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**

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 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 I			
Core I	**Groups and Rings**		
Course Code: 21PMAC11	**Hrs/Week: 6**	**Hrs/Sem: 90**	**Credits: 4**

Course Objectives

- To provide an introduction of Normal Subgroups, permutation groups, concept and to develop working knowledge of Ideals, Principle Ideal Domain, Euclidean Domain, Unique Factorization Domain and Modules.
- To enrich the students with the knowledge of Abstract Algebra.

Course Outcome

CO. No.	Upon completion of this course, students will be able to	PSO addressed	CL
CO-1	illustrate 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	Ap
CO-2	explainSylow's theorem for all finite groups.	5	Un
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	Evaluate the properties implied by the definition of Euclidean Rings and to illustrate and apply the concepts of Polynomial Rings.	6	Ev
CO-6	use orthogonality and matrices	2	Ap
CO-7	recall procedural fluency with polynomial expressions including basic factoring.	4	Re
CO-8	write the definitions of matrix multiplication that corresponds to composition of linear transformations.	2	Ap

Semester I			
Core I	**Groups and Rings**		
Course Code: 21PMAC11	**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: Section 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*. New Delhi: Wiley Eastern Ltd. Second Edition, 2013.

Books for Reference

1. Gavvett Birkhoff and Thomas C. Bartee. *Modern Applied Algebra.* Delhi: CSS Publishers and Distributors, 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**		
Course Code: 21PMAC12	**Hrs/Week: 6**	**Hrs/Sem: 90**	**Credits: 4**

Course Objectives

- To acquire thorough knowledge about real functions, limit functions and their properties.
- Have the knowledge of basic properties of the field of real numbers

Course Outcome

CO. No.	Upon completion of this course, students will be able to	PSO addressed	CL
CO-1	Recall the basic properties of real numbers.	5,6	Re
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	An
CO-4	evaluate 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	An
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	write fundamental properties of the real numbers that lead to the formal development of real analysis.	2	Cr

Semester I			
Core II	**Real Analysis**		
Course Code: 21PMAC12	**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 – Problems related to SET/NET.

(Chapter 3)

Unit IV

Limits of functions - Continuous functions - Continuity and Compactness - Continuity and Connectedness - Discontinuities - Monotone functions - Infinite limits and limits at infinity - Problems related to SET/NET.

(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)

Problems related to SET/NET is only for Internal Examination.

Text Book

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

Books for Reference

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

Semester I			
Core III	**Ordinary Differential Equations**		
Course Code: 21PMAC13	**Hrs/Week: 6**	**Hrs/Sem: 90**	**Credits: 4**

Course Objectives

- To obtain the general solution of any homogeneous second order ODE with constant coefficients
- To determine the solution of these special ordinary differential equations by the power series solution method.

Course Outcome

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

Semester I			
Core III	**Ordinary Differential Equations**		
Course Code: 21PMAC13	**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 - Problems related to SET/NET.

(Text Book:1 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.

(Text Book:1 Chapter 5: Sections 25, 26, 27)

Unit III

Ordinary points - Regular singular points - Frobenius series - Hermite Polynomials. Legendre polynomial – Bessel functions and Gamma functions.

(Text Book:1 Chapter 5: Sections 28, 29, Chapter 6: Sections 32, 33, 34, 35)

Unit IV

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

(Text Book:1 Chapter 7: Sections 37, 38, Chapter 11: Sections 55, 56)

Unit V

Introduction-StrurmLiouville problem-Green's function - Problems related to SET/NET

(Text Book 2: Chapter 7: Sections 7.1, 7.2, 7.3)

Problems related to SET/NET is only for Internal Examination.

Text Book

1. G.F.Simmons. *Differential equations with application and historical notes*. Tata McGraw Hill, 1997.
2. S.G.Deo, V.Lakshmikantham, V.Raghavendra. *Text book of Ordinary Differential Equations*.New Delhi: Tata McGraw- Hill Educational Private Limited, second edition, 1997.

Books for Reference

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

Semester II			
Core V	**Linear Algebra**		
Course Code: 21PMAC21	**Hrs/Week: 6**	**Hrs/Semester: 90**	**Credits: 4**

Course Objectives

- To reveal the ability to use algebraic properties to describe interpret and analyse the real world data.
- 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	define 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	Un
CO-3	demonstrate accurate and efficient use of field extension and Galois Theory.	5,6	Ap
CO-4	understand Polynomial Rings and its effect in Galois Theory.	6	Un
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	evaluate the fundamental concepts of algebra and their role in modern mathematics and applied contexts.	2	Ev
CO- 8	compare polynomials, matrices and transformations.	2	An

Semester II			
Core V	**Linear Algebra**		
Course Code: 21PMAC21	**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 - Problems related to SET/NET.

(Chapter 6: Sections 6.1, 6.2, 6.3)

Unit V

Canonical forms - Triangular form - Nilpotent Transformations - Jordan Form - Problems related to SET/NET.

(Chapter 6: Sections 6.4, 6.5, 6.6)

Problems related to SET/NET is only for Internal Examination.

Text Book

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

Books for Reference

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

Semester II			
Core VI	**Mathematical Analysis**		
Course Code: 21PMAC22	**Hrs/Week: 6**	**Hrs/Sem: 90**	**Credits: 4**

Course Objectives

- 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.
- To expose the concepts of convergence, uniform convergence, power series and the application of function of several variables.

Course Outcome

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

Semester II			
Core VI	**Mathematical Analysis**		
Course Code: 21PMAC22	**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*. McGraw Hill International Editions. Third Edition, 1953.

Books for Reference

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

Semester II			
Core VIII	**Calculus of Variations and Integral Equations**		
Course Code:21PMAC24	**Hrs/Week: 4**	**Hrs/Sem: 60**	**Credits: 4**

Course Objectives

- To impart analytical ability in solving variational problems and integral equations also to formulate the laws of mechanics and basic physics.
- To provide the foundation of Calculus of variation and give examples on some applications within Physics and Engineering Sciences.

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	applyvariational problems and isoperimetric problems.	2	Ap
CO-3	evaluate to the decomposition method.	2	Ev
CO-4	compare different types of integral equations.	2	An
CO-5	solvevariational problems with constraints both algebraic and isoperimetric.	2,6	Ap
CO-6	examine the Euler - Lagrange equation for variational problems including the case of general variations.	2,5	An
CO-7	recall symmetries and use them to solve the Euler- Lagrange equations.	2,6	Re
CO-8	solve integral equations and analyze the relation between differential equations and Volterra integral equations	2	Ap

Semester II			
Core VIII	**Calculus of Variations and Integral Equations**		
Course Code: 21PMAC24	**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: Sections: 2.1 - 2.6)**

Unit II

Constraints and Lagrange multipliers - Variable end points – Sturm - Liouville problems - Hamilton's principle - Lagrange's equations.

(Chapter 2: Sections: 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: Sections: 3.1 - 3.4)

Unit IV

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

(Chapter 3: Sections: 3.5 - 3.7)

Unit V

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

Text Book

1. Francis B. Hildebrand. *Methods of Applied Mathematics*. Prentice-Hall of India private limited. second edition, 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 III			
Core X	**Topology**		
Course Code: 21PMAC31	**Hrs/Week: 6**	**Hrs/Sem: 90**	**Credits: 4**

Course Objectives

- 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.
- 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.

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 X	**Topology**		
Course Code: 21PMAC31	**Hrs/Week: 6**	**Hrs/Sem: 90**	**Credits: 4**

Unit I

Topological spaces and Continuous functions: Topological spaces - Basis for a topology - Order Topology - The Product topology on 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 - Problems related to SET/NET.

(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 - Problems related to SET/NET.

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

Unit V

The UrysohnMetrizationtheorem - The Tietze extension theorem - The Tychonoff theorem.

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

Problems related to SET/NET is only for Internal Examination.

Text Book

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

Books for Reference

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

Semester III			
Core XI	**Graph Theory**		
Course Code: 21PMAC32	**Hrs/Week: 6**	**Hrs/Sem:90**	**Credits: 4**

Course Objectives

- To acquire a detail knowledge about graph theory and to solve problems in communication networks, railway networks etc,
- To introduce the basic concepts of Graph Theory such as Trees, Eulerian Graphs, Matchings, Vertex Colourings, Edge Colourings and Planarity.

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 XI	**Graph Theory**		
Course Code: 21PMAC32	**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 -Plane and Planar Graphs- Dual Graphs-Directed Graphs – Directed Paths.

(Chapter 7, Sections: 7.1, 7.2 , Chapter 9, Sections 9.1,9.2 & Chapter 10, Sections:10.1,10.2)

[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. Robin J. Wilson. *Graph Theory*. Pearson Education Asia,2002.

Semester III			
Core XII	**Measure Theory**		
Course Code: 219MAC33	**Hrs/Week:5**	**Hrs/Sem: 75**	**Credits: 4**

Course Objectives

- To introduce abstract integration theory for functions on measure spaces.
- To provide a basic course in bounded variation and differentiation of functions.

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 bounded variation.	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 XII	**Measure Theory**		
Course Code: 21PMAC33	**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

Differentiation of monotone functions- Functions of Bounded Variation – Differentiation of an Integral- Absolute Continuity

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

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*. New York: Collier, Macmillan Co , Second Edition, 2004.

Books for Reference

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

Semester III			
Core XIII	**Partial Differential Equations**		
Course Code: 21PMAC34	**Hrs/Week: 5**	**Hrs/Sem: 75**	**Credits: 4**

Course Objectives

- To focus on the formulation of first and second order Partial Differential Equations for three basic types of hyperbolic, parabolic and elliptic equations.
- To solve the problems of PDEs which include heat, wave and Laplace's Equation that arise in various physical systems.

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 XIII	**Partial Differential Equations**		
Course Code: 21PMAC34	**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 - Problems related to SET/NET.

(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 - Problems related to SET/NET.

(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 - Wave Equations - Elementary Solutions of one dimensional wave equations (**Chapter: 4, Sec: 1, 2, 3; Chapter 5, Sec 1,2)**

Problems related to SET/NET is only for Internal Examination.

Text Book

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

Books for Reference

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

Semester III			
Core XIV	**Research Methodology**		
Course Code: 21PMAC35	**Hrs/ week: 4**	**Hrs/Semester: 60**	**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	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 XIV	**Research Methodology**		
Course Code: 21PMAC35	**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 - Plagiarism - What is Plagiarism - Types of Plagiarism- Glossary – preventing plagiarism when writing.

(Text Book: 2, Chapter: 6, 12, http://www.plagiarism.org/plagiarism-101/what-is-plagiarism/

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 1-31)

Text Books

1. C.R. Kothari. *Research Methodology*, New Age International (P) Limited, Publishers, Second Revised Edition, 2009.
2. Janathan Anderson, Berry H. Durston& Millicent Poole. *Thesis and assignment Writing.* Wiley Eastern limited, Eleventh Reprint, 1991.
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.

Semester IV			
Core XV	**Complex Analysis**		
Course Code: 21PMAC41	**Hrs/Week: 6**	**Hrs/Sem: 90**	**Credits: 4**

Course Objectives

- To initiate the students to enjoy complex variables and to relate the problems with real life 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	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 XV	**Complex Analysis**		
Course Code: 21PMAC41	**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 - Problems related to SET/NET.

(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 - Problems related to SET/NET.

(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)

Problems related to SET/NET is only for Internal Examination.

Text Book

1. Lars V.Ahlfors. *Complex Analysis*. McGraw Hill International Edition. Third 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 XVI	**Functional Analysis**		
Course Code: 21PMAC42	**Hrs/Week: 6**	**Hrs/Semester: 90**	**Credits: 4**

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.

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 XVI	**Functional Analysis**		
Course Code: 21PMAC42	**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 - Problems related to SET/NET.

(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 - Problems related to SET/NET.

(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)

Problems related to SET/NET is only for Internal Examination.

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 XVII	**Number Theory and Cryptography**		
Course Code:21PMAC43	**Hrs/week: 5**	**Hrs/Sem:75**	**Credits: 4**

Course Objectives

- To introduce the basic concepts of Number Theory such as Divisibility, Congruences, Congruences with Prime Modules, Quadratic Reciprocity and some functions of Number theory.
- To understand basics of cryptography and network security.

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	explains the notions of public key encryption and digital signatures.	6	Un
CO-8	describe and implement the specifics of some of the prominent techniques for public key crypto systems and digital signature schemes	6	Re

Semester IV			
Core XVII	**Number Theory and Cryptography**		
Course Code:21PMAC43	**Hrs/week: 5**	**Hrs/Sem:75**	**Credits: 4**

Unit I

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

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

Unit II

Quadratic residues - quadratic reciprocity - The Jacobi symbol.

(Text Book 1, Chapter 3, Sections: 3.1, 3.2, 3.3)

Unit III

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

(Text Book 1, Chapter: 4 Sections: 4.1, 4.2, 4.3, 4.4)

Unit IV

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.

(Text Book 1, Chapter: 5, Sections: 5.5, 5.6, 5.7, 5.8, 5.9, 5.10)
(without Exercise problems)

Unit V

The Basics of Cryptography: Encryption and decryption - What is cryptography? - Conventional cryptography - Public key cryptography - How PGP works - Keys - Digital Signatures - Digital certificates - Validity and trust - Certificate Revocation - What is passphrase? RSA: Principles of Public - key Cryptosystems - The RSA Algorithm.

(Text Book 2, Chapter 1, Text Book 3, Chapter 9)

Text Book

1. Ivan Niven and Herbert S. Zuckerman. *An introduction to the theory of numbers*. Wiley Eastern ltd, Third Edition, 1976.
2. PGP Corporation. *An introduction to Cryptography*. version 8.0, Released Oct, 2002.
3. William Stallings. *Cryptography and Network Security Principles and Practice*. Pearson India Education Services Pvt.Ltd, Seventh Edition.

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*. Oxford university press, Sixth Edition, 2008.
3. Mohamed Barakat, Christian Eder and Timohanke. *An Introduction to Cryptography*. September 20, 2018.

Semester I			
Elective I A	**Combinatorics**		
Course Code:21PMAE11	**Hrs/week: 6**	**Hrs/Sem:90**	**Credits: 4**

Course Objectives

- To understand and demonstrate the basic concept of an algorithm and its applications in combinatorial mathematics.
- To emphasise on the importance of enumeration tools and techniques in diverse branches of mathematics and Applied Fields

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	Ap
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	evaluate the addition and multiplication principles of counting.	3	Ev
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	Un
CO-8	test combinatorial ideas to practical problems	1,6	An

Semester I			
Elective I A	**Combinatorics**		
Course Code: 21PMAE11	**Hrs/week: 6**	**Hrs/Sem:90**	**Credits: 4**

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 - A special class of nonlinear difference equations - Recurrence relation with two indices.

(Chapter 3: Sections: 3.1 - 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, 2002.
2. J.Hein. *Discrete Structures, Logic and Computability*. Jones and Barlett, 2002.

Semester I			
Elective I B	**Fuzzy Sets**		
Course Code :21PMAE12	**Hrs/week: 6**	**Hrs/Sem: 90**	**Credits: 4**

Course Objectives

- To establish thorough knowledge on the basic mathematical elements of the theory of fuzzy sets.
- 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	differentiate crisp sets and fuzzy sets.	6	An
CO-2	use the fuzzy set theory on statistical methods.	7	Ap
CO-3	compare statistical methods against fuzzy logic methods.	1,7	An
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	Ev
CO-7	identify the methods of fuzzy sets and fuzzy logic in solving problems in the theory of fuzzy control.	1,7	Un
CO-8	explain the theory of statistics fuzzy logic	5	Un

Semester I			
Elective I B	**Fuzzy Sets**		
Course Code:21PMAE12	**Hrs/week:6**	**Hrs/Sem:90**	**Credits:4**

Unit-I

Basic types - Additional properties of α-cuts - representation of fuzzy sets - Extension principle for fuzzy sets.

(Chapter 1: Sections 1.3 & 1.4 Chapter 2: Sections 2.1 & 2.3)

Unit-II

Types of operations - fuzzy complements - fuzzy intersections: t-norms - fuzzy unions: t-conorms- combinations of operations - aggregation operations.

(Chapter 3: Sections 3.1-3.6)

Unit-III

Fuzzy numbers - linguistic variables - arithmetic operations on intervals - arithmetic operations on fuzzy numbers.

(Chapter 4: Sections 4.1- 4.4)

Unit-IV

Lattice of fuzzy numbers - fuzzy equations - crisp versus fuzzy relations - projections and cylindric extensions.

(Chapter 4: Sections 4.5 & 4.6 Chapter 5: Sections 5.1 & 5.2)

Unit-V

Binary fuzzy relations - binary relations on a single set - fuzzy equivalence relations- fuzzy compatibility relations - fuzzy ordering relations.

(Chapter 5: Sections 5.3 - 5.7)

Text Book:

1. George J. Klir and Bo Yuan. *Fuzzy sets and Fuzzy Logic Theory and Applications*. New Delhi: PHI Learning Private Limited, 2012.

Reference Books:

1. J.Zimmerman. *Fuzzy set Theory and its Applications*. New Delhi: Allied Publishers Ltd, 1991.
2. Bhargava A.K. *Fuzzy set Theory Fuzzy Logic and their Applications*. S. Chand and company, 2013.

Semester II			
Elective II B	**Applied Algebra**		
Course Code: 21PMAE22	**Hrs/Week: 4**	**Hrs/Sem: 60**	**Credits: 3**

Course Objectives

- To acquire a thorough knowledge on Boolean Algebras, Switching circuits and linear codes.
- To provide with an overview of discrete mathematics and related disciplines.

Course Outcome

CO. No.	Upon completion of this course, students will be able to	PSO addressed	CL
CO-1	understand some fundamental mathematical concepts and terminology.	2,4	Un
CO-2	analyse recursive definitions.	2,6	An
CO-3	list some different types of discrete structure.	2	Re
CO-4	compare the different techniques for constructing mathematical proofs, illustrated by discrete mathematics examples	2	An
CO-5	solve linear codes and cyclic codes.	1,6	Ap
CO-6	understand the concepts of Boolean Algebra and lattices.	2	Un
CO-7	Apply basic and advanced principles of codes	2,6	Ap
CO-8	create logical proofs.	2	Cr

Semester II			
Elective II B	**Applied Algebra**		
Course Code: 21PMAE22	**Hrs/Week: 4**	**Hrs/Sem: 60**	**Credits: 3**

Unit I

Properties and examples of Lattices- Distributive Lattices-Boolean Algebras- Boolean Polynomials – Minimal forms of Boolean Polynomials.

(Sections : 1,2,3,4&6 Problems: Section 1:7,11,14,15**, Section 2:** 2,5,6,13**, Section 3:**3,4,8**, Section 4:**8,9**& Section 6:** 3,6,7,8**)**

Unit II

Switching circuits- Applications of Switching circuits

(Sections 7&8 Problems: Section 7: 1, 2,4,5,6**& Section 8:** 3, 4, 5**)**

Unit III

Irreducible Polynomials over Finite fields- Factorization of Polynomials over Finite Fields.

(Sections 14&15 Problems : Section 14:2,4,5,7,8,12,16**& Section 15:**2,3,4,5,8,9**)**

Unit IV

Introduction to Coding- Linear Codes.

(Sections 16&17 Problems : Section 16:3,4,5,7,10**& Section 17:**1,2,4,5,8,10,11,14**)**

Unit V

Cyclic Codes- Special Cyclic Codes

(Sections 18&19 Problems : Section 18: 1,2,4,7,10,11,16,17**& Section 19:** 2,3,4,7,8**)**

Text Book

1. Rudolf Lidi and Gunter Pilz. *Applied Abstract Algebra*. Springer Publications. Second Edition.

Books for Reference

1. Arumugam .S& Isaac .A.T.*Modern Algebra*. Scitech Publications (INDIA) PVT.LTD, 2003.
2. Daniel Augot et al. *An introduction to linear and cyclic codes*, Journal of Symbolic Computional, 2009.

Semester - III			
Elective III B	**Wavelet Analysis**		
Course Code: 21PMAE32	**Hrs/week: 4**	**Hrs/Sem: 60**	**Credits: 4**

Course Objectives

- To establish the theory necessary to understand and use wavelets and related constructions
- To apply wavelets, filter banks and multi irresolution techniques to a problem.

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 III B	**Wavelet Analysis**		
Course Code: 21PMAE32	**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 IV			
Elective IV A	**Differential Geometry**		
Course Code: 21PMAE41	**Hrs/Week: 5**	**Hrs/Sem: 75**	**Credits: 4**

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 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			
Elective IV A	**Differential Geometry**		
Course Code: 21PMAC44	**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*. Addison Wesley Publishing House, Second Edition,
2. William C.Graustein. *Differential Geometry.* New York: Dover Publications, 1962.

Semester IV			
Elective B	**Projective Geometry**		
Course Code: 21PMAE42	**Hrs/Week: 5**	**Hrs/Sem: 75**	**Credits: 4**

Objectives

- To acquire the essential ideas and methods of Projective Geometry.
- To study the properties of geometric objects such as curves and surfaces in terms of algebraic equations

Course Outcome:

CO. No.	Upon completion of this course, students will be able to	PSO addressed	CL
CO -1	Describe geometric objects and properties with the homogeneous coordinates of the projective plane	1	Ap
CO-2	Study the projective differential invariance of the projective transformations	6	Re
CO-3	Study the angle between the corresponding lines in 3-dimensional space	5	Un
CO-4	Demonstrate a deep understanding of the axiomatic approach to projective spaces	1	An
CO-5	Perform calculations in desarguesian planes and projective 3- spaces	5	Un
CO-6	Classify the structure of collineations of projective planes	1,6	Un
CO-7	Demonstrate an understanding of theory of conics in field planes	2	Ap
CO-8	Study the elementary properties of algebraic curves in real and complex projective plane.	2,6	Ev

Semester IV			
Elective B	**Projective Geometry**		
Course Code: 21PMAE42	**Hrs/Week :5**	**Hrs/Sem: 75**	**Credits : 4**

UNIT-I

Projective Geometry as an extension of high school geometry: Two approaches to projective geometry-An initial question-Projective invariants-Vanishing points - Vanishing lines- Some projective noninvariants-Betweenness-Division of a segment in a ratio-Desargues' Theorem-Perspectivity;projectivity-Harmonic tetrads;fourth harmonic-Further theorems on harmonic tetrads. **(Chapter 1: Sections 1-12)**

UNIT-II

Projective Geometry as an extension of high school geometry: The cross – ratio-Fundamental Theorem of Projective Geometry-Further remarks on the cross – ratio-Construction of the projective plane- Previous results in the constructed plane-Analytic construction of the projective plane. **(Chapter 1: Sections 13-18)**

UNIT-III

The axiomatic foundation: Unproved propositions and undefined terms-Requirements on the axioms and undefined terms-Undefined terms and axioms for a projective plane-Initial development of the system;the Principle of Duality-Consistency of the axioms-Other models-Independenceof the axioms-Isomorphism-Further axioms-Consequences of Desargues' Theorem-Free planes. **(Chapter 2: Sections 1-11)**

UNIT-IV

Establishing coordinates in a plane: Definitions of a field-Consistency of the field axioms-The analytic model - Geometric description of the operations plus and times- Setting up coordinates in the projective plane-The non commutative case.

(Chapter 3: Sections 1-6)

UNIT-V

Relations between the basic theorems & Axiomatic introduction of Higher - dimensional space: Higher - dimensional, especially 3-dimensional projective space-Desarguesian planes and higher - dimensional space. **(Chapter 4 & 5: Sections 1-2)**

Text Book:

1. A.Seidenberg. *Lectures In Projective Geometry*. New York: Van Nostrandrein hold Company, 1965.

Reference:

1. Herbert Busemann and Paul J. Kelly. *Projective Geometry and Projective Matrics*. NewYork: Academic Press INC Publishers, 1953.