/Sem: 90**	**Credits: 4**

Vision

To acquire a thorough knowledge of algorithms such as Branch and Bound algorithm, Cutting plane algorithm etc.

Mission

To provide mathematical techniques to model and analyze decision problems with effective application to real life.

Course Outcome

CO. No.	Upon completion of this course, students will be able to	PSO addressed	CL
CO-1	classify and formulate integer programming problems and solve them with Cutting Plane Algorithm, Branch and Bound Algorithm.	2,4	Un
CO-2	formulate and solve classical dynamic programming problems.	2,6	Un
CO-3	formulate and solve inventory models and other related models.	2	Un
CO-4	understand and solve problems regarding decision theory and game theory.	2	Un
CO-5	analyze a network of queues with Poisson external arrival, exponential service requirements and independent routing.	1,6	An
CO-6	explain the concept of complementary slackness and its role in solving prime and dual problems	2	Un
CO-7	set up decision models and use some solutions method for nonlinear optimization problems.	2,6	Cr
CO-8	propose the best strategy using decision making methods under uncertainty and game theory.	2	Ev

Semester I			
Core V	**Operations Research**		
Code: 19PMAC15	**Hrs/Week: 6**	**Hrs/Sem: 90**	**Credits: 4**

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

Queueing Theory: Elements of Queueing 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.

Semester II			
Core VI	**Linear Algebra**		
Code: 19PMAC21	**Hrs/Week: 6**	**Hrs/Semester: 90**	**Credits: 4**

Vision

To reveal the ability to use algebraic properties to describe interpret and analyse the real world data.

Mission

To introduce the concepts and to develop working knowledge on dual space, modules, extension fields and algebra of linear transformations.

Course Outcome

CO. No.	Upon completion of this course, students will be able to	PSO addressed	CL
CO-1	compute inner products and determine orthogonality on vector spaces including Gram Schmidt orthogonalization.	5,6	Re
CO-2	explain the concepts of field extensions and apply it to diverse situations in mathematical contexts.	7	Ev
CO-3	demonstrate accurate and efficient use of field extension and Galois Theory.	5,6	Un
CO-4	study Polynomial Rings and its effect in Galois Theory.	6	Ap,Ev
CO-5	define and illustrate the concepts of various polynomials and represent a linear transformation by a matrix with respect to a given basis.	2 ,6	Re
CO-6	understand the significance of various canonical forms.	5	Un
CO-7	explain the fundamental concepts of algebra and their role in modern mathematics and applied contexts.	2	Ev
CO- 8	provide information on polynomials, matrices and transformations.	2	Re

Semester II			
Core VI	**Linear Algebra**		
Code: 19PMAC21	**Hrs/Week: 6**	**Hrs/Semester: 90**	**Credits: 4**

Unit I

Dual Spaces - Inner product Spaces - Orthogonal Complement - Norm - Gram Schmidth Process - Schwartz Inequality - Modules - R-Module - Unital R-Module - Module Homomorphisms - Finitely Generated Module.

(Chapter 4: Sections 4.3, 4.4, 4.5)

Unit II

Extension fields - Algebraic Extension - Finite Extension - Roots of polynomials - Remainder theorem - Factor theorem - Splitting field - More about Roots - Irreducible - Simple extension.

(Chapter 5: Sections 5.1, 5.3, 5.5)

Unit III

Galois Group - Fixed Field - Automorphism - Normal Extension - Elements of Galois Theory - Fundamental Theorem - Solvability by Radicals - Commutators - Solvable - Abel's Theorem.

(Chapter 5: Sections 5.6, 5.7)

Unit IV

The Algebra of linear Transformations - Minimal Polynomial - Invertible - Singular - Regular - Rank - Characteristics Roots - Characteristics Vector - Matrix of linear Transformation.

(Chapter 6: Sections 6.1, 6.2, 6.3)

Unit V

Canonical forms - Triangular form - Nilpotent Transformations - Jordan Form.

(Chapter 6: Sections 6.4, 6.5, 6.6)

Text Book

1. I.N.Herstein: Topics in Algebra, Second Edition, Wiley Eastern Ltd. New Delhi 2013.

Books for Reference

1. Gavvett Birkhoff and Thomas C. Bartee: Modern Applied Algebra, CSS Publishers and Distributors, Delhi 1987.
2. P.B Bhattacharya, S.K. Jain and S.R. Nagpaul: Basic abstract algebra, Cambridge University Press, 1987.

Semester II			
Core VII	**Mathematical Analysis**		
Code: 19PMAC22	**Hrs/Week: 6**	**Hrs/Sem: 90**	**Credits: 4**

Vision

To interpret the fundamental concepts of analysis those underpin a large number of areas of mathematics both pure and applied.

Mission

To give a systematic study of Riemann Stieltjes integral and calculus on R^n and a brief study of convergence of sequence and series, power series and polynomial.

Course Outcome

CO. No.	Upon completion of this course, students will be able to	PSO addressed	CL
CO-1	determine the Riemann integrability and the Riemann-Stieltjes integrability of a bounded function and able to prove theorems concerning integration.	4	Ev
CO-2	recognize the difference between point wise and uniform convergence of a sequence of functions.	2,6	Ev
CO-3	illustrate the effect of uniform convergence on the limit function with respect to continuity, differentiability and integrability.	2	Un
CO-4	illustrate the convergent properties of power series.	2	Un
CO-5	analyze the concepts of Fourier Series and Beta, Gamma functions.	2	An
CO-6	propose rigorous proofs of results that arise in the context of real analysis	5,6	Cr
CO-7	prove theorems about the differentiability of functions and relate to the integrability of functions.	6	Ev
CO-8	describe fundamental properties of the real numbers that lead to the formal development of real analysis.	1	Re

Semester II			
Core VII	**Mathematical Analysis**		
Code: 19PMAC22	**Hrs/Week: 6**	**Hrs/Sem: 90**	**Credits: 4**

Unit I

Riemann - stieltjes integral: Definition and Existence of Riemann - Stieltjes Integral - Properties of the integral **(Chapter 6)**

Unit II

Integration and Differentiation - Rectifiable curves. Sequences and series of functions: Discussion of Main problem - Uniform Convergence - Uniform Convergence and Continuity **(Chapter 6&7)**

Unit III

Uniform Convergence and Integration - Uniform Convergence and Differentiation - Equicontinuous families of Functions - Stone Weierstrass Theorem.

(Chapter 7)

Unit IV

Some special functions: Power series - The Exponential and Logarithmic Functions - The Trigonometric Functions - The Algebraic Completeness of the Complex field

(Chapter 8)

Unit V

Fourier series - The Gamma function.

(Chapter 8)

Text Book

1. Walter Rudin: Principles of Mathematical Analysis, Third Edition, McGraw Hill International Editions, 1953.

Books for Reference

1. Apostol: Mathematical Analysis,Addition Wesley Publishing Company, London,1971.
2. Goldberg: Methods of Real Analysis, Oxford & IBH Publishing Company, 1970.

Semester II			
Core VIII	**Classical Mechanics**		
Code: 19PMAC23	**Hrs/Week: 6**	**Hrs/Sem: 90**	**Credits: 4**

Vision

To learn about the generalized coordinates, Lagrange's equations, different Variational Principles, Canonical transformations and its applications in Classical Mechanics.

Mission

To provide the students with thorough mastery both of the fundamental and of significant contemporary research developments.

Course Outcome

Co. No.	Upon completion of this course, students will be able to	PSO addressed	CL
CO-1	analyze the dynamics of system near equilibrium and find the normal modes of oscillation.	2	An
CO-2	understand D' Alembert's Principle and simple applications of the Lagrangian formulation.	2,6	Un
CO-3	calculate the principle co-ordinates and the principle moment of inertia for arbitrary rigid body.	2	Re
CO-4	understand the concepts and derivations of Hamilton's equations of motion.	5	Un
CO-5	explain Hamiltonian principles and establish the Hamiltonian equations.	2,5	Re
CO-6	calculate the magnitude of selected mechanical properties of materials.	2	Re
CO-7	distinguish the concept of the Hamilton equation of motion and the Principle of least Action.	6	An
CO-8	analyze the Canonical transformation and Hamilton Jacobi theory.	5	Un

Semester II			
Core VIII	**Classical Mechanics**		
Code: 19PMAC23	**Hrs/Week: 6**	**Hrs/Sem: 90**	**Credits: 4**

Unit I

Some Definitions-Lagrange's Equations for a Holonomic System- Lagrange's Equations of Motion for Conservative, Non - Holonomic system - Physical Significance of λ_l.

(Chapter 1: Sections 1.1, 1.2, 1.3, 1.4)

Unit II

Variational Principle - Calculus of Variations- Hamilton's Principle - Derivation of Hamilton's Principle from Lagrange's Equations- Derivation of Lagrange's Equations from Hamilton's Principle - Extension of Hamilton's Principle - Cyclic or Ignorable Coordinates- Conservation Theorems.

(Chapter 2: Sections 2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.8)

Unit III

Equations of Motion of a Rigid Body- Generalized Coordinates of a Rigid body- Eulerian Angles - Components of Angular Velocity along the Body Set of Axes- Rate of Change of a Vector-Coriolis force-Euler's Equations of motion for a rigid body-Motion of a Heavy Symmetrical Top.

(Chapter 3: Sections 3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7, 3.8)

Unit IV

Derivations of Hamilton's Equations of Motion - Routh's procedure - Equations of motion - Derivation of Hamilton's equations from Hamilton's principle - Principle of least action.

(Chapter 4: Sections 4.1, 4.2, 4.3, 4.4)

Unit V

Canonical coordinates and canonical transformations - Hamilton's Equations of Motion in Poisson's Bracket - Infinitesimal contact Transformation - Relation between Infintesimal contact Transformation and Poisson's Bracket - Hamilton - Jacobi theory.

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

Text Book

1. C.R.Mondal: Classical Mechanics, Prentice Hall of India, 2007.

Books for Reference

1. K. Sankara Rao: Classical Mechanics, Prentice Hall of India,2005.
2. Herbert Goldstein: Classical Mechanics, Second Edition, Narosa, 1994.

Semester II			
Core IX	**Calculus of Variations and Integral Equations**		
Code: 19PMAC24	**Hrs/Week: 4**	**Hrs/Sem: 60**	**Credits: 4**

Vision:

To impart analytical ability in solving variational problems and integral equations also to formulate the laws of mechanics and basic physics.

Mission:

To formulate variational problems and analyze them to deduce key properties of system behavior.

Course Outcome

CO. No.	Upon completion of this course, students will be able to	PSO addressed	CL
CO-1	understand the properties of geometrical problems	2	Un
CO-2	apply variational problems and isoperimetric problems.	2	Ap
CO-3	expose to the decomposition method.	2	E
CO-4	apply different types of integral equations.	2	Ap
CO-5	solve variational problems with constraints both algebraic and isoperimetric.	2,6	Ap
CO-6	derive the Euler - Lagrange equation for variational problems including the case of general variations.	2,5	Re, Ap
CO-7	derive conserved quantities from symmetries and use them to solve the Euler- Lagrange equations.	2,6	Re,Ap
CO-8	solve integral equations and analyze the relation between differential equations and Volterra integral equations	2	Ap

Semester II			
Core IX	**Calculus of Variations and Integral Equations**		
Code: 19PMAC24	**Hrs/Week: 4**	**Hrs/Sem: 60**	**Credits: 4**

Unit I

Calculus of Variations and Applications: Maxima and Minima - The Simplest case - Illustrative examples - Natural boundary conditions and transition conditions - The variational Notation - The more general case. **(Chapter 2: Sec: 2.1 - 2.6)**

Unit II

Constraints and Lagrange multipliers - Variable end points - Sturm-Liouville problems - Hamilton's principle - Lagrange's equations. **(Chapter 2: Sec: 2.7 - 2.11)**

Unit III

Integral Equations: Introduction - Relations between differential and integral equations - The Green's function - Alternative definition of the Green's function.

(Chapter 3: Sec: 3.1 - 3.4)

Unit IV

Linear equations in cause and effect - The influence function - Fredholm equations with separable kernels - Illustrative example.

(Chapter 3: Sec: 3.5 - 3.7)

Unit V

Hilbert-Schmidt theory- Iterative methods for solving equations of the second kind - Fredholm theory. **(Chapter 3: Sec: 3.8, 3.9, 3.11)**

Text Book

1. Francis B. Hildebrand: Methods of Applied Mathematics, second edition, Prentice-Hall of India private limited, 1968.

Books for Reference

1. L. Elsgolts: Differential Equations and the Calculus of Variations, University Press of the Pacific, 2003.
2. Mark Kot: A First Course in the Calculus of Variations, American Mathematical Society Providence Rhode Island, 2014.

Semester II			
Core X	**Fuzzy Algebra**		
Code :19PMAC25	**Hrs/week: 4**	**Hrs/Sem: 60**	**Credits: 4**

Vision

To establish thorough knowledge on the basic mathematical elements of the theory of fuzzy sets.

Mission

To provide an emphasis on differences and similarities between fuzzy sets and classical set theories.

Course Outcome

CO. No.	Upon completion of this course, students will be able to	PSO addressed	CL
CO-1	decide the difference between crisp sets and fuzzy sets.	6	Ev
CO-2	use the fuzzy set theory on statistical methods.	7	Ap
CO-3	compare statistical methods against fuzzy logic methods.	1,7	Ev
CO-4	apply fuzzy logic membership function.	2,6	Ap
CO-5	solve problems on fuzzy set theory.	2	Ap
CO-6	evaluate fuzzy statistics applications	2,7	Ap
CO-7	apply the methods of fuzzy sets and fuzzy logic in solving problems in the theory of fuzzy control.	1,7	Ap
CO-8	explain the theory of statistics fuzzy logic	5	Re, Un

Semester II			
Core X	**Fuzzy Algebra**		
Code:19PMAC25	**Hrs/week:4**	**Hrs/Sem:60**	**Credits:4**

Unit I

From Classical sets to Fuzzy sets- Fuzzy Sets – Basic concepts – Fuzzy sets versus Crisp sets - Additional Properties of Alpha cuts - Representation of fuzzy sets- Extension Principle for Fuzzy sets.

(Text book 1 - Chapter 1: Section 1.4, Chapter 2: Sections 2.1,2.2,2.3)

Unit II

Operations on Fuzzy sets - Types of operations - Fuzzy complements - Fuzzy intersections: t-Norms - Fuzzy Union: t-conorms- Combination of operations – Aggregation Operations**.**

(Text book 1 –Chapter 3: Sections 3.1,3.2,3.3,3.4,3.5,3.6)

Unit III

Fuzzy Subgroups – Union of two Fuzzy Subgroups- Fuzzy Subgroup Generated by a Fuzzy Subsets – Fuzzy Normal Subgroups,Fuzzy Conjugate Subgroups and Fuzzy Characteristic Subgroups – Fuzzy Sylow Subgroups.

(Text book 2 –Chapter 2: Sections 2.1,2.2,2.3,2.4)

Unit IV

Fuzzy Ideals and their operations –Some Elementary Properties- Union of Fuzzy Subrings-Fuzzy Subring Generated by a Fuzzy Subsets – Fuzzy Ideals and Homomorphisms.

(Text book 2 – Chapter 3: Sections 3.1, 3.2, 3.3,3.4)

Unit V

Fuzzy Prime Ideals, Fuzzy Maximal Ideals and Fuzzy Semi prime Ideals of Rings – Fuzzy Prime Ideals – Fuzzy Maximal Ideals – Fuzzy Semi prime Ideals

(Text book 2 – Chapter 4: Sections 4.1,4.2,4.3)

Text Books

1. George J.Klir & Bo Yuan:Fuzzy Sets and Fuzzy Logic Theory and Applications.
2. Rajesh Kumar: Fuzzy Algebra - volume 1 (Fuzzy Subgroups, Fuzzy Subrings and Fuzzy Ideals).

Books for Reference

1. Paul P. Wang, Da Ruan and Etienne E. Kerre: Fuzzy Logic, Springer International Edition, 2009.
2. S. Nanda and N.R. Das: Fuzzy Mathematical Concepts, Narosa Publishing House, 2012.

Semester II			
Elective I A	**Combinatorics**		
Code:19PMAE21	**Hrs/week: 4**	**Hrs/Sem:60**	**Credits: 3**

Vision

To introduce combinatorial techniques for solving enumeration problems.

Mission

To understand and demonstrate the basic concept of an algorithm and its applications in combinatorial mathematics.

Course Outcome

CO. No.	Upon completion of this course, students will be able to	PSO addressed	CL
CO-1	recognize the properties and behavior of permutations and combinations.	1, 6	Un
CO-2	solve problems involving strings, combinations, distributions and partitions.	2	Cr
CO-3	understand the ideas of permutations and combinations.	1,6	Un
CO-4	apply, implement and interpret the theory of combinatorics to relevant probability and statistics problems.	2	Ap
CO-5	understand the addition and multiplication principles of counting.	3	Un
CO-6	apply diverse counting strategies to solve varied problems involving combinations and distributions	2,3	Ap
CO-7	identify, formulate and solve combinatorial problems.	2	Ap
CO-8	apply combinatorial ideas to practical problems	1,6	Ap

Semester II			
Elective I A	**Combinatorics**		
Code: 19PMAE21	**Hrs/week: 4**	**Hrs/Sem:60**	**Credits: 3**

Unit I

Permutations and Combinations:

Introduction, rules of sum and product, Permutations and Combinations, Distributions of distinct objects, distributions of non - distinct objects.

(Chapter 1: Sections: 1.1 -1.6)

Unit II

Generating Functions:

Generating functions for combinations, enumerators for permutations, Distributions of distinct objects into non- distinct cells, partitions of integers.

(Chapter 2: Sections: 2.1 -2.5)

Unit III

Recurrence Relations:

Linear Recurrence relations with constant coefficients, Solution by the technique of generating functions, Recurrence relation with two indices.

(Chapter 3: Sections: 3.1 -3.3, 3.5)

Unit IV

The Principle of Inclusion and exclusion:

The principle of Inclusion and Exclusion, the general formula, Derangements, Permutations with restrictions on relative positions.

(Chapter 4: Sections: 4.1 -4.5)

Unit V

Polya's Theory of Counting:

Equivalence classes under a permutation group, Equivalence classes of functions, Weights and inventories of functions, Polya's fundamental theorem.

(Chapter 5: Sections: 5.3 -5.6)

Text Book

1. C. L. Liu: Introduction to Combinatorial Mathematics, McGraw Hill publications, 1968.

Books for Reference

1. Normal L. Biggs: Discrete Mathematics, Oxford University Press, Oxford, 2002.
2. J.Hein: Discrete Structures, Logic and Computability, Jones and Barlett, 2002.

Semester - II			
Elective I B	**Stochastic Processes**		
Code: 19PMAE21	**Hrs/week: 4**	**Hrs/Sem: 60**	**Credits: 4**

Vision

To develop and apply the knowledge of stochastic process in an uncertain environment.

Mission

To acquire knowledge about stochastic process relying on the probability theory and mathematical analysis.

Course Outcome:

CO. No.	Upon completion of this course, students will be able to	PSO addressed	CL
CO-1	understand the stochastic models for many real life probabilistic situations.	8	Un
CO-2	explain the well known models like birth-death and queueing to reorient their knowledge of stochastic analysis.	7	Cr
CO-3	understand the random walk associated with real life situation to solve.	1	Un
CO-4	analyze the transition probabilities and its classifications.	2	An
CO-5	discuss erlang process and execute it.	5	Un
CO-6	apply into real life problems	1,8	Ap
CO-7	understand the notions of stochastic process.	5	Un
CO-8	apply markov chains to practical problems	4	Ap

Semester - II			
Elective I B	**Stochastic Processes**		
Code: 19PMAE21	**Hrs/week: 4**	**Hrs/Sem: 60**	**Credits: 4**

Unit I

Generating functions - Laplace Transforms - Laplace Transforms of a Probability Distribution or of a Random variable - Difference Equations - Difference Equations in Probability Theory.

(Chapter: 1, Sec: 1.1 - 1.5)

Unit II

Differential - Difference Equations - Matrix analysis. Stochastic Process: Notion of Stochastic process - Specification of Stochastic Process.

(Chapter: 1, Sec: 1.6, 1.7 and Chapter: 2, Sec: 2.1 - 2.3)

Unit III

Higher transition probabilities and classification of states - Higher transition probabilities - Classification of states and chains - Determination of Higher transition probabilities -Stability of Markov system: Limiting Behavior.

(Chapter: 3, Sec: 3.1 - 3.5)

Unit IV

Statistical inference for Markov Chains-Markov chains with continuous state space-Non-stationary or Non-homogeneous chains-Poisson process-Poisson process and Related Distributions.

(**Chapter: 3, Sec: 3.6-3.8 and Chapter: 4, Sec 4.1 - 4.2)**

Unit V

Generalizations of Poisson Process-Birth and Death process-Markov Processes-Discrete State Spaces-Erlang Process.

(Chapter: 4, Sec: 4.3 - 4.36)

Text Book:

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

Books for Reference:

1. Srinivasan Mehata: Stochastic Process, Tata McGraw-Hill Publishing Company Limited, New Delhi, 1976.
2. Tapas kumar Chandra and Sreela Gangopadhyay: Introduction to Stochastic Process, Narosa Publishing House, 2018.

Semester III			
Core XI	**Topology**		
Code: 19PMAC31	**Hrs/Week: 6**	**Hrs/Semester: 90**	**Credits: 4**

Vision

To perform recognized research in topology and to explore applications of topology.

Mission

Introduce students to the field of topology and develop the knowledge and attitudes necessary to pursue further studies in topology.

Course Outcome

CO.No.	Upon completion of this course, students will be able to	PSO addressed	CL
CO-1	define and illustrate the concepts of topological spaces and product topology.	5	Re
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.	2	Ev
CO-3	explain the concepts concerned with properties that are preserved under continuous deformation of objects.	5&6	Ev
CO-4	apply the knowledge general topology to formulate and solve problems of a topological nature in mathematics and other fields where topological issues arise.	2	Ap
CO-5	define Connectedness and Compactness and prove the related theorems.	5	Re
CO-6	understand the separation axioms in different spaces.	5	Un
CO-7	familiar with the Uryshon lemma and the Tietze extension theorem, and can characterize metrizable spaces.	1&5	Ap
CO-8	explain the relation between the three types of compactness in general topological spaces and in metric spaces.	5	An

Semester III			
Core XI	**Topology**		
Code: 19PMAC31	**Hrs/Week: 6**	**Hrs/Semester: 90**	**Credits: 4**

Unit I

Topological spaces and Continuous functions: Topological spaces - Basis for a topology - Order Topology - The Product topology on X x Y - The Subspace Topology - Closed sets and Limit points.

(Chapter: 2, Sections: 12, 13, 14, 15, 16, 17)

Unit II

Continuous Functions - The Product Topology - The Metric Topology.

(Chapter: 2, Sections: 18, 19, 20, 21)

Unit III

Connectedness and Compactness: Connected Spaces - Connected subspaces of the real line - Compact spaces - Compact subspaces of the real line - Limit point compactness.

(Chapter: 3, Sections: 23, 24, 26, 27, 28)

Unit IV

Countability and Separation Axioms: The Countability Axioms - The separation axioms - Normal spaces - The Urysohn lemma.

(Chapter: 4, Sections: 30, 31, 32, 33)

Unit V

The Urysohn Metrization theorem - The Tietze extension theorem - The Tychonoff theorem.

(Chapter: 4, Sections: 34, 35, Chapter 5, Section: 37)

Text Book

1. J.R Munkres: Topology, Second Edition, Pearson Education Agency, New Delhi, 2002.

Books for Reference

1. George McCarty: Topology, Tata McGraw Hill Publications, New Delhi, 1967.
2. G.F.Simmons: Topology and Modern Analysis, Mc Graw - Hill International Editions, 1963.

Semester III			
Core XII	**Graph Theory**		
Code: 19PMAC32	**Hrs/Week: 6**	**Hrs/Sem:90**	**Credits: 4**

Vision

To acquire a strong background and to get comprehensive ideas on recent trends in graph theory.

Mission

To acquire a detail knowledge about graph theory and to solve problems in communication networks, railway networks etc.,

Course Outcome

CO. No.	Upon completion of this course, students will be able to	PSO addressed	CL
CO-1	understand the basic concepts of graphs, directed graphs and present the graph by matrices.	7	Un
CO-2	solve the problems involving edge and vertex connectivity, Planarity and crossing number and to determine the Eulerian and Hamiltonian graphs.	2,7	Ap
CO-3	develop the critical and analytical thinking about Matchings.	1	Ap
CO-4	analyze the properties of Trees and Connectivity	5,7	An
CO-5	solve the problems involving vertex and edge coloring.	2,7	Ap
CO-6	understand and apply the fundamental concepts of independent sets.	2	Un
CO-7	show a series of graph theoretical problems which have real world applications	1	Re
CO-8	discuss and understand the importance of the concepts Matchings and Colorings.	1,7	An,Un

Semester III			
Core XII	**Graph Theory**		
Code: 19PMAC32	**Hrs/Week: 6**	**Hrs/Sem: 90**	**Credits: 4**

Unit I

Graphs–Sub graphs- Graphs & Simple graphs- Graph Isomorphism- Vertex degrees –Path and connection – Trees-Cut edges and Bonds-Cut vertices - Cayley's formula.

(Chapter: 1, Sections: 1.1 - 1.7 & Chapter: 2, Sections: 2.1 - 2.4)

Unit II

Connectivity – Blocks – Euler tour – Hamilton cycle - Chavatal theorems.

(Chapter 3, Sections: 3.1, 3.2 & Chapter 4, Sections: 4.1, 4.2)

Unit III

Matchings - Matchings and Coverings in Bipartite Graphs – Marriage Theorem - Perfect Matching. **(Chapter 5, Sections: 5.1, 5.2, 5.3)**

Unit IV

Colorings - Edge Coloring- Edge Chromatic number - Vizing's theorem-Vertex Coloring-Chromatic number - Brook's Theorem-Hajo's Conjecture-Chromatic Polynomials- Girth and Chromatic Number.

(Chapter 6, Sections: 6.1, 6.2 & Chapter 8, Sections: 8.1 - 8.5)

Unit V

Independent sets – Cliques: Independents sets-Ramsey's Theorem – Erdo's Theorem-Turan's Theorem.

(Chapter 7, Sections: 7.1, 7.2, 7.3)

[Last sections (applications) in each chapter not included]

Text Book

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

Books for Reference

1. R.BalaKrishnan and K.Ranganathan: Text Book of Graph Theory, Springer Publications.
2. M.Murugan: Applications of Graph Theory, Muthali Publishing House.

Semester III			
Core XIII	**Measure Theory**		
Code: 19PMAC33	**Hrs/Week:5**	**Hrs/Sem: 75**	**Credits: 4**

Vision

To acquire the knowledge of integration and differentiation on R together with the fundamentals of abstract measure and integration.

Mission

To provide a basic course in Lebesque measure and integration and study of inequalities and L^p spaces.

Course Outcome

CO. No.	Upon completion of this course, students will be able to	PSO addressed	CL
CO-1	understand the basic definitions and the properties of Lebesgue measure of measurable sets.	1	Un
CO-2	define Lebesgue integral and discuss its properties.	6	Re
CO-3	analyze the concept of L^p spaces.	1,2	An
CO-4	explain the concept of simple functions and Lebesgue integral of nonnegative integral functions.	6	Ap
CO-5	summarize and discuss the properties of outer measure.	2	Un
CO-6	develop a basic knowledge of measure theory needed to understand probability theory and functional analysis	7	Cr
CO-7	develop probabilistic concepts within the frame work of measure theory.	7	Cr
CO-8	integrate a measurable function with respect to a measure.	1	Cr, Ap

Semester III			
Core XIII	**Measure Theory**		
Code: 19PMAC33	**Hrs/Week: 5**	**Hrs/Sem: 75**	**Credits: 4**

Unit I

Lebesgue Measure: Outer measure - Measurable sets and Lebesgue measure - Measurable functions.

(Chapter 3: Sections 1, 2, 3, 5)

Unit II

The Lebesgue Integral: The Riemann Integral - The Lebesgue integral of a bounded function over a set of finite measure - The integral of a non-negative function – The general Lebesgue Integral.

(Chapter 4: Sections 1, 2, 3, 4)

Unit III

Classical Banach Spaces: L^p space – Holder and Minkowski inequalities- Convergence and completeness- Bounded linear functionals on the L^p spaces. **(Chapter 6)**

Unit IV

General Measure and Integration: Measure spaces- Measurable functions - Integration - Signed Measures -The Radon Nikodym Theorem.

(Chapter 11: Sections 1, 2, 3, 5, 6)

Unit V

Measure and Outer measure: Outer measure and Measurability- The Extension theorem – The Lebesgue - stieltjes Integral - Product Measures.

(Chapter 12: Sections 1, 2, 3, 4)

Text Book

1. H.L.Royden: Real Analysis, Second Edition, Collier , Macmillan Co., New York, 2004.

Books for Reference

1. Munroe M.E: Introduction to Measure and Integration, Addition - Wesley Publishing Company, U.S.A 1959.
2. Donald L. Cohn: Measure theory, second edition, Springer International Edition, 2013.

Semester III			
Core – XIV	**Partial Differential Equations**		
Code: 19PMAC34	**Hrs/Week: 5**	**Hrs/Sem: 75**	**Credits: 4**

Vision

To acquire a detail knowledge about partial differential equations and its various concepts.

Mission

To provide the students with a technique in analysis of partial differential equations.

Course Outcome

CO. No.	Upon completion of this course, students will be able to	PSO addressed	CL
CO-1	apply the fundamental concepts of Ordinary Differential Equations and Partial Differential Equations and the basic numerical methods for their resolution.	2	Ap
CO-2	demonstrate accurate and sufficient use of Laplace's equation and their applications in the theory of PDE.	2,6	Ap
CO-3	investigate the behavior of second order partial differential equations.	1,2	Un
CO-4	analyze the Partial Differential Equations using separation of variables techniques.	6	An
CO-5	formulate and solve the differential equations using Laplace Equation.	2	Un
CO-6	extract information from partial derivative models in order to interpret reality.	6	Cr
CO-7	apply partial derivative techniques to predict the behavior of certain phenomena.	2	Ap
CO-8	extract information from partial derivative models in order to interpret reality.	5	An

Semester III			
Core – XIV	**Partial Differential Equations**		
Code: 19PMAC34	**Hrs/Week: 5**	**Hrs/Sem: 75**	**Credits: 4**

Unit I

Partial differential equations of the first order: Partial differential equations -Origins of first order partial differential equations-Linear equations of the first order-Surface orthogonal to a given system of surfaces-Nonlinear PDE of the first order-Cauchy's method of characteristics.

(Chapter: 2, Sec: 1, 2, 4, 6, 7, 8)

Unit II

Compatible systems of first order equations - Charpit's Method-Special types of first order equations-Solutions satisfying given conditions.

(Chapter: 2, Sec: 9, 10, 11)

Unit III

Partial differential equations of second order: The origin of second order equations-higher order equations in physics-Linear PDE with constant coefficients-Equations with variable coefficients. **(Chapter: 3, Sec: 1, 3, 4, 5)**

Unit IV

Characteristic curves of second order equations-Characteristics of equations in three variables-The solution of linear hyperbolic equations-Separation of variables in a PDE.

Chapter: 3, Sec: 6, 7, 8, 9)

Unit V

Laplace's equation, elementary solutions of Laplace's equations; families of equipotential surfaces. (**Chapter: 4, Sec: 1, 2, 3)**

Text Book

1. I. N. Sneddon: Elements of Partial Differential Equation, Third edition, McGraw Hill Book Company, 1998.

Books for Reference

1. E. T. Copson: Partial Differential Equations Second edition, Cambridge University,1975.
2. M.D. Raisinghania & R.S. Aggarwal: Ordinary and partial differential equations, Second Edition, S. Chand and company Ltd., Ram nagar, New Delhi.

SEMESTER III			
Core XV	**Research Methodology**		
Code: 19PMAC35	**Hrs/ week: 4**	**Hrs/Semester: 60**	**Credits: 4**

Vision

To motivate the students for presenting and writing research papers and to train the students to understand a general definition of research design.

Mission

To contribute to the development of the new statistical methodology to address substantive problems and to promote the use of these methods through publications.

Course Outcome

CO. No.	Upon completion of this course, students will be able to	PSO addressed	CL
CO-1	use Mathematical and Statistical techniques for research.	5,8	Ap
CO-2	acquire basic knowledge about various instruments and techniques in Mathematical research.	5,1	Un
CO-3	acquire knowledge in research publication and thesis writing.	5	Un
CO-4	understand the basic aspects in research.	5	Un
CO-5	practice and improve the research presentation skills with latest tools.	5	Re
CO-6	organize and conduct research in a more appropriate manner.	5	Cr
CO-7	identify appropriate research topics.	5	Ap
CO-8	select and define appropriate research problems and parameters.	5	Re

SEMESTER III			
Core XV	**Research Methodology**		
Code: 19PMAC35	**Hrs/ week: 4**	**Hrs/Semester: 60**	**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.

(**Text Book: 1, Chapter: 1, pages 1-9)**

Unit II

Importance of knowing how research is done - Research Process - Criteria of Good Research.

(**Text Book: 1, Chapter: 1, pages 10-20)**

Unit III

Planning the Thesis: Selecting a topic-Reviewing the literature-Designing the study-The chapter outline. Writing the Thesis: The preliminaries - The text-The reference material-The abstract-The final product-Chapter divisions and subdivisions-Spacing-Pagination-Margins-Paragraph indentation-Sample pages.

(Text Book: 2, Chapter: 3, 5)

Unit IV

Revising the Thesis: Editing the final draft-Evaluating the final draft- Proof reading the final typed copy.

(Text Book: 2, Chapter: 6, 12)

Unit V

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

(Text Book: 3, Pages 1-22)

Text Books

1. C.R. Kothari – Research Methodology, Second Revised Edition – 2009, New Age International (P) Limited, Publishers.
2. Janathan Anderson, Berry H. Durston & Millicent poole – Thesis and assignment Writing - Eleventh Reprint 1991, Wiley Eastern limited.
3. The Grammar According to West by Douglas B. West.

Book for Reference

1. Leonie Elphinstone and Robert Schweitzer; How to get a research degree - A Surival Guide, Allen and Unwin Publication, 1998.

Semester III			
Elective II A	**Fluid Mechanics**		
Code: 19PMAE31	**Hrs/Week: 4**	**Hrs/Sem: 60**	**Credits: 3**

Vision

To empower students with the knowledge of basic laws, principles and phenomena in the area of fluid mechanics and to solve problems.

Mission

Enable the students to apply the acquired knowledge and skills in professional and specialist courses.

Course Outcome

CO.No.	Upon completion of this course, students will be able to	PSO addressed	CL
CO-1	explain fundamentals of fluid mechanics, which is used in the applications of Hydraulics.	1,8	Un
CO-2	employ Archimedes principle to solve numerical examples on Buoyancy.	2,5	Ap
CO-3	develop understanding about hydrostatic law, principle of buoyancy and stability of a floating body and application of mass, momentum and energy equation in fluid flow.	2	Ap
CO-4	imbibe basic laws and equations used for analysis of static and dynamic fluids.	1,8	Un
CO-5	examine stability of submerged and floating bodies.	6	An
CO-6	differentiate horizontal motion and vertical motion.	1	An
CO-7	describe methods of implementing fluid mechanics laws and phenomena.	5,6	Re
CO-8	calculate and optimize operational parameters of hydraulic problems, systems and machines	2	Cr,Ap

Semester III			
Elective II B	**Fluid Mechanics**		
Code: 19PMAE31	**Hrs/Week: 4**	**Hrs/Sem: 60**	**Credits: 3**

Unit I

Properties of Fluids: Fluid Mechanics and hydraulics- Definition of a fluid- American engineering system of units- Specific weight- Mass density- Specific gravity- Viscosity- Vapor pressure- Surface tension- Capillarity- Fluid pressure- Unit pressure- Difference in pressure – Pressure variations in a compressible fluid- Pressure head h- Bulk modulus of elasticity- Compression of gases. Isothermal conditions- Adiabatic or Isentropic conditions- Pressure disturbances.

(Chapter 1)

Unit II

Hydrostatic force on surfaces: Force exerted on plane area- Line of action of force- Horizontal and vertical components of force- Hoop tension- Longitudinal stress.

(Chapter 2)

Unit III

Buoyancy and flotation: Archimedes' Principle- Stability of submerged and floating bodies.

(Chapter 3)

Unit IV

Translation and Rotation of liquid masses: Horizontal motion- Vertical motion- Rotation of open vessels- Rotation of closed vessels.

(Chapter 4)

Unit V

Dimensional analysis and hydraulic similitude: Dimensional analysis- Buckingham Pi theorem- Hydraulic models- Geometric similitude- Kinematic similitude- Dynamic similitude- Inertia force ratio- Inertia-pressure force ratio- Inertia-viscous force ratio- Inertia-gravity force ratio- Inertia-elasticity force ratio- Inertia-surface tension ratio- Time ratios.

(Chapter 5)

Text Book

1. Ranald V. Giles: Fluid Mechanics and Hydraulics, Second Edition, McGraw - Hill Book Company.

Books for Reference

1. Dr.R.K. Bansal, A text bookofFluid Mechanics, Laxmi Publication private limited.
2. Joseph H.Spurk,Nuri Aksel, Fluid Mechanics,Secon Edition,Springer- Verlag Berlin Heidelberg ,2008.

Semester - III			
Elective II B	**Wavelet Analysis**		
Code: 19PMAE31	**Hrs/week: 4**	**Hrs/Sem: 60**	**Credits: 4**

Vision

To expose the students to the basics of Wavelet theory and to illustrate the use of Wavelet Processing for data compression and noise suppression.

Mission

To handle problems and conduct researches related to theoretical and applied problems in Wavelet Theory.

Course Outcome:

CO. No.	Upon completion of this course, students will be able to	PSO addressed	CL
CO-1	understand wavelet basis and characterize continuous and discrete wavelet transform	2	Un
CO-2	understand multi resolution analysis and identify various wavelets and evaluate their time frequency resolution properties	3	Un
CO-3	analyze discrete wavelet transforms with multirate digital filters	8	An
CO-4	discuss and explain the main merits and limitations of wavelet analysis	2	An
CO-5	explain the properties and applications of wavelet transform	1	Ev
CO-6	apply into real life problems	2,3	Ap
CO-7	explain brief features and strength of transform beyond wavelet.	2	Ev
CO-8	design certain classes of wavelets to specification and justify the basis of the application of wavelet transforms to different fields	1,6	Cr

Semester - III			
Elective II B	**Wavelet Analysis**		
Code: 19PMAE31	**Hrs/week: 4**	**Hrs/Sem: 60**	**Credits: 4**

Unit I

Motivation and Heuristics - Heuristics Treatment of the Wavelet Transform - Wavelet Transform - Wavelet Characterization of Smoothness - Haar Wavelet Expansion - Haar Functions and Haar Series - Haar Sums and Dyadic Projections - Completeness of the Haar Functoins. **(Chapter: 6, Sec: 6.1 - 6.3, except 6.3.4 - 6.3.7)**

Unit II

Multi resolution Analysis - Orthonormal System and Riesz Systems - Scaling Equations and Structure Constants - From Scaling Function to MRA - Meyer Wavelets - From Scaling Function to Orthonormal Wavelet. **(Chapter: 6, Sec 6.4)**

Unit III

Wavelets with Compact Support - From Scaling Filter to Scaling Function - Explicit Construction of Compact Wavelets - Smoothness of Wavelets - Cohen's Extension **(Chapter: 6, Sec: 6.5)**

Unit IV

Convergence Properties of Wavelet Expansions - Wavelet Series in L^P Spaces - Jackson and Bernstein Approximation Theorems. (**Chapter: 6, Sec: 6.6)**

Unit V

Wavelets in Several Variables - Two important Examples - General Formulation of MRA and Wavelets in R^d - Examples of Wavelets in R^d. **(Chapter: 6, Sec: 6.7)**

Text Book:

1. Mark A. Pinsky: Introduction to Fourier Analysis and Wavelets, Published by the American Mathematical Society, First Indian Edition, 2015.

Books for Reference:

1. E. Hernandez and G. Weiss: A First Course on Wavelets, CRC Press, 1996.
2. L. Prasad & S.S. Iyengar: Wavelet Analysis with Applications to Image Processing, CRC Press, 1997.

Semester III	
Self-Study Course	**Discrete Mathematics**
Code: 19PMASS1	**Credits: 2**

Vision

To acquire the detailed knowledge about various discrete structures of mathematics.

Mission

To get familiar and understand the fundamental notions in discrete mathematics.

Course Outcome

CO. No.	Upon completion of this course, students will be able to	PSO addressed	CL
CO-1	simplify and evaluate basic logic statements including compound statements, implications, inverses, converses, and contra positives using truth tables and the properties of logic.	1,6	**Cr**
CO-2	express a logic sentence in terms of predicates, quantifiers, and logical connectives.	1	Ev
CO-3	solve problems using the principle of inclusion-exclusion and use Venn diagrams to solve problems.	2	Cr
CO-4	determine simple or a multigraph, directed or undirected graph, cyclic or acyclic graph and determine the connectivity of a graph.	1,6	Un
CO-5	analyze the growth of elementary functions and determine their Big-O value; analyze simple algorithms and compare two algorithms based on computational complexity.	5	An
CO-6	explain the Inclusion- Exclusion principle and pigeonhole principle.	6	Ev
CO-7	apply counting principles to determine probabilities	1,6	Ap
CO-8	determine the level of a node, the height of a tree or sub tree and apply counting theorems to the edges and vertices of a tree.	1,6	Un

Semester III	
Self-Study Course	**Discrete Mathematics**
Code: 19PMASS1	**Credits: 2**

Unit I

The Foundation: Logic, Sets and Functions- Logic, Propositions, Translating English Sentences, Propositional Equivalences, Logic Equivalence.

(Chapter: 1 Sec: 1.1, 1.2)

Unit II

Predicates and Quantifiers, Translating Sentences into Logical Expressions, Examples from Lewis Carroll.

(Chapter: 1 Sec: 1.3)

Unit III

Counting: Basic Counting Principles, The Inclusion-Exclusion Principle, Tree Diagrams, The Pigeonhole Principle, The Generalized Pigeonhole Principle, Some Elegant Applications of The Pigeonhole Principle.

(Chapter: 4 Sec: 4.1, 4.2)

Unit IV

Permutations and combinations – Binomial coefficients – Pascal's Identity Vandermonde's Identity, The Binomial Theorem, Generalized Permutations and Combinations, Permutations with Repetition, Combinations with Repetitions.

(Chapter: 4 Sec: 4.3, 4.6)

Unit V

Advanced Counting Techniques: Recurrence Relations, Modeling with Recurrence Relations, Solving Recurrence Relations, Solving Linear homogeneous Recurrence Relation with Constant coefficients.

(Chapter: 5 Sec: 5.1, 5.2)

Text Book

1. Kenneth H. Rosen: Discrete Mathematics and its Applications, fourth edition, WC B/McGraw Hill publications, 2007.

Books for Reference

1. P. K. Mittal: Discrete Structures, Paragon International Publishers, New Delhi, 2007.
2. Gary Haggard, John Schlipf and Sue Whitesides: Discrete Mathematics for Computer Science, Thomson Brooks/Cole Publications.

Semester IV			
Core XVI	**Complex Analysis**		
Code: 19PMAC41	**Hrs/Week: 6**	**Hrs/Sem: 90**	**Credits: 4**

Vision

To introduce the basic ideas of complex analysis with particular emphasis on Cauchy's theorem and the calculus of residues.

Mission

To initiate the students to enjoy complex variables and to relate the problems with real life problems.

Course Outcome

CO. No.	Upon completion of this course, students will be able to	PSO Addressed	CL
CO-1	define and analyze limits and continuity for complex functions as well as consequences of continuity.	1,6	Re
CO-2	evaluate the complex contour integral directly and by the fundamental theorem.	6	Re
CO-3	represent functions as Taylor, power and Laurent series, classify singularities and poles, find the residues and evaluate complex integrals using the residue theorem.	6	Un
CO-4	apply the concept and consequences of analyticity and the Cauchy-Riemann equations and of results on Harmonic and entire functions including the fundamental theorem of algebra.	2,6	Ap
CO-5	analyze the sequence and series of analytic functions and types of convergence.	1,6	An
CO-6	represent complex numbers algebraically and geometrically	6	Un
CO-7	demonstrate accurate and efficient use of complex analysis techniques	6	An
CO-8	apply the methods of complex analysis to evaluate definite integrals and infinite series.	1,2	Ap

Semester IV			
Core XVI	**Complex Analysis**		
Code: 19PMAC41	**Hrs/Week: 6**	**Hrs/Sem: 90**	**Credits: 4**

Unit I

Analytic functions as mappings: Conformality: arcs and closed curves - analytic functions in regions - conformal mapping - length and area. Linear transformations: linear group - the cross ratio - symmetry - oriented circles - family of circles. Elementary conformal mappings: the use of level curves - a survey of elementary mappings - elementary Riemann surfaces.

(Chapter 3: Sections 2, 3 and 4)

Unit II

Complex Integration Fundamental theorem: line integrals - rectifiable arcs - line integrals as functions of arcs - Cauchy's theorem for a rectangle - Cauchy's theorem in a disk. Cauchy's integral formula: the index of a point with respect to a closed curve - the integral formula - higher derivatives.

(Chapter 4: Sections 1 and 2)

Unit III

Local properties of analytical functions: removable singularities - Taylor's theorem - zeros and poles - the local mapping - the maximum principle. The general form of Cauchy's theorem: chains and cycles - simple connectivity - homology - general statement of Cauchy's theorem - proof of Cauchy's theorem - locally exact differentials - multiply connected regions.

(Chapter 4: Sections 3 and 4)

Unit IV

Calculus of Residues: the residue theorem - the argument principle - evaluation of definite integrals. Harmonic functions: definition and basic properties - the mean value property - Poisson's formula - Schwartz theorem - the reflection principle.

(Chapter 4: Sections 5 and 6)

Unit V

Power series Expansions - Partial Fractions - Infinite Products - Canonical Products.

(Chapter 5: Sections 1 and 2.1, 2.2, 2.3)

Text Book

1. Lars V.Ahlfors: Complex Analysis .Third Edition, Mc Graw Hill International Edition,1979.

Books for Reference

1. Karunakaran.V: Complex Analysis, Narosa Publications, 2002.
2. S.Ponnusamy: Foundation of Complex Analysis, Narosa Publishing House, 2005.

SEMESTER IV			
CORE XVII	**Functional Analysis**		
Code: 19PMAC42	**Hrs/Week: 6**	**Hrs/Semester: 90**	**Credits: 4**

Vision

To acquire a detail knowledge about Banach spaces, Hilbert spaces, Banach Algebras and Functionals defined on a set of functions.

Mission

To equip the students with the knowledge of functional analysis to solve mathematical problems.

Course Outcome

CO. No.	Upon completion of this course, students will be able to	PSO addressed	CL
CO-1	apply the spectral theorem for compact self- adjoint operators and decide which properties an operator has.	5	Ap
CO-2	understand the various concepts of Banach Spaces.	5	Un
CO-3	attain a detailed knowledge about Hilbert Spaces.	2,5	Re
CO-4	understand the Operator theory in Hilbert Spaces.	1,5	Un
CO-5	explain the concepts of different operators.	5	Un
CO-6	get clear ideas about the finite dimensional Spectral Theory.	1	Re
CO-7	independently decide if a linear space is a Banach space.	5	An
CO-8	understand the statements and proof of important theorems and explain the key steps in proofs sometimes with variation	1	Un

SEMESTER IV			
CORE XVII	**Functional Analysis**		
Code: 19PMAC42	**Hrs/Week: 6**	**Hrs/Semester: 90**	**Credits: 4**

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 and unitary 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 Spectrum - The formula for the Spectral Radius - The Radical and Semi-simplicity.

(Chapter 12: Sections 67, 68, 69)

Text Book

1. G.F.Simmons: Topology and Modern Analysis, McGraw Hill International Editions.

Books for Reference

1. M.Thamban Nair: Functional Analysis A first course, Prentice Hall of India.
2. S. Ponnusamy: Functional Analysis, Narosa Publishing.

Semester IV			
Core XVIII	**Number Theory**		
Code:19PMAC43	**Hrs/week: 5**	**Hrs/Sem:75**	**Credits: 4**

Vision

To make the students to understand the various analytical concepts in numbers.

Mission

To introduce the concepts of arithmetic function, Dirichlet multiplications, averages of arithmetic functions, congruences and quadratic residues and teach some techniques of solving problems.

Course Outcome:

CO. No.	Upon completion of this course, students will be able to	PSO addressed	CL
CO-1	define the key notions of algebraic number theory and outline their interrelation.	5	Re
CO-2	calculate the most important number theoretical quantities introduced during the course.	5	Re
CO-3	give an account of fundamental theorems of the course and apply them in specific cases.	1,6	Re
CO-4	calculate and solve the system of linear congruences and warning problem.	2,6	Re
CO-5	differentiate the greatest integer functions and arithmetic function.	1,6	An
CO-6	define and interpret the concepts of divisibility, congruence and prime factorization.	5	Re
CO-7	apply Euler-Fermat's theorem to prove relations involving prime numbers.	2	Ap
CO-8	solve problems on quadratic reciprocity and the Jacobi symbol.	2,6	Cr

Semester IV			
Core XVIII	**Number Theory**		
Code:19PMAC43	**Hrs/week: 5**	**Hrs/Sem:75**	**Credits: 4**

Unit I

Divisibility - primes - Congruences - Solutions of Congruences - Congruences of degree one.

(Chapter: 1 & 2, Sections: 1.1, 1.2, 1.3, 2.1, 2.2, 2.3)

Unit II

The function f(n) - congruences of higher degree - prime power moduli-prime modulus-congruences of degree two, prime modulus - power residues.

(Chapter: 2, Sections: 2.4, 2.5, 2.7, 2.8, 2.9)

Unit III

Quadratic residues - quadratic reciprocity - The Jacobi symbol.

(Chapter 3, Sections: 3.1, 3.2, 3.3)

Unit IV

Greatest integer Function –Arithmetic functions- The Moebius inversion formula-Multiplication of Arithmetic functions.

(Chapter: 4 Sections: 4.1, 4.2, 4.3, 4.4)

Unit V

The equation $x^2+ y^2=z^2$, The equation $x^4+y^4=z^2$, sum of four and five squares - Waring's problem: Sum of fourth powers-sum of two squares.

(Chapter: 5, Sections: 5.5, 5.6, 5.7, 5.8, 5.9, 5.10)
(without Exercise problems)

Text Book

1. Ivan Niven and Herbert S. Zuckerman: An introduction to the theory of numbers, Third Edition, Wiley Eastern ltd, 1976.

Books for Reference

1. Harriet Griffin: Elementary Theory of Numbers, McGraw-Hall Book Company, INC 1954.
2. G.H. Hardy and E.M. Wright: An Introduction to the theory of numbers, Sixth Edition, Oxford university press, 2008.

Semester IV			
Core XIX	**Differential Geometry**		
Code: 19PMAC44	**Hrs/Week: 5**	**Hrs/Sem: 75**	**Credits: 4**

Vision:

To acquire essential ideas and methods of differential geometry and to learn about the classical theory of curves, surfaces and vector methods.

Mission:

To make students understand the basic terms and tools of differential geometry, which will be used in formulating and solving problems.

Course Outcome:

CO. No.	Upon completion of this course, students will be able to	PSO addressed	CL
CO -1	construct a variety of geometrical objects.	1	Ap
CO-2	acquire the essential ideas about the theory of space curves.	6	Re
CO-3	understand the concepts of the contact between curves and surfaces.	5	Un
CO-4	analyze the different consequences and meanings of parallelism on Euclidean and hyperbolic planes.	1	An
CO-5	demonstrate the knowledge of the historical developments of Euclidean and Non- Euclidean geometry.	5	Un
CO-6	demonstrate the knowledge of family of curves, geodesics and the fundamental forms.	1,6	Un
CO-7	use concrete models to demonstrate geometric concepts	2	Ap
CO-8	evaluate the principal curvatures, the mean curvature and Gauss curvature of a given surface.	2,6	Ev

Semester IV			
Core XIX	**Differential Geometry**		
Code: 19PMAC44	**Hrs/Week :5**	**Hrs/Sem: 75**	**Credits: 4**

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.

(Chapter 2: Sections 7, 10, 11, 12)

Unit V

The Second and Fundamental form: The Second and Fundamental form - Principal curvatures - Lines of Curvature - Geodesic Parallel - Geodesic curvature.

(Chapter 2: Sections 14, 15 & Chapter 3: Sections 1, 2, 3)

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, Second Edition, Addison Wesley Publishing House.
2. William C.Graustein: Differential Geometry, 1962, Dover Publications, New York.