ANNAMALAI UNIVERSITY

401 - M.Sc. MATHEMATICS

(Applicable to the candidates admitted from the academic year 2022-2023 onwards)

COURSE CODE	STUDY COMPONENTS AND COURSE TITLE	HOURS /WEEK	CREDIT	MAXIMUM MARKS		
				CIA	ESE	TOTAL
	SEMESTER - I					
22PMATC11	Core Theory-I: Advanced Abstract Algebra	6	4	25	75	100
22PMATC12	Core Theory-II: Advanced Real Analysis	6	4	25	75	100
22PMATC13	Core Theory-III: Ordinary Differential Equation	6	4	25	75	100
22PMATC14	Core Theory-IV: Optimization Technique	5	4	25	75	100
22PMATE15	Core Elective I	4	4	25	75	100
22PMATO16	Open Elective I	3	3	25	75	100
	TOTAL	**30**	**23**			**600**
	SEMESTER - II					
22PMATC21	Core Theory-V: Advanced Linear Algebra	6	4	25	75	100
22PMATC22	Core Theory-VI: Measure Theory and Integration	6	4	25	75	100
22PMATC23	Core Theory-VII: Partial Differential Equation	6	4	25	75	100
22PMATC24	Core Theory-VIII: Classical Dynamics	6	4	25	75	100
22PMATE25	Core Elective II	4	4	25	75	100
22PHUMR27	**Compulsory Course: Human Rights**	2	2	25	75	100
	TOTAL	**30**	**22**			**600**

List of Core Electives (Choose any one out of three given in each Semester)

Semester	Course Code	Course Title	H/W	C	CIA	ESE	TOTAL
I	22PMATE15-1	Fuzzy Sets and Applications	4	4	25	75	100
	22PMATE15-2	Mathematical Statistics	4	4	25	75	100
	22PMATE15-3	Wavelets	4	4	25	75	100
II	22PMATE25-1	Number Theory and Cryptography	4	4	25	75	100
	22PMATE25-2	Formal Languages and Automata Theory	4	4	25	75	100
	22PMATE25-3	Differential Geometry	4	4	25	75	100

List of Open Electives (Choose 1 out of 3 in each semester)

Semester	Course Code	Course Title	H/W	C	CIA	ESE	TOTAL
I	22PMATO16-1	Basic Mathematics	3	3	25	75	100
	22PMATO16-2	Mathematical Foundations	3	3	25	75	100
	22PMATO16-3	Latex	3	3	25	75	100

SEMESTER: I PART: COREI	COURSE CODE: 22PMATC11 COURSE TITLE:ADVANCED ABSTRACT ALGEBRA	CREDITS: 4 HOURS: 6

COURSE OBJECTIVE

1) To learn the importance of Sylow's Theorems
2) To learn the basic concepts of Direct Products and ideas of polynomials
3) To attain depth knowledge about the algebraic structure of extension fields
4) To provide the use of Galois theory in discussing the existence of roots of the polynomials
5) To learn about finite fields and important theorem related to division rings.

UNIT – I (Group Theory) **Hours: 18**

Another Counting Principle – 1^{st}, 2^{nd} and 3^{rd} parts of Sylow's Theorem – Double coset – the normalizer of a group.

UNIT – II (Group theory and Ring Theory) **Hours: 18**

Direct Products – Finite Abelian groups –Polynomial Rings.

UNIT – III (Ring Theory and Fields) **Hours: 18**

Polynomial Rings Over the Rational field – Extension Fields – Roots of Polynomial.

UNIT – IV (Fields) **Hours: 18**

More About Roots – The Elements of Galois Theory.

UNIT – V (Finite fields) **Hours: 18**

Solvability by Radicals – Finite Fields.

TEXT BOOK:

I.N. Herstein, Topics in Algebra, 2^{nd} Edition. John Wiley and Sons, New Delhi, 1999.

UNIT – I– Chapter II (Sections: 2.11 and 2.12)

UNIT – II – Chapter II(Sections: 2.13 and 2.14)

Chapter III (Section: 3.9)

UNIT – III– Chapter III (Section: 3.10)

Chapter V (Sections: 5.1 and 5.3)

UNIT – IV– Chapter V (Sections: 5.5 and 5.6)

UNIT – V– Chapter V (Section: 5.7)

Chapter VII (Section: 7.1)

Text Books

1) D.S.Dummit and R.M. Foote, Abstract Algebra. Wiley 2003.
2) M.Artin, Algebra, Prentice Hall of India, New Delhi, 1991.
3) I.S. Luther and I.B.S. Passi,Algebra, Vol. 1 – Groups (1996), Vol. 2 Rings,Narosa Publishing House, New Delhi 1999.
4) V.K. Khanna and S.K. Bhambri, A First Course in Abstract Algebra, Vikas Publishing House Pvt Limited, 1993.

COURSE OUTCOMES:

At the end of the course, the student will be able

1) To find the number of Sylow sub groups.
2) To find the number of non-Isomorphic Abelian groups.
3) To understand fields and roots of polynomials.
4) To find the splitting field, Galois group of the given polynomial.
5) To check whether the given polynomial is solvable by radicals or not.

OUTCOME MAPPING

PO/CO	PO1	PO2	PO3	PO4	PO5
CO1	3	3	3	2	3
CO2	3	3	3	3	2
CO3	2	3	3	3	3
CO4	3	2	3	3	3
CO5	2	3	3	3	2

SEMESTER: I PART: CORE II	COURSE CODE: 22PMATC12 COURSE TITLE: ADVANCED REAL ANALYSIS	CREDIT:4 HOURS: 6

COURSE OBJECTIVES

1) To give the students a thorough knowledge of real valued functions and their properties.
2) To discuss the concepts of Riemann –stieltjes integral and its properties.
3) To develop the concept of analysis in abstract situations.

Unit – I **Hours: 18**

Functions of bounded variation – properties of monotonic functions, functions of bounded variation, total variation, additive property of total variation, total variation on (a,x) as a function of x, funtions of bounded variation expressed as the difference of increasing functions, continuous functions of bounded variation, Riemann – stieltjes integral, the definition of the Riemann-stieltjes integral, linear properties, integration by parts.

Unit – II **Hours: 18**

Riemann stieltjes integral – change of variable in a Riemann-stieltjes integral, reduction to a Riemann integral, step functions as a integrators, reduction of a Riemann stieltjes integral to a finite sum, Euler's summation formula, monotonically increasing integrators, upper and lower integrals, additive and linearity properties of upper and lower integrals, Riemann's condition, comparison theorems, integrators of bounded variation- sufficient and necessary conditions for existence of Riemann-stieltjes integral-, mean value theorems for Riemann-stieltjes integrals.

Unit - III **Hours: 18**

Sequence of functions- definition of uniform convergence- uniform convergence and continuity- the Cauchy condition for uniform convergence- uniform convergence of infinite series of functions- a space filling curve- uniform convergence and Riemann – stieltjes integration- nonuniformly convergent sequences that can be integrated term by term- uniform convergence and differentiation- sufficient conditions for uniform convergence of a series – uniform convergence and double sequences- mean convergence – power series- multiplication of power series.

Unit - IV **Hours: 18**

Multivariable differential calculus- the directional derivative- directioanal derivatives and continuity- the total derivative- the total derivative expressed in terms of partial derivatives- an application to complex-valued functions- the matrix of a linear function- the jacobian matrix- the chain rule- matrix form of the chain rule- the mean value theorem for differentiable functions- a sufficient condition for differentiability.

Unit - V **Hours: 18**

Implicit functiojns and extremum problems- functions with nonzero jacobian determinant- the inverse function theorem- the implicit function theorem- extrema of real-valued functions of one variable- extrema of real-valued functions of severable variables.

Text Books

Tom.M.Apostol,, Mathematical Analysis, Narosa publishing house, 1974.

Unit - I	- Chapter 6,	Sections 6.1 to 6.8
		Sections 7.1 to 7.5
Unit - II	- Chapter 7	Sections 7.6 to 7.18
Unit - III	- Chapter 9	Sections 9.3 to 9.15
Unit - IV	- Chapter 12	Sections 12.1 to 12.12
Unit - V	- Chapter 13	Sections 13.1 to 13.6

Supplementary Reading:

1) Royden, Real Analysis, MacMillan Publishing Company, New York, 1968.
2) Walter Rudin, Principles of mathematical analysis,McGraw-Hill international book Company, New Delhi, 2013.

COURSE OUTCOMES

Our successful completion of this course, students will be able to

1) Demonstrate an understanding the theory of function of bounded variations,sequence Of functions, Riemann-stieltjes integrals.
2) To apply the theory in the course to solve a variety of problems at an appropriate Level of difficulty.
3) Demonstrate skills in constructing rigorous mathematical analysis.
4) The student will gain confidence in proving theorems and solving problems.
5) Student will understand the generalized concept of Differential Calculus.

OUTCOME MAPPING

PO/CO	PO1	PO2	PO3	PO4	PO5
CO1	3	3	3	2	3
CO2	3	3	2	3	2
CO3	3	2	3	3	3
CO4	3	3	3	3	3
CO5	2	3	3	3	3

SEMESTER: I PART: CORE III	COURSE CODE: 22PMATC13 COURSE TITLE: ORDINARY DIFFERENTIAL EQUATIONS	CREDIT:4 HOURS:6

COURSE OBJECTIVES

1.To develop strong background on finding solutions to linear differential equations with constant and variable coefficients and also singular points.

2.To study existence and uniqueness of the solutions of first order differential equations.

UNIT-I : LINEAR EQUATIONS WITH CONSTANT COEFFICIENTS

Second order homogeneous equations, Initial value problems, Linear dependence and independence, Wronskian and a formula for Wronskian Non-homogeneous equation of order two. (18 Hours)

UNIT-II : LINEAR EQUATIONS WITH CONSTANT COEFFICIENTS

Homogeneous and non-homogeneous equation of order n, Initial value problem, Annihilator method to solve non-homogeneous equation, Algebra of constant coefficient operators. (18 Hours)

UNIT-III : LINEAR EQUATIONS WITH VARIABLE COEFFICIENTS

Initial value problems, Existence and uniqueness theorems, solutions to solve a homogeneous equation, Wronskian and linear dependence, reduction of the order of a non- homogeneous equation, homogeneous equation with analytic coefficients, The Legendre equation. (18 Hours)

UNIT-IV : LINEAR EQUATIONS WITH REGULAR SINGULAR POINTS

Euler equation, Second order equations with regular singular points, Bessel Function. (18 Hours)

UNIT-V : EXISTENCE AND UNIQUNESS OF SOLUTIONS TO FIRST ORDER EQUATIONS

Equation with variable separated, Exact equation , method of successive approximations, the Lipschitz condition , convergence of the successive approximations and the existence theorem. (18 Hours)

COURSE OUTCOMES

After successful completion of the course the student will be able to:

1) Understand the concept of Wronskian formula;
2) Understand the concept of initial value problems;
3) Understand the concept of Existence and uniqueness theorems;
4) Understand the Bessel Function;
5) Understand the Lipschitz condition;

Text book

1) E.A.Coddigton, An introductionto ordinary differential equations (3rd reprint) Prentice-Hall of India Ltd., New Delhi, 1987.

Supplementary Readings

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

2) N.N.Lebedev, Special functions and their applications, Prentice-Hall of India Ltd., New Delhi, 1965.
3) W.T.Reid, Ordinary Differential Equations , John Wiley and sons, New York, 1971.

OUTCOME MAPPING

PO/CO	PO1	PO2	PO3	PO4	PO5
CO1	3	3	3	2	3
CO2	3	3	2	3	2
CO3	2	2	3	3	3
CO4	3	3	3	2	3
CO5	2	3	3	3	2

SEMESTER: I PART: CORE IV	COURSE CODE: 22PMATC14 COURSE TITLE: OPTIMIZATION TECHNIQUES	CREDIT: 4 HOURS: 5

COURSE OBJECTIVES

1) To enlighten the students in the field of operations research.
2) To help the students to apply OR techniques in business and management problems.
3) To provide a mathematical programming for finding applications in diverse fields Including engineering, computer science and economics.

Unit – I **Hours:15**

Integer programming algorithms –Branch and bound algorithm-cutting plane algorithm-computational considerations in ILP – travelling salesman problem – heuristic algorithms – B & B solution algorithm – cutting plane algorithm.

Unit – II **Hours:15**

Dynamic programming – Recursive nature of computations in DP – forward and backward recursion – knapsack/fly away/cargo – loading model – work force size model – equipment replacement model – investment model – inventory model.

Unit – III **Hours:15**

Decision analysis and Games – Decision making under certainty – analytic hierarchy process – decision making under risk – decision tree – based expected value criterion – variations of the expected value criterion – decision under uncertainty – game theory – optimal solution of two person zero sum games – solutions of mixed strategy games.

Unit – IV **Hours:15**

Classical optimization theory – unconstrained problems – necessary and sufficient conditions – the newton raphson method – constrained problems – equality constraints – inequality constraints – karush Kuhn tucker conditions

Unit – V **Hours:15**

Non-Linear Programming algorithms – unconstrained algorithms – direct search method – gradient method – constrained algorithms – seperable programming – quadratic programming.

Text Books

Hamdy A. Taha, Operations Research (8^{th} Edn.), McGraw Hill Publications, New Delhi,
2006.

Unit - I - Chapter 9, Sections 9.2.1 to 9.2.3, 9.3.1 to 9.3.3
Unit - II - Chapter 10, Sections 10.1 to 10.3, 10.3.1 to 10.3.5
Unit - III - Chapter 13, Sections 13.1, 13.2, 13.2.1, 13.2.2, 13.3, 13.4, 13.4.1,
13.4.2.
Unit - IV - Chapter 18, Sections 18.1, 18.1.1, 18.1.2, 18.2, 18.2.1, 18.2.2.
Unit - V - Chapter 19, Sections 19.1, 19.1.1, 19.1.2, 19.2, 19.2.1, 19.2.2

Supplementary Readings

1) O.L. Mangasarian, Non Linear Programming, McGraw Hill, New York.
2) Mokther S. Bazaraa and C.M. Shetty, Non Linear Programming, Theory and Algorithms, Willy, New York.
3) Prem Kumar Gupta and D.S. Hira, Operations Research : An Introduction, S. Chand and Co., Ltd. New Delhi.
4) S.S. Rao, Optimization Theory and Applications, Wiley Eastern Limited, New Delhi.

COURSE OUTCOMES

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

1) Ability to apply the theory of optimization methods and algorithms to develop and For solving various types of optimization problems.
2) Ability to go in research by applying optimization techniques in real value problems
3) Analyze decision making under certainty and uncertainty by game theory.
4) Understand unconstrained and constrained optimization problems.
5) Understand Non-Linear programming problems.

OUTCOME MAPPING

PO/CO	PO1	PO2	PO3	PO4	PO5
CO1	3	3	3	2	3
CO2	3	3	3	3	2
CO3	2	3	3	3	3
CO4	3	2	3	3	3
CO5	2	3	3	3	2

SEMESTER – I	CORE CODE:22PMATE15-1 COURSE TITLE: FUZZY SUBSETS AND APPLICATIONS	HRS/WK – 4
PART:CORE ELECTIVE– 1		CREDITS – 4

COURSE OBJECTIVES

Familiarize the students with the fundamentals of fuzzy sets, operations on these sets and concept of membership function. Familiar with fuzzy relations and the properties of these relations .To know the concept of a fuzzy number and how it is defined. Become aware of the use of fuzzy inference systems in the design of intelligent systems

Unit I: Fuzzy Sets **(12 Hours)**

Fuzzy sets – Basic types – basic concepts – Characteristics – Significance of the paradigm shift – Additional properties of α–cuts.

Chapter 1: 1.3 - 1.5 and Chapter 2: 2.1

Unit II: Fuzzy sets versus CRISP sets **(12 Hours)**

Representation of fuzzy sets – Extension principle of fuzzy sets – Operation on fuzzy sets – Types of operation – Fuzzy Complements.

Chapter 2: 2.2 - 2.3 and **Chapter 3:** 3.1 - 3.2

Unit III: Operations on Fuzzy sets **(12 Hours)**

Fuzzy intersection – t-norms, fuzzy unions – t-conorms – Combinations of operations – Aggregation operations.

Chapter 3: 3.3 - 3.6

Unit IV: Fuzzy Arithmetic **(12 Hours)**

Fuzzy numbers – Linguistic variables – Arithmetic operation on intervals – Lattice of fuzzy numbers.

Chapter 4: 4.1 - 4.4

Unit V: Constructing Fuzzy Sets **(12 Hours)**

Methods of construction on overview – direct methods with one expert – direct method with multiple experts – indirect method with multiple experts and one expert – Construction from sample data.

Chapter 10: 10.1 - 10.7.

COURSE OUTCOME

At the completion of the Course, the Students will able to

1) Understand the concepts of Fuzzy sets and its types – Characteristics – Significance of the paradigm shift.
2) Be able to distinguish between the crisp set and fuzzy set concepts through the learned differences between the crisp set characteristic function and the fuzzy set membership function.

3) To know Fuzzy intersection – t-norms, fuzzy unions – t-conorms. Combinations of operations – Aggregation operations.
4) Apply the concept of a fuzzy number and apply in real world problems.
5) Student practice to construct various methods of fuzzy sets using sample data.

Text Book:

1) G.J Klir and Bo Yuan, Fuzzy sets and Fuzzy Logic: Theory and Applications, Prentice Hall of India Ltd, New Delhi, 2005.

Supplementary Readings

1) H.J Zimmemann, Fuzzy Set Theory and its Applications, Allied Publishers, Chennai, 1996.
2) A.Kaufman, Introduction to the Theory of fuzzy subsets, Academic press, New York, 1975.
3) V.Novak, Fuzzy Sets and Their Applications, Adam Hilger, Bristol, 1969.

OUTCOME MAPPING

PO/CO	PO1	PO2	PO3	PO4	PO5
CO1	3	3	3	2	3
CO2	3	3	2	3	2
CO3	3	2	3	3	3
CO4	3	3	3	3	3
CO5	2	3	3	3	3

SEMESTER: I PART: CORE ELECTIVE -2	COURSE CODE: 22PMATE15 – 2 COURSE TITLE: MATHEMATICAL STATISTICS	CREDIT: 4 HOURS: 4

COURSE OBJECTIVES

1) To study random variables and its applications.
2) To explore probability distributions.
3) To understand moments and their functions.
4) To introduce significance tests.
5) Concepts of ANOVA

Unit I: Random Variables **Hours: 12**

The concepts of random variables – The distribution function – Random variable of the discrete type and the continuous type – Functions of random variables – Marginal distributions – Conditional distributions – Independent random variables.

Unit II: Some Probability Distributions **Hours: 12**

The Binomial Distribution – The Poisson Distribution – The Uniform Distribution – The Normal Distribution – The Gamma Distribution – The Beta Distribution.

Unit III: Sample Moments and Their Functions **Hours: 12**

Notion of a sample and a statistic - Distribution of the arithmetic mean of independent normally distributed random variables – The χ^2-distribution – The distribution of the statistics ($\bar{X}$, S) – Student's t - distribution - Fisher's Z – distribution.

Unit IV: Significance tests **Hours: 12**

Concept of a statistical test – Parametric tests for small samples and large samples - χ^2 test - Tests of Kolmogorov and Smirnov type – Independence Tests by contingency tables.

Unit V: Analysis of Variance **Hours: 12**

One-way Classification and two-way Classification. **Hypotheses Testing:** The Power functions and OC function – Most Powerful test – Uniformly most powerful test – unbiased tests.

COURSE OUTCOMES

After completion of this course the student will be able to

1) Apply the concepts of random variables in real life situations.
2) Identify the type of statistical situation to which different distributions can be applied.
3) Calculate moments and their functions.
4) Explore knowledge in the various significance tests for statistical data.
5) Analyze statistical data using ANOVA.

Text Book (In API Style)

1) M. Fisz , Probability Theory and Mathematical Statistics, John Wiley and sons, New Your, 1967.

Supplementary Readings

1) E.J. Dudewicz and S.N. Mishra , Modern Mathematical Statistics, John Wiley and Sons, New York, 1988.
2) V.K.Rohatgi An Introduction to Probability Theory and Mathematical Statistics,
3) Wiley Eastern New Delhi, 1988(3rd Edn).
4) B.L.Vander Waerden, Mathematical Statistics, G.Allen & Unwin Ltd., London, 1968.

OUTCOME MAPPING

PO/CO	PO1	PO2	PO3	PO4	PO5
CO1	3	3	3	2	3
CO2	3	3	2	3	3
CO3	2	2	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	2

SEMESTER: I PART: CORE ELECTIVE- 3	CORE CODE: 22PMATE15-3 COURSE TITLE: WAVELETS	CREDIT: 4 HOURS: 4

COURSE OBJECTIVES

1) To introduce the basic notions and techniques of Wavelets Theory.
2) To establish the Concepts to understand and use wavelets from Fourier to wavelet analysis.

Unit I : AN OVERVIEW Hours: 12

Fourier analysis to wavelet analysis - Integral Wavelet Transform and Time-frequency analysis - Inversion formulas and duals - Classification of Wavelets – Multire solution analysis - Splines and Wavelets – Wavelet decompositions and reconstructions.

Chapter 1: Sections 1.1 to 1.6

Unit II : FOURIER ANALYSIS Hours: 12

Fourier and Inverse Fourier Transforms – Continuous-time convolution and the delta function - Fourier Transform of square-integrable functions- Fourier Series - Basic Convergence Theory - Poisson Summation Formula.

Chapter 2: 2.1 and 2.5

Unit III : WAVELET TRANSFORMS AND TIME FREQUENCY ANALYSIS Hours: 12

The Gabor Transform – Short-time Fourier Transforms and the uncertainty principle - The integral Wavelet Transform - Dyadic Wavelets and Inversions - Frames - Wavelet Series.

Chapter 3: Section 3.1 to 3.6

Unit IV : CARDINAL SPLINE ANALYSIS Hours: 12

Cardinal Spline spaces. – B-Splines and their basic properties - The two-scale relation and an interpolatory graphical display algorithm - B-Net representations and computation of cardinal splines - Construction of cardinal splines - construction of spline application formulas - Construction of Spline interpolation formulas.

Chapter 4: Sections 4.1 to 4.6

Unit V: SCALING FUNCTIONS AND WAVELETS Hours: 12

Multiresolution analysis - Scaling functions with finite two scale relations – Direction sum Decompositions of L 2 (R) - Wavelets and their duals.

Chapter 5: Sections 5.1 to 5.4

COURSE OUTCOMES

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

1) Understand the terminologies that are used in the wavelets, from Fourier analysis to wavelet analysis.
2) Determine the concepts of the Fourier and Inverse Fourier Transforms.
3) know the Wavelet Transforms and Time Frequency Analysis.
4) Learn the concepts on Cardinal Spline Analysis.
5) Study the Scaling Functions and Wavelets theory.

Text Books

1) Charles K.Chui , An Introduction to Wavelets, Academic Press, New York, 1992.

Supplementary Readings

1) Chui. C.K. (ed) Approximation theory and Fourier Analysis, Academic Press Boston, 1991.
2) Daribechies,I. Wavelets, CBMS-NSF Series in Appl.. math. SIAM. Philadelphia, 1992.
3) Schumaker,L.L. Spline Functions: Basic Theory , Wiley, New York 1981.
4) Nurnberger, G. Applications to Spline Functions, Springer Verlag, New York. 1989.5. Walnut,D.F. Introduction to Wavelet Analysis, Birhauser, 2004.

OUTCOME MAPPING

PO/CO	PO1	PO2	PO3	PO4	PO5
CO1	3	3	3	2	3
CO2	3	3	2	3	2
CO3	2	2	3	3	3
CO4	3	3	3	2	3
CO5	2	3	3	3	2

SEMESTER: II PART: CORE V	COURSE CODE: 22PMATC21 COURSE TITLE:ADVANCED LINEAR ALGEBRA	CREDITS: 4 HOURS: 6

COURSE OBJECTIVES

1) To aim learning the students to solve systems of linear equations using multiple methods, matrix operations including inverses
2) To establish basic properties of algebra of polynomials over a field
3) To apply principles of matrix algebra
4) To investigate determinant of matrices and its properties
5) To understand the canonical forms of matrices and its properties.

UNIT – I (Linear Equations and Vector Spaces) Hours: 18

Systems of Linear Equations – Matrices and Elementary Row Operations – Row-Reduced echelon Matrices – Matrix Multiplication - Invertible Matrices – Bases and Dimension of vector spaces.

UNIT – II (Linear Transformations) Hours: 18

The algebra of linear transformations – Isomorphism – Representation of Transformations by Matrices – Linear Functionals – The Double Dual – The Transpose of Linear Transformation.

UNIT – III (Polynomials) Hours: 18

The algebra of polynomials – Lagrange interpolation – Polynomials ideals – The prime factorization of a polynomial.

Determinants – Commutative rings – Determinant functions.

UNIT – IV (Determinants – Continued) Hours: 18

Permutations and the Uniqueness of determinants – Additional properties of determinants **Canonical forms** – Characteristic values – Annihilating polynomials.

UNIT – V (Canonical Forms – Continued) Hours: 18

Invariant subspaces – Simultaneous triangulation: Simultaneous Diagonalization – Direct sum Decompositions – Invariant Direct sums – The Primary Decomposition Theorem.

TEXT BOOK:

Kenneth M Hoffman and Ray Kunze, Linear Algebra, 2^{nd} Edition, Prentice – Hall of India Private Limited, New Delhi, 1971.

UNIT – I – Chapter I (Sections: 1.2 to 1.6)
Chapter II (Section: 2.3)
UNIT – II – Chapter III (Sections: 3.2 to 3.7)
UNIT – III – Chapter IV (Sections: 4.1 to 4.5)
Chapter V (Sections: 5.1 and 5.2)
UNIT – IV – Chapter V (Sections: 5.3 and 5.4)
Chapter VI (Sections: 6.1 to 6.3)
UNIT – V – Chapter VI (Sections: 6.4 to 6.8)

Text Books:

1) I.N. Herstein, Topics in Algebra, John Wiley & Sons 2nd Edition New Delhi, Third Reprint, 2007.
2) Rao, A.R. and Bhimasankaram, P, Linear Algebra, 2nd Edition, TRIM series 19, Hindustan Book Agency, 2000.
3) Charles W. Curtis, Linear Algebra, – An Introductory Approach by Springer, 1984.
4) W. Keith Nicholson, Linear Algebra with Applications, 5th Edition, Mc Graw Hill, 2006.

COURSE OUTCOMES:

Students will be introduced to and have the knowledge of many mathematical concepts, Examples and Counter Examples, Proof Techniques and Problem Solving studied in Linear Algebra such as

1) Systems of linear equations
2) The algebra of linear Equations
3) The algebra of Polynomials
4) Determinant functions
5) Diagonalization, Decompositions.

OUTCOME MAPPING

PO/CO	PO1	PO2	PO3	PO4	PO5
CO1	3	3	3	2	3
CO2	3	3	2	3	2
CO3	3	2	3	3	3
CO4	3	3	3	3	3
CO5	2	3	3	3	3

SEMESTER: II PART: CORE VI	COURSE CODE: 22PMATC22 COURSE TITLE: MEASURE THEORY and INTEGRATION	CREDIT: 4 HOURS: 6

Learning Objectives(LO):

1) To generalize the concept of integration using measures.
2) To develop the concept of analysis in abstract situations.
3) To discuss convergence in measure and properties of L^p Space.

Unit – I **Hours: 18**

Measure on Real line – Lebesgue outer measure – Measurable sets – Regularity – Measurable function – Borel and Lebesgue measurability.

Unit – II **Hours: 18**

Integration of non-negative functions – The General integral – Integration of series – Riemann and Lebesgue integrals.

Unit - III **Hours: 18**

Abstract measure spaces – Measures and outer measures – Extension of a measure – Uniqueness of the extension – Completion of a measure – Measure spaces – Integration with respect to a measure.

Unit - IV **Hours: 18**

Convergence in measure – Almost uniform convergence – Signed measures and Halin decompostion – The Jordan decomposition.

Unit - V **Hours: 18**

Measurability in a product space – The product measure and Fubini's Theorem.

Text Book:

G.De Barra, Measure Theory and Integration, New age international (P) Limited, 2005.

Unit - I - Chapter II: Sections 2.1 to 2.5
Unit - II - Chapter III: Sections 3.1 to 3.4
Unit - III - Chapter V: Sections 5.1 to 5.6
Unit - IV - Chapter VII: Sections 7.1 and 7.2,
Chapter VIII: Sections 8.1 and 8.2
Unit - V - Chapter X: Sections 10.1 and 10.2

Supplementary Reading:

1) Royden, Real Analysis, MacMillan Publishing Company, New York, 1968.
2) V. Ganapathy Iyer, Mathematical Analysis, Tata McGraw Hill Publication Co. Ltd., New Delhi,1977.
3) P.R. Halmos, Measure Theory, Van Nostrand Princeton, New Jersey, 1950.
4) Michael E. Taylor, Measure Theory and Integration by Graduate Studies in Mathematics, Volume 76, American Mathematical Society, Indian Edition, 2006.

Course Outcomes(CO):

Students will be able to get knowledge of many mathematical concepts

1) Examples and counter examples
2) Problem solving techniques
3) Understand the fundamental studies in measurable sets, measurable functions and convergence in measure.
4) Student will understand the generalized concept of convergence in measure.
5) Student will understand the measurability in a product space.

OUTCOME MAPPING

PO/CO	PO1	PO2	PO3	PO4	PO5
CO1	3	3	3	2	3
CO2	3	3	2	3	2
CO3	2	2	3	3	3
CO4	3	3	3	2	3
CO5	2	3	3	3	3

SEMESTER: II PART: CORE VII	COURSE CODE: 22PMATC23 COURSE TITLE: PARTIAL DIFFERENTIAL EQUATIONS	CREDIT:4 HOURS:6

COURSE OBJECTIVES

1) To introduce to the students the various types of partial differential equations.
2) How to solve the partial differential equations.

UNIT – I : PARTIAL DIFFERENTIAL EQUATIONS OF FIRST ORDER

Formation and solution of PDE, Integral surfaces, Cauchy problem order equation, orthogonal surfaces, First order non-linear, characteristics, compatible system, Charpits method. (18 Hours)

UNIT – II : FUNDAMENTALS

Introduction, Classification of second order PDE, Canonical forms, Adjoint operators, Riemann's method. (18 Hours)

UNIT – III : ELLIPTIC DIFFERENTIAL EQUATIONS

Derivation of Laplace and Poisson equation, BVP, Separation of variables, Dirichlet's problem and Newmann problem for a rectangle, solution of Laplace equation in Cylindrical and Spherical coordinates, Examples. (18 Hours)

UNIT – IV : PARABOLIC DIFFERENTIAL EQUATIONS

Formation and solution of Diffusion equation, Dirac- Delta function, Separation of variables method, solution of Diffusion equation in Cylindrical and Spherical coordinates, Examples. (18 Hours)

UNIT – V : HYPERBOLIC DIFFERENTIAL EQUATIONS

Formation and solution of one-dimensional wave equation, canonical reduction, IVP, D'Alembert's solution, IVP and BVP for two-dimensional wave equation, Periodic solution of one-dimensional wave equation in Cylindrical and Spherical coordinate systems, Uniqueness of the solution for the wave equation, Duhamel's Principle, Examples. (18 Hours)

COURSE OUTCOMES

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

1) Solve various types of first order PDE.
2) Solve various types of second order PDE.
3) Solve Elliptic differential equation.
4) Solve Parabolic differential equation.
5) Solve Hyperbolic differential equation

Text book

1) K.Sankar Rao, Introduction to Partial Differential Equations, 2nd Edition, Prentice Hall of India, New Delhi, 2005.

Supplementary Readings

1) R.C.McOwen, Partial Differential Equations, 2nd Edition Pearson Education, New Delhi, 2005.
2) I.N.Sneddon, Elements of Partial Differential Equations, McGraw Hill, New Delhi,1983.
3) R.Dennemeyer, Introduction to Partial Differential Equations and Bounded Value Problems, McGraw Hill, New York,1968.
4) M.D.Raisinghania, Advanced Differential Equations, S.Chand & Company Ltd, New Delhi, 2001.

OUTCOME MAPPING

PO/CO	PO1	PO2	PO3	PO4	PO5
CO1	3	3	3	2	3
CO2	3	3	3	3	2
CO3	2	3	3	3	3
CO4	3	2	3	3	3
CO5	2	3	3	3	2

SEMESTER: III PART: CORE VIII	COURSE CODE: 22PMATC34 COURSE TITLE:CLASSICAL DYNAMICS	CREDIT:4 HOURS: 6

COURSE OBJECTIVES

1) Classical mechanics afford the student an opportunity to master many of mathematics techniques.
2) It is certainly true that classical mechanics today is far from being a closed subject.
3) Alternate means exist in the curriculum for acquiring the mathematics needed in other branches
4) To give a details knowledge about the mechanical system of particles, applications of Lagrange's equations and Hamilton's equations as well as the theory of Hamilton Jacobi Theory.

Unit I : INTRODUCTORY CONCEPTS **Hours: 18 Hrs**

The mechanical systems - Generalized Coordinates-Constraints –Virtual work – Principle of virtual work – D'Alemberts principle – Examples – Generalized force – Example.

Unit II: LAGRANGE'S EQUATIONS **Hours: 18 Hrs**

Derivation of Lagrange's Equations – Examples –Integral of the motion – Ignorable coordinates – the Routhian function – example – Liouville's system – examples.

Unit III: SPECIAL APPLICATIONS OF LAGRANGE'S EQUATIONS **Hours: 18 Hrs**

Rayleigh's Dissipation Function - impulsive motion - Gyroscopic systems – small motions – Gyroscopic stability – examples.

Unit IV: HAMILTON'S EQUATIONS **Hours: 18 Hrs**

Hamilton's principle – Hamilton's equations - other variational principles – Principle of least action – example.

Unit V: Hamilton-Jacobi Theory **Hours: 18 Hrs**

Hamilton's Principal function – the canonical integral – Pfaffian forms - The Hamilton-Jacobi Equation - Jacobi's theorem - example.

COURSE OUTCOMES

1) Be able to solve the Lagrange‘s equations for simple configurations using various methods
2) Be able to understand the concept of Hamilton Jacobi Theory.
3) Be able to understand the concept canonical Transformations
4) To develop skills in formulating and solving physics problems
5) Able to get idea of dynamical systems are of relatively recent origin, the concept of motion in phase- space and its geometrical depiction is simple

Text Books

Donald T. Greenwood, Classical Dynamics, PHI Pvt. Ltd., New Delhi, 1985.

Unit I - Chapter I: Sections 1.1 to 1.5

Unit II - Chapter II: Sections : 2.1-2.4

Unit III - Chapter III: Sections: 3.1,3.2 and 3.4 (3.3 Omitted)

Unit IV - Chapter IV: Sections: 4.1-4.4

Unit V - Chapter V: Sections: 5.1-5.3

Supplementary Readings(Reference Books)

1) John L. Synge, Byron A. Griffith, Principles of Mechanics, Third Edition, McGraw-Hill Book, New York, 1959.
2) Herbert Goldstein, Charles P. Poole, John L. Safko, Classical Mechanics, Addison-Wesley Press Inc., 2002.
3) Narayan Chandra Rana & Promod Sharad Chandra Joag, Classical Mechanics, Tata McGrawHill, 1991.

OUTCOME MAPPING

PO/CO	PO1	PO2	PO3	PO4	PO5
CO1	3	3	3	2	3
CO2	3	3	2	3	2
CO3	3	2	3	3	3
CO4	3	3	3	3	3
CO5	2	3	3	3	3

SEMESTER – II CORE ELECTIVE –1	CORE CODE: 22PMATE25-1 COURSE TITLE: NUMBER THEORY AND CRYPTOGRAPHY	HRS/WK – 4 CREDIT – 4

COURSE OBJECTIVES

The course aim is to introduce the concept divisibility and Euclidean algorithm, quadratics residues and reciprocity, encryption and decryption, primality test.

UNIT-1: INTRODUCTION TO NUMBER THEORY (12 HOURS)

The estimates for doing arithmetic-Divisibility and the Euclidean algorithm-Congruences-Model exponentiation-Some applications to factoring.

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

UNIT-2: QUADRATIC RESIDUES AND RECIPROCITY (12 HOURS)

Finite Fields-Multiplication generators-Uniqueness of fields with prime power elements-Quadratic residues and reciprocity.

Chapter 2, Sections: 2.1,2.2

UNIT-III : CRYPTOSYSTEMS (12 HOURS)

Some simple crypto systems- Digraph transformation-Enciphering Matrices-Affine enchipering transformation RSA- Discrete log- Diffie-Hellman Key exchange-The massey-Omura cryptosystem-Digital signature standard-Computation of discrete log.

Chapter 3,Sections: 3.1,3.2

UNIT-IV : PRIMALITY AND FACTORING-I (12 HOURS)

Pseudoprimes- Strong pseudo primes- Solovay- Strassen primality test- Miller- Rabin test- Rho method-Fermat factoring and factor bases-Quadratic sieve method.

Chapter 5,Sections:5.1,5.2,5.3

UNIT-V: PRIMALITY AND FACTORING-II (12 HOURS)

Elliptic curves-Elliptic curve primality test – Elliptic curve factoring –pollard's p-1 method – Elliptic curve reduction modulo n – Lenstras method.

Chapter 6,Sections: 6.1,6.3,6.4

COURSE OUTCOMES

1) Students able to understand the divisibility and Euclidean algorithm.
2) Students able to understand quadratics residues and reciprocity.
3) Students able to analyse encryption and decryption.
4) Students able to do the primality test.
5) Students able to the determine the elliptic curve primality test.

Text books

1) Neal Koblitz, ”A course in number theory and cryptography”,2nd Edition, Springer-Verlag,1994.

Supplementary Readings

1) MenezesA, “ Van Oorschot and Vanstone S.A,Hand book of applied cryptography”,CRC press, 1996.

OUTCOME MAPPING

PO/CO	PO1	PO2	PO3	PO4	PO5
CO1	3	3	3	2	3
CO2	3	3	2	3	2
CO3	2	2	3	3	3
CO4	3	3	3	2	3
CO5	2	3	3	3	2

SEMESTER: II PART: CORE ELECTIVE-2	**COURSE CODE: 22PMATE25-2 COURSE TITLE:FORMAL LANGUAGES and AUTOMATA THEORY**	**CREDIT:4 HOURS: 4**

COURSE OBJECTIVES

1) Identify the role of switch as simple nontrivial finite automaton
2) Describe states, deterministic and nondeterministic nature of transition
3) Differentiate various languages and the corresponding Machines which accepts them
4) Ascertain the limitations of automaton

Unit I: Introduction to the theory of computation: Three basic concepts. Hours: 12

Finite automata: Deterministic Finite Accepters – Nondeterministic Finite Accepters – Equivalence of deterministic and nondeterministic finite accepters – Reduction of the number of states in finite automata.

Chapter 1 (1.2)

Chapter 2 (2.1 – 2.4)

Unit II: Regular Languages and Regular Grammars: Hours: 12

Regular Expressions-Connection between Regular Expressions and Regular Languages – Regular Grammars.

Chapter 3 (3.1 – 3.3)

Unit III: Properties of Regular Languages: Hours: 12

Closure properties of Regular Languages – Elementary questions about regular languages – identifying non-regular languages.

Chapter 4 (4.1 – 4.3)

Unit IV: Hours: 12

Context Free Languages: Context Free Grammars (CFG).

Simplification of CFG and Normal Forms: Methods for transforming Grammars-Two important

Normal Forms.

Chapter 5 (5.1)

Chapter 6 (6.1, 6.2)

Unit V: Hours: 12

Pushdown Automata: Nondeterministic pushdown automata – Pushdown Automata and CFL

Deterministic Pushdown Automata and Deterministic CFL.

Properties of CFL: Two Pumping Lemmas. **Turing Machines**: The Standard Turing Machines.

Chapter 7 (7.1 –7.3)

Chapter 8 (8.1)

Chapter 9 (9.1)

COURSE OUTCOMES

1) Formulate grammar which produces a language
2) Identify an automaton which accepts a given language
3) Formulate automaton from grammar
4) Critically analyze the relationship between grammar, language and automaton
5) Student understand the pushdown Automata and CFL.

Text Books

Contents and treatment as in

An introduction to Formal Languages and Automata by Peter Linz, 4th edition (2006), Narosa.

Supplementary Readings (Reference Books)

1) Introduction to Automata Theory, Languages, and Computation by John E.Hopcroft, Rajeev Motwani and Jeffrey D. Ullman, 3 rd edition, Prentice Hall.
2) A Course in Formal Languages , Automata and Groups by Ian M.Chiswell,1 st Edition,(2009), Springer
3) Introduction to Languages and the Theory of Computation by John C Martin, 4 th edition(2010), McGraw-Hill.
4) Introduction to Formal Languages, Automata Theory and Computation by Kamala Krithivasan and Rama R, (2009),Pearson.
5) Formal Languages and Automata by Rani Siromoney(1979), The Christian Literature Society.

OUTCOME MAPPING

PO/CO	PO1	PO2	PO3	PO4	PO5
CO1	3	3	3	2	3
CO2	3	3	2	3	2
CO3	2	2	3	3	3
CO4	3	3	3	2	3
CO5	2	3	3	3	2

SEMESTER: II PART: CORE ELECTIVE -3	COURSE CODE:22PMATE25-3 COURSE TITLE: DIFFERENTIAL GEOMEMETRY	CREDIT: 4 HOURS: 4

COURSE OBJECTIVES

1) To introduce space curves , surfaces ,curves on surfaces ,and study some of their properties.
2) To study the notion of geodesics and its properties.
3) To understand some type of special surfaces such as developables and minimal surfaces.

UNIT-I : Space curves

Space curves, Arc length, Tangent, normal and binormal, curvature torsion of a curve given as the intersection of two surfaces, Contact between curves and surfaces. (12 Hours)

UNIT-II: Space curves (continued)

Tangent surface, involutes and evolutes, Intrinsic equations, Fundamental existence theorem for space curves, Helices, Definition of a surface, Curves on a surface, Surface of revolution. (12 Hours)

UNIT-III : Metric

Metric, Direction coefficients, Geodesics, Canonical geodesic equations, Normal property of geodesics, Geodesic curvature, Gauss-Bonnet Theorem. (12 Hours)

UNIT-IV : Metric (continued)

Gaussian curvature, Surface of constant curvature, Principal curvature, Lines of curvature, Conformal mapping, Dini's theorem, Tissot's theorem. (12 Hours)

UNIT-V : Second Fundamental form

Second fundamental form, Developables, Developables associated with space curves and with curves on surfaces, Minimal surfaces, Ruled surfaces, Compact surfaces whose points are umblics, Hilbert's lemma, Compact surface of constant curvature. (12 Hours)

COURSE OUTCOMES

1) Understand the concept of a space curve in 3D and compute the curvature and torsion of space curves.
2) Understand the fundamental existence theorem.
3) Find geodesics equation on a surface.
4) Understand surfaces of constant curvature , Dini's and Tissot' theorems
5) Determine the second fundamental form, compact surface, Hilbert's lemma.

Text Books

1) Willmore.T.J. (1959). An Introduction to Differential Geometry, Oxford Univesity Press, New Delhi.

Supplementary Readings

1) Struik.D.T., (1950), Lectures on Classical Differential Geometry, Addison-Wesley Press.
2) Andrew Pressley, (2001), Elementary Differential Geometry, Springer.
3) Heinrich.W.Guggenheimer,(1977), Differential Geometry, Dover Publications, Inc., New York.

OUTCOME MAPPING

PO/CO	PO1	PO2	PO3	PO4	PO5
CO1	3	3	3	2	3
CO2	3	3	3	3	2
CO3	2	2	3	3	3
CO4	3	3	2	2	3
CO5	2	3	3	3	2