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.2021)

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 2021)
Semester - I

Subject	Course Code	Course Title	Contact Hours / Week	Credits	Max. Marks		
					CIA	ESE	Total
Core I	21PMAC11	Groups and Rings	6	4	40	60	100
Core II	21PMAC12	Real Analysis	6	4	40	60	100
Core III	21PMAC13	Ordinary differential Equations	6	4	40	60	100
Core IV	21PMAC14	Mathematical Statistics	6	4	40	60	100
Elective I	21PMAE11/ 21PMAE12	A. Combinatorics/ B.Fuzzy Sets	6	4	40	60	100
			30	**20**			

Semester - II

Subject	Course Code	Course Title	Contact Hours / Week	Credits	Max. Marks		
					CIA	ESE	Total
Core V	21PMAC21	Linear Algebra	6	4	40	60	100
Core VI	21PMAC22	Mathematical Analysis	6	4	40	60	100
Core VII	21PMAC23	Classical Mechanics	6	4	40	60	100
Core VIII	21PMAC24	Calculus of Variations and Integral Equations	4	4	40	60	100
Core IX	21PMAC25	Stochastic Processes	4	4	40	60	100
Elective II	21PMAE21/ 21PMAE22	A. Operations Research/ B. Applied Algebra	4	3	40	60	100
			30	**23+2**			

Semester - III

Subject	Course Code	Course Title	Contact Hours / Week	Credits	Max. Marks		
					CIA	ESE	Total
Core X	21PMAC31	Topology	6	4	40	60	100
Core XI	21PMAC32	Graph Theory	6	4	40	60	100
Core XII	21PMAC33	Measure Theory	5	4	40	60	100
Core XIII	21PMAC34	Partial Differential Equations	5	4	40	60	100
Core XIV	21PMAC35	Research Methodology	4	4	40	60	100
Elective III	21PMAE31/ 21PMAE32	A. Fluid Mechanics/ B. Wavelet Analysis	4	3	40	60	100
Self Study Course / MOOC/ Internship	21PMSS31 21PMAM31 21PMAI31	Course on Competitive Exams		+2		100	100
			30	**23 + 2**			

Semester - IV

Subject	Course Code	Course Title	Contact Hours / Week	Credits	Max. Marks		
					CIA	ESE	Total
Core XV	21PMAC41	Complex Analysis	6	4	40	60	100
Core XVI	21PMAC42	Functional Analysis	6	4	40	60	100
Core XVII	21PMAC43	Number Theory and Cryptography	5	4	40	60	100
Elective IV	21PMAE41/ 21PMAE42	A. Differential Geometry/ B. Projective Geometry	5	4	40	60	100
Project	21PMAP41	Project	8	8	40	60	100
			30	**24**			
Total			**120**	**90+2+2**			

Master of Science (Mathematics)

Components	No. of Courses	No. of Hours	Credits	Extra Credits
Core	17	93	68	
Elective	4	18	14	
Project	1	8	8	
MOOC	1			+2
Self Study Course/MOOC/Internship	1			+2
	Total	120	90	+4

Program Specific Outcome

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

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 I

Core IV	Mathematical Statistics		
Course Code: 21PMAC14	**Hrs/Week: 6**	**Hrs/Sem: 90**	**Credits: 4**

Course Objectives

- To enable the use of statistical techniques whenever relevant.
- To have a proper understanding of statistical applications in real life.

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	examine 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	Compare the distribution with one another.	2,8	An
CO-5	test statistical hypothesis.	2	An
CO-6	illustrate 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	Ap
CO-7	define a probability generating function, a moment generating function and derive them in simple cases.	5,8	Re
CO-8	write the central limit theorem, and apply it.	1,5	Cr

Semester I

Core IV	Mathematical Statistics		
Course Code: 21PMAC14	**Hrs/Week: 6**	**Hrs/Sem: 90**	**Credits: 4**

Unit I

Distribution of Two Random Variables – Conditional Distributions and Expectations- The correlation coefficient-Independent Random Variables-Extension to Several Random Variables.

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

Unit II

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 III

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 IV

Extensions of the Change of variable technique – Distributions of Order statistics – The Moment generating function technique – The Distributions of$\bar{X}$ and $nS^2/\ \sigma^2$ – Expectations of functions of random variables.

(Chapter 4: Sections 4.5, 4.6, 4.7, 4.8, 4.9)

Unit V

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

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

Text Book

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

Books for Reference

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

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			
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 VII	**Classical Mechanics**		
Course Code:21PMAC23	**Hrs/Week: 6**	**Hrs/Sem: 90**	**Credits: 4**

Course Objectives

- To represent the equations of motion for complicated mechanical systems using the Lagrangian and Hamiltonian formulation.
- To develop math skills as applied to physics.

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	test the principle co-ordinates and the principle moment of inertia for arbitrary rigid body.	2	An
CO-4	evaluate Hamilton's equations of motion.	5	Ev
CO-5	explain Hamiltonian principles and establish the Hamiltonian equations.	2,5	Un
CO-6	write the magnitude of selected mechanical properties of materials.	2	Cr
CO-7	distinguish the concept of the Hamilton equation of motion and the Principle of least Action.	6	An
CO-8	illustrate the Canonical transformation and Hamilton Jacobi theory.	5	Ap

Semester II

Core VII	Classical Mechanics		
Course Code:21PMAC23	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 - Problems related to SET/NET.

(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 - Problems related to SET/NET.

(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)

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

Text Book

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

Books for Reference

1. K. SankaraRao. *Classical Mechanics*. Prentice Hall of India, 2005.
2. Herbert Goldstein. *Classical Mechanics*. Narosa Second Edition, 1994.

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 - II	
Core IX	**Stochastic Processes**

Course Code: 21PMAC25	Hrs/week: 4	Hrs/Sem: 60	Credits: 4

Course Objectives

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

Course Outcome:

CO. No.	Upon completion of this course, students will be able to	PSO addressed	CL
CO-1	illustrate the stochastic model.	8	Ap
CO-2	explain the well known models like birth-death and queueing to reorient their knowledge of stochastic analysis.	7	Un
CO-3	list the random walk associated with real life situation to solve.	1	Re
CO-4	analyzethe transition probabilities and its classifications.	2	An
CO-5	discusserlang process and execute it.	5	Un
CO-6	compare the different stochastic models.	1,8	An
CO-7	understand the notions of stochastic process.	5	Un
CO-8	apply markov chains to practical problems	4	Ap

Semester - II			
Core IX	Stochastic Processes		
Course Code: 21PMAC25	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.

(Chapter1: Sections: 1.1 - 1.5)

Unit II

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

(Chapter 1: Sections: 1.6, 1.7 and Chapter 2: Sections: 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: Sections: 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: Sections: 3.6-3.8 and Chapter4: Sections: 4.1 - 4.2)**

Unit V

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

(Chapter 4: Sections: 4.3 - 4.6)

Text Book:

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

Books for Reference:

1. SrinivasanMehata. *Stochastic Process*. New Delhi: Tata McGraw-Hill Publishing Company Limited, 1976.
2. Tapas kumar Chandra and SreelaGangopadhyay. *Introduction to Stochastic Process*, Narosa Publishing House, 2018.

Semester II	
Elective II A	**Operations Research**

Course Code: 21PMAE21	Hrs/Week: 4	Hrs/Sem: 60	Credits: 3

Course Objectives

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

Course Outcome

CO. No.	Upon completion of this course, students will be able to	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	Ap
CO-3	compare inventory models and other related models.	2	An
CO-4	understand and identify the generalized inventory models in real life situation	2	Un
CO-5	analyze a network of queues with Poisson external arrival, exponential service requirements and independent routing.	1,6	An
CO-6	evaluate the concept of complementary slackness and its role in solving prime and dual problems	2	Ev
CO-7	create the most optimal order quantity and minimal costs while ordering materials.	2,6	Cr
CO-8	define probabilistic inventory models that accounts for all variations in real systems.	2	Re

Semester II	
Elective II A	**Operations Research**

Course Code: 21PMAE21	Hrs/Week: 4	Hrs/Sem: 60	Credits: 3

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

Inventory Models: The ABC Inventory System - A generalized inventory model - Deterministic models: Single item static model and multiple item static model.

(Chapter 13: Sections 13.1, 13.2, 13.3)

Unit IV

Inventory Models: Probabilistic models– A continuous review model-Single Period Models: Instantaneous Demand, No Setup Cost and s-S Policy

(Chapter 13: Sections 13.4(13.4.1, 13.4.2))

Unit V

Queueing Theory: Elements of Queueing model - Roles of the Poisson and Exponential Distributions - Arrivals Process- Departures Process

(Chapter 15: Sections 15.1, 15.2)

Text Book

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

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.

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 III			
Elective III A	**Fluid Mechanics**		
Course Code: 21PMAE31	**Hrs/Week: 4**	**Hrs/Sem: 60**	**Credits: 3**

Course Objectives

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

Course Outcome

CO.No.	Upon completion of this course, students will be able to	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 III A	**Fluid Mechanics**		
Course Code: 21PMAE31	**Hrs/Week: 4**	**Hrs/Sem: 60**	**Credits: 3**

Unit I

Properties of Fluids: Viscosity - Thermodynamic properties- Compressibility and Bulk modulus - Surface Tension and Capillarity - Vapour Pressure and Cavitation.

(Chapter 1: Sec 1.1 – 1.7)

Unit II

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

(Chapter 2: Sec 2.1 – 2.8)

Unit III

Hydrostatic forces on Surfaces: Total pressure and Centre of Pressure- Vertical Plane Surfaces submerged in liquid - Horizontal Plane Surfaces submerged in liquid -Inclined Plane Surface submerged in liquid - Curved Surface submerged in liquid

(**Chapter 3: Sec 3.1-3.6)**

Unit IV

Total Pressure and Centre of pressure on lock gates - Pressure Distribution in a liquidsubjected to Horizontal/Vertical Acceleration.

(Chapter3:Sec3.7-3.9)

Unit V

Buoyancy and flotation: Buoyancy - Centre of Buoyancy - Metacentre - Metacentric height - Conditions of Equilibrium of a Floating and Submerged bodies - Experimental Method of Determination of Meta - centric Height - Oscillation of a floating body.

(Chapter 4 Sec 4.1 – 4.9)

Text Book

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

Books for Reference

1. Joseph H.Spurk, NuriAksel. *Fluid Mechanics*. Springer- Verlag Berlin Heidelberg, Second Edition, 2008.
2. Ranald V. Giles. *Fluid Mechanics and Hydraulics*. McGraw - Hill Book Company, Second Edition.

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 III	
Self-Study Course **Course on Competitive Exams**	
Course Code: 21PMSS31	**Credits: 2**

Course Objectives

- To provide a platform to the students for building the fundamentals of basic mathematics for competitive examinations preparation strategy
- Establish a framework to help students acquire knowledge and expertise necessary to secure employment opportunities in the government sector

Course Outcome

CO. No.	Upon completion of this course, students will be able to	PSO addressed	CL
CO-1	solve real life problems requiring interpretation and comparison of various representations of ratios.	2,6	Ap
CO-2	distinguish between proportional and non-proportional situations and when appropriate apply proportional reasoning	6	An
CO-3	solve problems applying probabilistic reasoning to make decisions	2	Ap
CO-4	evaluate claims based on empirical, theoretical and subjective probabilities	6,4	Re
CO-5	create and use visual displays of data	4	Cr
CO-6	solve problems using high speed mental calculations	6	Ap
CO-7	understand the basic concepts of logical reasoning skills.	1,4	Un
CO-8	acquire satisfactory competency in use of data analysis	7	Un

Semester III	
Self-Study Course **Course on Competitive Exams**	
Course Code: 21PMSS31	**Credits: 2**

Unit I

Number System (Including divisibility) - HCF and LCM (Including Factors, Multiples and Prime Factorization)

(Chapter: 1&2, pages 1 – 46)

Unit II

Fractions and Decimals - Square and Square roots, Cube and Cube Roots, Indices and Surds.

(Chapter: 3 &4, pages 47 – 94)

Unit III

Time, Work and Wages (Including Pipes & Cistern) - Time, Speed and Distance (Including Trains, Boats and Stream, Circular Motion, Races and Games.

(Chapter: 15 & 16, pages 317 - 374)

Unit IV

Permutations & combinations and Probability.

(Chapter: 18, pages 391 - 416)

Unit V

Set Theory (Including Venn Diagram) - Data Analysis and Data Interpretation (Including Caselet, Table, Line Graph, Bar Graph, Mixed Bar)

(Chapter: 24 & 27, pages 559 – 570, 615 – 648)

Text Book

1. Er.DeepakAgarwal and Mr.D.P.Gupta. *Rapid Quantitative Aptitude with Shortcuts and Tricks for Competitive Exam.* Disha Publication.

Books for Reference

1. Dr.R.S.Aggarwal. *Quantitative Aptitude for Competitive Examinations*. S.Chand Publication.
2. Rajesh Verma. *Fast Track Objective Arithemetic*. Arihant Publication.

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 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.