ANNAMALAI UNIVERSITY

401 - M.Sc. MATHEMATICS

Programme Structure and Scheme of Examination (under CBCS)
(Applicable to the candidates admitted in the academic year 2022 -2023 only)

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 Equations	6	4	25	75	100
22PMATC14	Core Theory-IV: Optimization Techniques	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 Equations	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**
	SEMESTER – III					
22PMATC31	Core Theory-IX: Advanced Complex Analysis	6	4	25	75	100
22PMATC32	Core Theory-X: Topology	6	4	25	75	100
22PMATC33	Core Theory-XI: Research Methodology	6	4	25	75	100
22PMATC34	Core Theory-XII: Stochastic Processes	5	4	25	75	100
22PMATE35	Core Elective III	4	4	25	75	100
22PMATO36	Open Elective II	3	3	25	75	100
	MOOC Courses					
	TOTAL	**30**	**23**			**600**
	SEMESTER - IV					
22PMATC41	Core Theory-XIII: Functional Analysis	6	4	25	75	100
22PMATC42	Core Theory-XIV: Fluid Dynamics	6	4	25	75	100
22PMATC43	Core Theory-XV: Graph Theory	6	4	25	75	100
22PMATE44	Core Elective IV	4	4	25	75	100
22PMATD45	Core Project	8	6	25	75	100
	TOTAL	**30**	**22**			**500**

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
III	22PMATE35-1	Discrete Mathematics	4	4	25	75	100
	22PMATE35-2	Mathematical Methods	4	4	25	75	100
	22PMATE35-3	Theory of Relativity	4	4	25	75	100
IV	22PMATE44-1	Programming in C++	4	4	25	75	100
	22PMATE44-2	Mathematical Modelling	4	4	25	75	100
	22PMATE44-3	Numerical Methods	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
III	22PMATO36-1	Elementary Numerical Methods	3	3	25	75	100
	22PMATO36-2	Operations Research	3	3	25	75	100
	22PMATO36-3	Mathematics for Competitive Examinations	3	3	25	75	100

Credit Distribution

Study Components	Papers	Credits	Total Credits	Marks	Total Marks
Core theory	15	4	60	100	1500
Core Practical	-	-	-	-	-
Core Electives	4	4	16	100	400
Open Electives	2	3	6	100	200
Project	1	6	6	100	100
Common Compulsory Paper	1	2	2	100	100
	23		**90**		**2300**

SEMESTER: I PART: CORE I	22PMATC11: ADVANCED ABSTRACT ALGEBRA	CREDITS: 4 HOURS: 6/W

COURSE OBJECTIVES

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 – 1st, 2nd and 3rd 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 Books

I.N. Herstein, Topics in Algebra, 2nd 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)

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.

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.

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	22PMATC12: ADVANCED REAL ANALYSIS	CREDIT:4 HOURS: 6/W

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.

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.

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 Readings

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.

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	22PMATC13: ORDINARY DIFFERENTIAL EQUATIONS	CREDIT:4 HOURS:6/W

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 Books

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	22PMATC14: OPTIMIZATION TECHNIQUES	CREDIT: 4 HOURS: 5/W

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.

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.

Text Books

Hamdy A. Taha, Operations Research (8th 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.

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 ELECTIVE– 1	22PMATE15-1: FUZZY SETS AND APPLICATIONS	CREDITS – 4 HOURS – 4/W

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 OUTCOMES

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 Books

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	22PMATE15-2: MATHEMATICAL STATISTICS	CREDIT: 4 HOURS: 4/W

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 Books

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	22PMATE15-3: WAVELETS	CREDIT: 4 HOURS: 4/W

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: I PART: OPEN ELECTIVE-1	22PMATO16-1: BASIC MATHEMATICS	CREDIT: 3 HOURS: 3/W

COURSE OBJECTIVES

The objectives of the course are to know about the concepts of matrices and its applications, Ordinary and Partial Differential Equations, Laplace Transforms and Fourier Series.

Unit I: Matrices **Hours: 9**

Matrices – Simultaneous Linear equations– Cayley-Hamilton Theorem – Eigen values and Eigen vectors

Chapter 3 – Sections: 3.1 to 3.4 of Text Book 1

Unit II: Differential Equations **Hours: 9**

Equations of first order higher degree – Linear equations of higher Order – Homogeneous linear equations.

Chapter 6: Sections: 6.1 to 6.3 of Text Book 1

Unit III: Partial Differential Equations **Hours: 9**

Formation of Partial Differential Equations - First Order Partial Differential Equations – Some Standard forms – Lagrange's form.

Chapter 8: Sections: 8.1 to 8.4 of Text Book 1

Unit IV: Laplace transforms **Hours: 9**

Laplace transform – Inverse Laplace transform – Solution of Differential Equations using Laplace Transform.

Chapter 7: Section 7.1 – 7.3 of Text Book 1

Unit V: Fourier Series **Hours: 9**

Fourier Expansion – Fourier Co-efficients – Fourier series for Odd and Even Functions – Half Range Fourier Series.

Chapter 43 of Text Book 2

COURSE OUTCOMES

After the successful completion of this course, the students will be able to:

1) Understanding about matrices and its applications.
2) Acquire the knowledge about the Differential Equations.
3) Formulate and solve the partial differential equations
4) Apply the results on Laplace transform and solution of Differential Equations using Laplace Transform.
5) Acquire the techniques of Fourier series.

Text Books

1) S. Arumugam and A. Thangapandi Isaac, Mathematics for Physical Sciences- Volume II, New Gamma Publishing House, Palayamkottai, 2000.
2) P.R. Vittal, Mathematical Foundations, Margham Publications, Chennai,2003.

Supplementary Readings

1) P. Balasubramaniyam, K. G. Subramanian, Ancillary Mathematics, Volume-I, Tata McGraw – Hill publishing company limited, New Delhi, 1996.
2) G. Britto Antony Xavier, V. Balaji, S.U. Vasantha Kumar, B. Govindan, Mathematical Sciences, Jayalakshmi Publications, 2-e, 2015.
3) P. DuraiPandian, S. UdayaBaskaran, Allied Mathematics, Volume – I, Muhil publishers, 1st Edition, Chennai, 1997.
4) P.Kandsamy and K. Thilagavathy, Allied Mathematics volume–I, Volume – II, S. Chand & Company, New Delhi, 2004.
5) Shanti Narayan, P.K.Mittal, Differential Calculus, S.Chand& Co, New Delhi, 2005. 5. A.Singaravelu, Allied Mathematics, Meenakshi Agency, Chennai, 2001.
6) P.R.Vittal, Allied Mathematics, Margham Publications, Chennai, 1999.

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: OPEN ELECTIVE- 2	22PMATO16-2: MATHEMATICAL FOUNDATIONS	CREDIT:3 HOURS: 3/W

COURSE OBJECTIVES

1) To learn how to apply fundamental mathematical tools and techniques used in most
2) fields of science and mathematics
3) To learn the different types of functions and operators
4) To learn the conditional and bi conditional statements ,conjunction and disjunction
5) To learn the concepts of lattices and Boolean Algebra
6) To know the different kinds of Interpolation.

Unit I :

Hours: 9

Relations – Equivalence Relation – Functions and Operators – One-to-one, Onto Functions –Special Types of Functions – Invertible Functions – Composition of Function – Mathematical Induction.

Unit II:

Hours: 9

Logic: Introduction – TF – Statements – Connectives – Conjunction – Disjunction – Negation – Conditional Statements – Bi conditional Statements – The Truth Table of a Formula – Tautology.

Unit III: **Hours: 9**

Lattices – Some Properties of Lattices - New Lattices – Lattice Homomorphism's – Product Lattices of Two Lattices– Modular and Distributive Lattices – Boolean Algebra.

Unit IV: **Hours: 9**

Iterative Methods: Birge – Vieta – Graeffe's Root squaring methods - System of linear algebraic equations: Gauss Elimination, Jacobi iteration method - Gauss-Seidel iteration method.

Unit V: **Hours: 9**

Interpolation: Lagrange interpolation – Newton's Forward Difference Interpolation–Newton's Backward Difference Interpolation – Trapezoidal Rule - Simpson Rule - Romberg integration.

COURSE OUTCOMES

1) Students will be able to have knowledge of relations, functions, mathematical logic, lattices and numerical methods.
2) Understand the types of functions, conditional statements and tautology in Mathematical logic, properties of lattices, Boolean algebra, numerical techniques to find the roots and interpolation methods.
3) Apply mathematical induction, composition of functions, logical notation to write an argument, suitable method to solve linear equations and numerical integration, interpolation.

4) Analyze various types of function, statements using truth tables, use Boolean algebra to design and simplify logic circuits, numerical methods to find solutions of linear equations and system of equations using different methods.
5) Justify relations and functions, to construct mathematical arguments using logical connectives and quantifiers, lattices. Evaluate solutions of system of linear equations and numerical integration .

Text Books

1. Dr. M.K. Venkataraman, Dr. N. Sridharan, N. Chandrasekaran., Discrete Mathematics, The National Publishing Company, Chennai. 2006.

Unit-I Chapter II (Sec 2, 5), Chapter III (Sec 1, 2, 3, 4, 5), Chapter IV (Sec (Theorems are excluded).

Unit-II Chapter IX (Sec 1, 2, 3, 6, 7)

Unit-III Chapter X (Sec 1, 2, 3, 4, 5) (Definition and example only for Sec 5)

2. M.K. Jain, S.R.K. Iyengar, R.K. Jain., Numerical Methods for Scientific and Engineering Computation, 4th Edition, New Age International (P) Limited, Publishers, 2003.

Unit-IV Chapter 2 (Sec 2.9,), Chapter 3 (Sec 3.2, 3.4).

Unit-V Chapter 4 (Sec 4.2, 4.4), Chapter 5 (Sec 5.9, 5.10).

Supplementary Readings

1) J.P. Trumblay, R. Manohar. Discrete Mathematical Structures with Applications to Computer Sciences, McGraw-Hill International Edition, 1987.
2) S.S. Sastry, Introductory Methods of Numerical Analysis, PHI Learning Private Limited, 4th Edition, New Delhi 2009
3) P. Kandasamy, K.Thilagavathy, K.Gunavathi, Numerical Methods, S. Chand & Company Ltd-2008.

OUTCOME MAPPING

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

SEMESTER: I PART: OPEN ELECTIVE - 3	22PMATO16-3: Latex	CREDITS: 3 HOURS: 3/W

COURSE OBJECTIVES

The main objectives of this course are to:

1) Introduce the Software knowledge in Latex
2) Learn Mathematics structures using Latex
3) Understanding the basic concepts and their properties are important for the development of the present and further courses.

UNIT – I **Hours: 9**

Text formatting – TEX and its offspring.

UNIT – II **Hours: 9**

What's different in LaTeX2∈ – Distinguishing LaTeX 2∈ – Basic of a LaTeX file.

UNIT – III **Hours: 9**

Commands and Environments – Command names and arguments – Declarations – Lengths – Special Characters.

UNIT – IV **Hours: 9**

Document layout and Organization – Document class – Page style Parts of the Document.

UNIT – V **Hours: 9**

Table of Contents – Fine tuning text – Footnotes and marginal notes.

COURSE OUTCOMES

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

1) Remember to Download and install open course software LaTeX
2) Understanding and formatting LaTeX
3) Illustrate to learn to create Latex file
4) Apply and Analyze the LaTeX commands to large files
5) Able to learn mathematics derivations and structures using LaTeX.

Text Books

1) H. Kopka and P.W. Daly, A guide to Latex, 3rd Edition, Addison – Wesley, London, 1999.
2) Stefan Kottwitz,LaTeX Beginner's Guide: Create High Quality and Professional Looking Texts, Articles and Books for Business and Science Using Latex, Packt Publishing, 2011.

OUTCOME MAPPING

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

SEMESTER: II PART: CORE V	22PMATC21: ADVANCED LINEAR ALGEBRA	CREDITS: 4 HOURS: 6/W

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.

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.

Text Books

Kenneth M Hoffman and Ray Kunze, Linear Algebra, 2nd 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.

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	22PMATC22: MEASURE THEORY AND INTEGRATION	CREDIT: 4 HOURS: 6/W

COURSE OBJECTIVES

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.

COURSE OUTCOMES

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.

Text Books

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 Readings

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.

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	22PMATC23: PARTIAL DIFFERENTIAL EQUATIONS	CREDIT:4 HOURS:6/W

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 Books

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: II PART: CORE VIII	22PMATC24: CLASSICAL DYNAMICS	CREDIT:4 HOURS: 6/W

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

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	22PMATE25-1: NUMBER THEORY AND CRYPTOGRAPHY	CREDIT – 4 HOURS – 4/W

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	22PMATE25-2: FORMAL LANGUAGES AND AUTOMATA THEORY	CREDIT:4 HOURS: 4/W

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

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	22PMATE25-3: DIFFERENTIAL GEOMETRY	CREDIT: 4 HOURS: 4/W

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

SEMESTER – II	2PHUMR27: HUMAN RIGHTS	CREDIT:2 HOURS:2/W

COURSE OBJECTIVES

1) To understands the conceptual background of Human Rights.
2) To study international and regional norms and institutional mechanisms of Human Rights.
3) To know the international concern for Human Rights.
4) To explores the emerging issues in international human rights.
5) To study the Classification of Human Rights.

UNIT-I: CONCEPTUAL BACKGROUND OF HUMAN RIGHTS

Meaning, Nature and Scope of Human Rights - Need for the Study of Human Rights - Philosophical and Historical foundations of Human Rights - Classification of Human Rights –Major Theories of Human rights.

UNIT-II: INTERNATIONAL HUMAN RIGHTS NORMS AND MECHANISMS

UN Charter - Universal Declaration of Human Rights - International Covenant on Civil and Political Rights - International Covenant on Economic, Social and Cultural Rights - Other Major instruments on Human rights (Conventions on Racial Discrimination. Women and Child Rights. Torture, Apartheid and Refugees) -UN High Commissioner for Human Rights and its Sub-Commissions - Geneva Conventions and Protocols - UN High Commission for Refugees -Humanitarian Interventions of UN

UNIT-III: REGIONAL HUMAN RIGHTS STANDARDS AND MECHANISMS

European Convention on the protection of Human Rights - European Commission on Human Rights -American Convention on Human Rights - American Commission and Court of Human Rights - African Charter on Human and People's Rights -African Commission and African Court for Human Rights- Universal Islamic Declaration of Human rights (198l)

UNIT-IV: ISSUES

Violence against Women and Children - Refugees & Internally Displaced People's rights - Racism - Rights of Prisoners, Rights of Prisoners of War - Rights of Disabled, Aged, and Homeless Persons - Cyber Crimes and Human Rights - Euthanasia Debate- Bio-Technology and Human Rights (Human Cloning. Feticide and Medical Termination of Pregnancy, Surrogate Parenthood, Sale of Human Organs. Drugs and Technologies)

UNIT V: EMERGING DIMENSIONS

Third Generation Human Rights: Right to Water, Food, Health, Clothing, Housing, and Sanitation- Right to Education – Right to Peace and Prosperity - Right to have Clean Environment.

COURSE OUTCOMES

At the end of the course, the student

1) will have knowledge about the conceptual background of Human Rights.
2) can apprise on International Human Rights norms and mechanisms.
3) can understand the emerging dimensions of Human Rights in international forum.
4) can explain about the Third Generation Human Rights
5) can discusses about Right to Clean Environment.

Text Books

1) M.P. Tandon. Anand. V.K. International Law and Human Rights. Haryana. Allahabad Law house, Allahabad, 2013.
2) N. Sanajauba. Human Rights in the New Millennium, New Delhi Manas Publications, 2011.
3) S.K. Kapoor. Human Rights under International Law and Indian Law. Allahabad: Central Law Agency. 2012,
4) Daniien Kings Lurge & Leena Avonius. Ed. Human Rights in Asia, London. Maemillan Publishers. 2016.

Supplementary Readings

1) Todd, Land Man, ed., Human Rights. London. Sage Publications. 2018.
2) G. Van Bueren, The International Law on the Rights of the child. Dordrecht: Martinus Nijhoff Publishers, 2011.
3) B.S. Waghmnre. ed. Human Rights. Problems and Prospects. Delhi. Lalinga Publications. 2011.

OUT COME MAPPING

CO/PO	PO				
	PO1	PO2	PO3	PO4	PO5
CO1	2	2	3	3	2
CO2	1	2	2	3	3
CO3	2	2	3	2	2
CO4	2	3	3	2	3
CO5	2	2	2	3	3

***1-Low *2-Medium *3-Strong**

SEMESTER: III PART: CORE: IX	22PMATC31: ADVANCED COMPLEX ANALYSIS	CREDIT:4 HOURS:6/W

COURSE OBJECTIVES

This course aims to train the students to get essential knowledge in functions of a complex variable, Analytic functions and their properties, Residue theorem and its applications, Riemann mapping theorem are discussed in detail.

Unit I: Complex integration **Hours: 18**

Line integrals, Rectifiable arcs, Line integrals as functions of arcs, Cauchy's theorem for a rectangle, Cauchy's theorem in a Disc. Cauchy's integral Formula: The index of a point with respect to a closed curve, The integral formula, Higher derivatives.

Chapter 4 Sections 1 & 2.

Unit II: Local Properties of Analytic Functions **Hours: 18**

Removable Singularities, Taylor's theorem, Zeros and poles, The Local Mapping and The Maximum Principle. The General Form of Cauchy's Theorem: Chains and cycles, Simple connectivity, locally exact differentials, multiply connected regions.

Chapter 4 Sections 3, 4 (4.1, 4.2, 4.6 and 4.7 only).

Unit III: Harmonic Functions **Hours: 18**

Definition and basic properties, The mean-value property, Poisson's Formula, Schwarz's theorem, The Reflection principle. Power Series Expansions:
Weierstrass's Theorem, The Taylor series, The Laurent Series.

Chapter 4 Section 6; Chapter 5 Section 1.

Unit IV: Partial Fractions and Factorization **Hours: 18**

Partial fractions, Infinite products and Canonical products. Normal Families: Equicontinuity, Normality and Compactness, Arzela's Theorem, Families of Analytic Functions, The classical definition.

Chapter 5 Section 2 (2.1, 2.2 and 2.3 only) & Chapter 5 Section 5.

Unit V: The Riemann Mapping Theorem **Hours: 18**

Statement and Proof Conformal mapping of Polygons: The behaviour at an angle, The Schwarz-Christoffel formula, Mapping on a rectangle, The triangle functions of Schwarz. A Closer look at Harmonic Functions:
Functions with the Mean-value Property, Harnack's Principle.

Chapter 6 Sections 1 (1.1 only), 2 and 3.

COURSE OUTCOMES

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

1) To learn the concepts of Complex Integration.
2) Compute the Taylor's theorem, to determine the nature of the removable Singularities, zeros and poles.
3) Explain the convergence of power series and develop analytical capabilities in Taylor or Laurent series in a given domain;

4) Determine the concept of conformal mapping of polygons, to find Schwarz – Christoffel formula.
5) With this course students are prepared to learn about advance complex Analysis.

Text Books

1) L.V. Ahlfors , Complex Analysis, Third Edition, McGraw Hill, New York, 1979.

Supplementary Readings

1) J.B. Conway, Functions of One Complex Variable, Narosa Publication House, New Delhi, 1980.
2) S. Ponnusamy, Foundations of Complex Analysis, Narosa Publication House, New Delhi 2004.
3) S. Lang, Complex Analysis, Addison - Wesley Mass, 1977.

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: III PART: CORE X	22PMATC32: TOPOLOGY	CREDIT:4 HOURS: 6/W

COURSE OBJECTIVES

To provide knowledge on point set topology, topological space, Quotient spaces, product spaces and metric spaces sequences, continuity of functions connectedness and compactness, homotopy and covering spaces.

Unit I: Topological Spaces (18 Hours)

Topological Spaces - Examples− Basis for a topology–Sub-basis− closed sets – interior – closure - boundary – Limitpoints − Hausdorff spaces−Subspace topology – The product topology on $X \times Y$ - Projections.

Chapter 2: Section: 12 - 17

Unit II: Continuous Functions (18 Hours)

Continuous functions−Examples−Homeomorphisms −topological property − pasting lemma −the product topology– Box topology - Comparison of the product topology and the box topology –the metric topology – Sequence Lemma –Uniform Limittheorem.

Chapter 2: Section: 18 - 21

Unit III: Connected Spaces (18 Hours)

Connected Spaces–connected subspace of the real line – Linear continuum – Intermediate Theorem – components and Local connectedness– Totally disconnected spaces.

Chapter 3: Section: 23 - 25

Unit IV: Compact Spaces (18 Hours)

Compact Spaces - Compact subspace of the real line – The Lebesque number lemma –Uniform continuitytheorem–Limit point compactness–Local compactness– one point compactification.

Chapter 3: Section: 26 - 29

Unit V: Countability and Separation Axioms (18 Hours)

First countable and second countable spaces – separation axioms– regular and completely regular spaces–Normal and completely Normal spaces–Urysohn‟s lemma–Urysohn‟s metrization theorem –Tietze Extension theorem.

Chapter 4: Section: 30 - 35

COURSE OUTCOMES

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

1) Define and illustrate the concept of topological spaces and continuous functions.
2) Prove a selection of theorems concerning topological space, continuous functions, product topologies, and quotient topologies.

3) Define and illustrate the concept of product of topologies and illustrate the concepts of the separation axioms.
4) Define connectedness and compactness, and prove a selection of related theorems, and describe different examples distinguishing general, geometric, and algebraic topology.

Text Books

1) James R. Munkres, "Topology", 2nd Edition, Prentice Hall of India Pvt.Ltd., (Third Indian Reprint).

Supplementary Readings

1) J.Dugundji, Topology, Prentice Hall of India, New Delhi,1975.
2) George F.Simmons, Introduction to Topologyand Modern Analysis, McGraw Hill International Edition, New York, 1963.
3) J.L.Kelly, General Topology, Van Nostrand , Reinhold co., New York.
4) K.D.Joshi, Introduction to General Topology, Wiley Eastern Ltd., 1983.
5) C.Wayne Patty, Foundations of Topology, (Student Edition), Jones & Bartlett India Pvt.Ltd., New Delhi.
6) Colin Adams, Robert Franzosa, Introduction to Topology Pure and Applied, Pearson Education, Indian Edition,2009.

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	2	3
CO5	2	3	3	3	2

SEMESTER: III PART: CORE XI	22PMATC33: RESEARCH METHODOLOGY	CREDIT: 4 HOURS: 6/W

COURSE OBJECTIVES

1) The prime aim of this paper is to enrich the knowledge of Research and motivation in Research.
2) The concept of different types of modules are introduced.
3) Localization and its applications introduced.
4) Holomorphic functions, complex differentiation, integrations are discussed in detail.
5) Fourier transform formal properties are discussed.

Unit I

Research Methodology: Meaning of Research – Objectives of Research – Motivation in Research – Types of Research – Research Approaches – Significance of Research – Research Methods versus Methodology – Research and Scientific method – Importance of knowing How Research is done – Research Process – Criteria of Good Research – Problems Encountered by Researchers in India. Defining the Research Problem: Research problem – Selecting the Problem – Necessity of Defining the Problem – Technique Involved in Defining the problem.

Unit II

Preparation of thesis and research papers, Tables and illustrations, Guidelines for writing the abstract, introduction, methodology, results and discussion, conclusion sections of a manuscript. References, Citation and listing system of documents, intellectual property rights. Report Writing: Significance of Report Writing – Different steps in writing Report – Layout of the Research Report – Types of Reports – Oral Presentation - Mechanics of writing a Research Report – Precautions for writing Research Reports.

Unit III

Modules: Free Modules – Project Modules – Tensor product – Flat Modules.

Unit IV

Localization: Ideals- Local Rings- Localization-Applications.

Unit V

Elementary Properties of Holomorphic Functions: Complex differentiation – Integration over paths – The local Cauchy theorem – The power series representation – The open mapping theorem – The global Cauchy theorem – The calculus of residues.

COURSE OUTCOMES

1) To understand meaning of Research and objectives of Research.
2) To understand various stages of preparing publishing a research articles and ethical issues.
3) To understand the fundamental of logical reasoning in pure mathematics and modelling aspects of applied mathematics.
4) To understand Different technique of interpretation.
5) To understand Holomorphic functions and the calculus of residues.

Text Books

1) C.R. Kothari, Research Methodology, New age international publishers.
2) Davis, M., Davis. K., and Dunagan M., " Scientific Papers and Presentation" 3rd Edition, Elsevier Inc.
3) C. George Thomas : " Research Methodology and Scientific Writing" Springer Nature, 2015.
4) N. S. Gopalakrishnan, Commutative Algebra, Oxonian Press, New Delhi, Second Printing 1988.
5) W.Rudin, Real and Complex Analysis, Tata Mc-Graw Hill, Third Edition, 2006.

Supplementary Readings

1) Real Analysis, by N.L.Carothers, Cambridge, University Press. First South Asian Edition 2006.
2) James Ward Brown and Ruel V.Churchill,(2014), Complex Variables and Applications, McGraw Hill Education (India), New Delhi.
3) Content and Treatment as in the book ' How to write and publish a Scientific Paper' by Robert A.Day, Cambridge University Press.

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	3	3	3	3	3

SEMESTER: IV PART: CORE XII	22PMATC34: STOCHASTIC PROCESSES	CREDITS: 4 HOURS: 5/W

COURSE OBJECTIVES

The objectives are to

1) Acquire the skill of advanced level of mathematical sophistication and enhancing the horizons of knowledge.
2) Acquire understanding of applicability of different concepts of stochastic processes on some physical situation.
3) To familiarize the students with the use of stochastic models in different areas.

Unit I: (Stochastic Processes) Hours: 15

Introduction – Specification of Stochastic Processes – Stationary Processes – Martingales – Markov Chains: Definition and Examples – Higher Transition Probabilities – Generalization of independent Bernoulli Trials: Sequence of Chain Dependent Trials – Classification of States and Chains.

Unit II: (More on Markov Chains) Hours: 15

Determination of Higher Transition Probabilities – Stability of a Markov System – Markov Chain with Denumerable Number of States – Reducible Chains.

Unit III: (Markov Processes with Discrete State Space: Poisson Process and its Extensions) Hours: 15

Poisson Process – Poisson Process and Related Distributions – Generalization of Poisson Process – Birth and Death Process – Markov Process with Discrete State Space (Continuous Time Markov Chains).

Unit IV: (Markov Chains and Markov Processes with Continuous State Space) Hours: 15

Markov Chains with Continuous State Space – Introduction: Brownian Motion – Wiener Process – Differential Equations for a Wiener Process – Kolmogorov Equations – First Passage Time Distribution for Wiener Process.

Unit V: (Renewal Processes and Theory) Hours: 15

Renewal Process – Renewal Processes in Continuous Time – Renewal Equation – Stopping time: Wald's Equation – Renewal Theorems – Delayed and Equilibrium Renewal Processes.

COURSE OUTCOMES

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

1) working knowledge related to the problems of uncertainty.
2) a basic knowledge for doing research in this area.
3) Classify Poisson, Markov and birth and death process.
4) Understand the Markov chains and Markov processes.
5) Understand Renewal process.

Text Books

1) J. Medhi, Content and treatment as in the book Stochastic Processes, Wiley Eastern Limited, New Delhi, (Second Edition), 1994.

UNIT – I	–	Chapter II (Sections: 1 to 4)
		Chapter III (Sections: 1 to 4)
UNIT – II	–	Chapter III (Sections: 5,6,8 and 9)
UNIT – III	–	Chapter IV (Sections: 1 to 5)
UNIT – IV	–	Chapter III (Section: 11)
		Chapter V (Sections: 1 to 5)
UNIT – V	–	Chapter VI (Sections: 1 to 6)

Supplementary Readings

1) S. Karlin and H.M. Taylor, A First Course in Stochastic Processes, Academic Press (second edition), New York, 2011.
2) S.M. Ross, Stochastic Processes, Wiley India Pvt., Ltd., 2nd Edition, 2008.

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: III PART:CORE ELECTIVE -1	22PMATE35-1: DISCRETE MATHEMATICS	CREDIT: 4 HOURS: 4/W

COURSE OBJECTIVES

1) To explore the knowledge in Lattices and their applications.
2) To develop applications of switching circuits.
3) To understand mathematical reasoning in order to read, comprehend and construct mathematical arguments.
4) To develop mathematical foundations to understand and create mathematical arguments in crpto systems.
5) To motivate students how to solve practical problems using Discrete Mathematics.

Unit I: Lattices **Hours: 12**

Properties and examples of Lattices – Distributive lattices – Boolean algebras – Boolean polynomials – Minimal Forms of Boolean Polynomials.

Unit II: Applications of Lattices **Hours: 12**

Switching Circuits - Applications of Switching Circuits – More Applications of Boolean Algebras.

Unit III: Coding Theory **Hours: 12**

Introduction to Coding – Linear Codes – Cyclic Codes – Special Cyclic Codes.

Unit IV: Cryptology **Hours: 12**

Classical Cryptosystems – Public key Cryptosystems – Discrete Logarithms and other Ciphers.

Unit V: Applications of Algebra **Hours: 12**

Semigroups – Semigroups and Automata – Semigroups and Formal Languages – Semigroups and Biology – Semigroups and Sociology.

COURSE OUTCOMES

After completion of this course the student will be able to

1) Understand how Lattices can be used as a tool and mathematical model in the study of networks and circuits.
2) Construct mathematical arguments using logical connectives and quantifiers.
3) Apply codes to develop Mathematical Models.
4) Explore Applications of crypto systems in modern technology.
5) Learn how to work with some of the discrete structures which include semi-groups and its applications.

Text Books

1) Rudolf Lidl & Gunter Pilz. APPLIED ABSTRACT ALGEBRA, Springer Verlag, NewYork, Second Indian Reprint 2006.

Supplementary Readings

1) J.P. Tremblay & R. Manohar, A First Course in Discrete Structures with Applications to Computer Science, McGraw Hill, 1987.
2) Kenneth H. Rosen, Discrete Mathematics and it's Applications, 7th Edition/ McGraw Hill Education, New York, 2012.
3) Liu C.L, Elements of Discrete Mathematics, McGraw Hill, New York, 1978.

OUTCOME MAPPING

PO/CO	PO1	PO2	PO3	PO4	PO5
CO1	3	3	3	3	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:III PART: CORE ELECTIVE-2	22PMATE35-2: MATHEMATICAL METHODS	CREDIT:4 HOURS: 4/W

COURSE OBJECTIVES

1) Generating the special functions of polynomials and series
2) Introduce fundamentals of infinite and finite Integral transforms and applying differential equation and integral equation.
3) Use in special functions, Integral transforms and differential equations as tools for problem solving.

Unit I: Legendre Differential Equation and Legendre Functions Hours: 12

Generating functions of Legendre polynomial-Rodrigues's Formula for Legendre Polynomials- Orthogonal Properties of Legendre's polynomial - Recurrence Formulae for $P_n(x)$ – Expansion of Arbitary Functions in Series of Legendre polynomial.

Chapter:7.12 – 7.16 & 7.20

Unit II: Bessel's Differentiation Equation; Bessel's Functions of first kind and Second kind Hours: 12

Limiting values of $J_n(x)$ and $Y_n(x)$ –Differential Equations Reducible to Bessel"s Equation- Bessel"s Functions of third kind; Hankel Functions-Recurrence formulae for $J_n(x)$ –Generating Function for $J_n(x)$ –Jacobi Series- Bessel"s Integrals-Orthonormality of Bessel"s Functions.

Chapter: 7.22 – 7.30

Unit III: Fourier Equation of Heat flow Hours: 12

Solution of Heat Flow Equation: Method of Separation of Variables-Linear Flow in Semi – infinite solid- Variable Linear Flow in an Infinite Bar-Two-Dimensional Heat Flow-Three Dimensional Heat Flow- Heat Flow in Circular Plate(Use of Cylindrical coordinates.

Chapter: 9.7-9.13

Unit IV: Fourier Transform Hours:12

Properties of Fourier Transform- Fourier Transform of a Derivative- Fourier sine and cosine Transforms of Derivatives- Fourier Transform of Functions of Two or Three Variables- Finite Fourier Transforms –Simple Applications of Fourier Transforms

Chapter: 10.2-10.8

Unit V: Hours: 12

Properties of Laplace Transforms –Laplace Transform of the Derivative of a Function- Laplace Transform of Integral- Laplace Transform of Periodic functions-Laplace Transform of Some Special Functions- Inverse Laplace Transform – Properties of Inverse Laplace Transform - Evaluations of Inverse Laplace Transforms by Convolution Theorem- Method of Partial Fractions - Differential Equations - Applications of Laplace Transform

Chapter: 10.9-10.15, 10.17 & 10.19-10.22

COURSE OUTCOMES

1) Understand to Generating the special functions such as Legendre functions and Bessel‟s functions, basic properties, solving in differential equations.
2) Understand to solve the boundary value problems in such as a two and three dimension heat flow by using Fourier series.
3) Acquire a basic knowledge in Fourier transform of properties, Derivatives and its application of Differential Equations.
4) Acquire a basic knowledge in Laplace transform of properties, Derivatives and its application of Differential Equations.
5) Apply the acquired knowledge in solving applied problems

Text Books

1) SATYA PRAKASH, Mathematical Physics with Classical Mechanics, Sultan Chand & Sons, Educational Publishers, New Delhi, sixth revised 2012.

Supplementary Readings

1) Advanced Engineering & Sciences M.K.Venkataraman, The National Publishing Co.
2) F.B.Hildebrand. (1977) Advanced Calculus for Applications. Prentice Hall. New Jersey.
3) Engineering Mathematics Series, Veerarajan. T, Tata Mcgraw Hill Publication.
4) Advanced Engineering Mathematics, Erwin Kreyszing, fifth edition, Wiley Eastern pubishers, 1985.

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: III PART: CORE ELECTIVE-3	22PMATE35-3: THEORY OF RELATIVITY	CREDIT: 4 HOURS:4/W

COURSE OBJECTIVES

1) The main purpose of the course is to introduce students to understand the concepts of the Special Theory of Relativity and Relativistic Dynamics.
2) Students should be able to implement the methods taught in the course to work associated problems, including proving results of suitable accessibility in different field.

Unit I: Special Theory of Relativity **Hours: 12**

Galilean transformation – Maxwel's equations – The Ether theory – The principle of Relativity.

Chapter 7: 7.1

Unit II: Relativistic Kinematics **Hours: 12**

Relativistic Kinematics: Laurent's transformation equations - Events and simultaneity – Example – Einstein train – Time dilation – Longitudinal contraction.

Chapter 7: 7.2

Unit III: Relativistic Kinematics(Contd.) **Hours: 12**

Invariant interval – Proper time and proper distance – World line – Example – Twin paradox – Addition of velocities – Relativistic Doppler effect.

Chapter 7: 7.2 (Contd.)

Unit IV: Relativistic Dynamics **Hours: 12**

Momentum – Energy – Momentum-Energy four vector – Force – Conservation of energy – Mass and energy – Example – Inelastic collision – Principle of equivalence – Lagrangian and Hamiltonian formulations.

Chapter 7: 7.3

Unit V: Relativistic Dynamics(Contd.) **Hours: 12**

Accelerated Systems: Rocket with constant acceleration – Example – Rocket with constant thrust.

Chapter 7: 7.4

COURSE OUTCOMES

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

1) Understand Special Theory of Relativity terminologies and principle.
2) Discuss special theory of relativity concepts of Laurent"s transformation equations, Einstein train – Time dilation – Longitudinal contraction.
3) To learn the Relativistic Kinematics concepts of Invariant interval - Proper time and proper distance, Twin paradox, Addition of velocities and Relativistic Doppler effect.
4) To Understand the Relativistic Dynamics ideas of Momentum-Energy four vector, Conservation of energy, Lagrangian and Hamiltonian formulations

5) To Study the application of theory relativistic dynamics on Accelerated Systems, Rocket with constant acceleration and Rocket with constant thrust.

Text Books

1) D.T.Greenwood, Classical Dynamics, Prentice Hall of India, New Delhi, 1985.

Supplementary Readings

1) P.G.Bergman, An Introduction to Theory of Relativity, New York, 1942.
2) A.S.Eddington, The Mathematical Theory of Relativity, Cambridge

OUTCOME MAPPING

PO/CO	PO1	PO2	PO3	PO4	PO5
CO1	3	3	3	3	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: III PART: OPEN ELECTIVE-1	22PMATO36-1: ELEMENTARY NUMERICAL METHODS	CREDIT: 3 HOURS: 3/W

COURSE OBJECTIVES

1) To introduce wide range of range of numerical methods for solving mathematical problems.
2) To explore the concepts of Derivation and Analysis in numerical methods.
3) To Solve system of linear algebraic equations and interpolations.
4) To learn Solving techniques in Numerical integration & differentiation.
5) To upgrade the students to learn Numerical solution of ordinary differential equations.

Unit I: The solution of Numerical Algebraic and Transcendental Equations

Hours: 9

The Bisection Method or Bolzano's Method – Iteration Method or Method of Successive Approximations – The Regular Falsi Method or the Method of False Position – Newton Raphson's Method or Newton's Method.

Unit II: Solution of Simultaneous Linear Algebraic Equations Hours: 9

Direct Methods: Gauss Elimination Method – Gauss-Jordon Elimination Method – Inverse of a matrix using Gauss Elimination Method. **Iterative methods**: Jacobi Method of Iteration (Gauss-Jacobi Method) – Gauss Seidel Method of Iteration.

Unit III: Interpolation Hours: 9

For Equal Intervals: Introduction – Linear interpolation – Gregory Newton Forward and Backward interpolation Formula. Stirling's formula – Simple Problems.

For unequal intervals: Introduction **–** Divided Differences – Properties of Divided differences – Lagrange's interpolation formula, Inverse interpolation.

Unit IV: Numerical Differentiation and Integration Hours: 9

Differentiation: Introduction – Newton's forward difference formula to compute the derivative – Newton's backward difference formula to compute the derivative - Derivatives using Stirling's formula.

Integration: The Trapezoidal Rule -Simpson's 1/3 rule and 3/8 rules – Practical Applications.

Unit V: Numerical Solution of Ordinary Differential Equations Hours: 9

Euler's Method – Improved Euler Method – Modified Euler Method – Second order Runge-Kutta Method – Higher order Runge - Kutta method (III & IV order).

COURSE OUTCOMES

After completion of this course the student will be able to

1) Obtain numerical solution of algebraic and transcendental equation.
2) Learn about interpolation with evenly and unevenly spaced points.
3) Develop logical skills in Solving numerical differentiation and integration.
4) Obtain numerical solution of ordinary differential equations.
5) Develop and apply the appropriate Numerical techniques in various Science and Engineering problems, interpret the results and assess accuracy.

Text Books

1) P. Kandasamy, K. Thilagavathy and K. Gunavathi, Content and treatment as in the book Numerical Methods, S. Chand & Company Pvt. Ltd., New Delhi, 2013.

Supplementary Readings

1) M.K. Venkataraman, Content and treatment as in the book Numerical Methods in Science and Engineering, The National Publishing Company, Madras, 1991.
2) S.S. Sastry, Content and treatment as in the book Introductory Methods of Numerical Analysis by Prentice Hall of India (P) Ltd. 1994.
3) E. Balagurusamy, Numerical Methods, Tata McGraw-Hill Publishing Company Ltd, New Delhi, 2002.

OUTCOME MAPPING

PO/CO	PO1	PO2	PO3	PO4	PO5
CO1	3	3	3	3	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:III PART: OPEN ELLECTIVE-2	22PMATO36-2:OPERATIONS RESEARCH	CREDIT:3 HOURS:3/W

COURSE OBJECTIVE

To introduce Linear Programming Problems

1) To study the Artificial Variable Techniques
2) To understand the Games and Strategies
3) To understand some types of Inventory Problems
4) To understand some types of Queueing Problems

Unit I: Linear Programming Problems

Introduction of Linear Programming Problems, slack, surplus, artificial variables Graphical method, Simplex method, applications of simplex method.

(9 Hours)

Unit II: LPP (Continued)

Formulating a Dual Problem, Dual simplex method, Big-M method, Two Phase simplex method. (simple problems only). (9 Hours)

Unit III: GAME THEORY

Introduction, Some basic terms, the maximin-minimax principle, game without saddle points-mixed strategies, graphical solutions of 2 x n and m x 2 games.

(9 Hours)

Unit IV: INVENTORY THEORY

Introduction, concept of EOQ , Deterministic inventory problems with no shortages, the fundamental problem of EOQ , Problem of EOQ with several production runs of unequal length, problem of EOQ with finite replenishment, Deterministic inventory problems with shortages (simple problems only).

(9 Hours)

Unit V: QUEUEING THEORY

Introduction, queueing system, elements of a queueing system, operating characteristics of a queueing system, deterministic queueing system, classification of queueing system, (M/M/1): (∞/ FIFO) model, (M/M/1): (N/ FIFO) model, (M/M/C): (∞/ FIFO) model. (9 Hours)

COURSE OUTCOMES

1) Understand the concept of the Linear Programming Problems.
2) Understand the concept of the Artificial Variable Technique.
3) Understand the concept of the Games and Strategies.
4) Understand the Inventory Problems.
5) Understand the Queueing Problems

Text Books

1) Operations Research . Kanti Swarup, P.K. Gupta, Man Mohan.(Sultan Chand & Sons) Sixteenth Thoroughly Revised Edition.

Supplementary Readings

1) Hamdy A. Taha, Operations Research (Sixth Edition) Prentice-Hall of India Private Limited, New Delhi, 1997.
2) Panneerselvam.R, Operations Research, 2nd Edition, PHI Learning Private Limited, Delhi, 2015.
3) Prem kumar Gupta.Er, Hira.D.S. , Operations Research, 7th Edition, S.Chand & Company Pvt.Ltd.2014.

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	3	3	3	3	3

SEMESTER:III PART: OPEN ELECTIVE -3	22PMATO36-3: MATHEMATICS FOR COMPETITIVE EXAMINATIONS	CREDIT: 3 HOURS: 3/W

COURSE OBJECTIVES

1) To enrich the problem solving skills.
2) To acquire knowledge to write the competitive examinations.
3) To solve problems using visual reasoning.

Unit I **Hours:9**

HCF and LCM of numbers.

Unit II **Hours: 9**

Profit, Loss and Discount.

Unit III **Hours:9**

Simple Interest

Unit IV **Hours: 6**

Compound Interest

Unit V **Hours:9**

Races

COURSE OUTCOMES

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

1) Recognize, describe and represent numbers and their relationships
2) Estimate, calculate with competence and confidence in solving problems
3) To inculcate the habit of self –learning.
4) Understand compound interest clearly.
5) Understand the strategies of races.

Text Books

1) Abhijit Guha, 'Quantitative Aptitude for competitive examinations', Fourth edition, Tata McGraw Hill Education private limited, 2011.
   Unit - I : Chapter 2, Sections 2.1 to 2.7, solved examples.
   Unit - II : Chapter 13, Sections 13.1 to 13.11, solved examples.
   Unit - III : Chapter 14, Sections 14.1 to 14.6, solved examples.
   Unit - IV : Chapter 15, Sections 15.1 to 15.9, solved examples.
   Unit - V : Chapter 20, Sections 20.1 to 20.3, solved examples.

Supplementary Readings

1) R.S. Aggarwal, 'A modern approach to non-verbal reasoning ', S.chand and company Ltd., New Delhi, 2007.

OUTCOME MAPPING

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

SEMESTER – IV CORE – XIII	22PMATC41: FUNCTIONAL ANALYSIS	CREDITS – 4 HOURS – 6/W

COURSE OBJECTIVES

This course introduces functional analysis and perator theoretic concepts. This area combines ideas from linear algebra and analysis in order to handle infinite-dimensional vector spaces and linear mappings thereof.

Unit I: BANACH SPACES (18 Hours)

Banach spaces - Definition and examples - Continuous Linear Transformations – Hahn Banach Theorem.

Chapter 9: Sections 46 to 48.

Unit II: BANACH SPACES (18 Hours)

The natural embedding of N in N** - Open mapping theorem - Conjugate of an operator

Chapter 9: Sections 49 to 51.

Unit III: HILBERT SPACE (18 Hours)

Hilbert space - Definition and properties - Orthogonal complements - Orthonormal sets - Conjugate space H* - Adjoint of an operator.

Chapter 10: Sections 52 to 56.

Unit IV: OPERATIONS ON HILBERT SPACES (18 Hours)

Self-adjoint operator - Normal and Unitary Operators – Projections.

Chapter 10: Sections 57 to 59.

Unit V: BANACH ALGEBRAS (18 Hours)

Banach Algebras - Definition and examples - Regular and simgle elements - Topological divisors of zero - spectrum - the formula for the spectral radius - the radical and semi-simplicity.

Chapter 12: Sections 64 to 69.

COURSE OUTCOMES

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

1) Appreciate how ideas from different areas of mathematics combine to produce new tools that are more powerful than would otherwise be possible.
2) Understand how functional analysis underpins modern analysis.
3) Develop their mathematical intuition and problem-solving capabilities, especially in predicting the space in which the solution of a partial differential equation belongs to.
4) Learn advanced analysis in terms of Sobolev spaces, Besov spaces, Orlicz spaces and other distributional spaces.
5) Definition and examples of Banach Algebras – To understand the Regular and simple elements, radical and semi-simplicity

Text Books

1) G.F.Simmons, Introduction to topology and Modern Analysis, McGraw Hill International Book Company, New York, 1963.

Supplementary Readings

1) W. Rudin *Functional Analysis,* Tata McGraw-Hill Publishing Company, New Delhi, 1973.
2) H.C. Goffman and G. Fedrick, *First Course in Functional Analysis,* Prentice Hall of India, New Delhi, 1987.
3) Bela Bollobas, *Linear Analysis an introductory course,* Cambridge Mathematical Text books, Cambridge University Press, 1990.
4) D. Somasundaram, *Functional Analysis,* S. Viswanathan Pvt. Ltd., Chennai, 1994.
5) G. Bachman &L.Narici, *Functional Analysis* Academic Press, New York, 1966.
6) E. Kreyszig*Introductory Functional Analysis with Applications*, John wiley& Sons, New York.,1978.

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:IV PART: CORE XIV	22PMATC42: FLUID DYNAMICS	CREDIT: 4 HOURS: 6/W

COURSE OBJECTIVES

1) To know the knowledge about fluid particles in steady and unsteady compressible and incompressible flows.
2) To provide the basic knowledge of two and three dimensional potential flows.
3) To apply the viscous flow in some real life situations.

Unit I: **Hours: 18**

Real fluids and ideal fluids – Velocity of a fluid at a point – Streamlines and path lines; steady and unsteady flows – The velocity potential – The vorticity vector – Local and particle rates of change – The equation of continuity – Worked examples – Acceleration of a fluid – Pressure at a point in a fluid at rest – Pressure at a point in moving fluid – Conditions at a boundary of two invisid Immiscible fluids.

Unit II: **Hours: 18**

Euler's equations of motions – Bernoulli's equation – Worked examples – Some flows involving axial symmetry – Some special two – dimensional flows – Some three – dimensional flows: Introduction – sources, sinks and doublets – Axi – symmetric flows; Stokes stream function.

Unit III: **Hours: 18**

Some two – dimensional flows: Meaning of a two – dimensional flow – use of cylindrical polar coordinates – The stream function – The complex potential for two – dimensional, irrotational, incompressible flow – Complex velocity potentials for standard two dimensional flows – Some worked examples.

Unit IV: **Hours: 18**

Stress components in real fluid – Relations between cartesian components of stress - Translational motion of fluid element – The rate of strain quadric and principal stresses – Some further properties of the rate of strain quadric.

Unit V: **Hours: 18**

The coefficient of viscosity and Laminar flow – The Navier – Stokes equations of motions of a viscous fluid. Some solvable problems in viscous flow – steady viscous flow in tubes of uniform crass section.

COURSE OUTCOMES

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

1) Identify and obtain the values of fluid properties and relationship between them and understand the principles of continuity, momentum, and energy as applied to fluid motions.
2) Recognize these principles written in form of mathematical equations.
3) Apply dimensional analysis to predict physical parameters that influence the flow in fluid dynamics.

4) Understand stress components and rate of strain quadric.
5) Understand Viscosity, Laminar flow, Viscous flow.

Text Books

1) F.Charlton, Content and Treatment as in Text Book of Fluid Dynamics, CBS Publishers and Distributors, New Delhi, 1985.

Unit - I : Chapter II, Sections 2.1 to 2.9 and
Chapter III, Sections 3.1 to 3.3

Unit - II : Chapter III, Sections 3.4 to 3.6, 3.9, 3.10
Chapter IV, Sections 4.1, 4.2, 4.5

Unit - III : Chapter V, Sections 5.1 to 5.6

Unit - IV : Chapter VIII, Sections 8.1 to 8.5

Unit - V : Chapter VIII, Sections 8.8 to 8.12

Supplementary Readings

1) G.K. Batchaelor, An Introduction to Fluid Mechanics, Foundation Books, New Delhi, 1994.
2) S.W. Yuan, Foundations of Fluid Mechanics, Prentice Hall of India Pvt. Ltd., New Delhi, 1976.
3) R.K. Rathy, An Introduction to Fluid Dynamics, IBH Publ. Comp. New Delhi, 1976.
4) Pijush K. Kundu, Ira M. Cohen and David R. Dowling, Fluid Mechanics, Fifth Edition, 2010.

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: IV PART: CORE XV	22PMATC43: GRAPH THEORY	CREDIT: 4 HOURS: 6/W

COURSE OBJECTIVES

1) To understand and apply the fundamental concepts in graph theory.
2) To apply graph theory based tools in solving practical problems.
3) To understand the Eulerian graphs and Hamiltonian graphs.
4) To introduce the idea of coloring in graphs.
5) To develop the understating of Geometric Duals in Planar graphs.

Unit I: Basic concepts **Hours: 18**

Graphs – Subgraphs – Degrees of vertices – Paths and connectedness – Automorphism of a simple graph, Line Graphs. Connectivity: Vertex cuts and Edge cuts – Connectivity and edge – connectivity, Blocks.

Unit II: Trees **Hours: 18**

Trees – Characterization and Simple properties. Independent sets and Matchings: Vertex Independent sets and Vertex Coverings – Edge-Independent Sets – Matchings and Factors, Matchings in Bipartite Graphs (except the proof of Tutte's 1-factor theorem).

Unit III: **Hours: 18**

Eulerian Graphs. Hamiltonian Graphs.

Unit IV: Graph Colorings **Hours: 18**

Vertex Colorings – Critical Graphs – Brooks' Theorem. Edge Colorings of Graphs – Vizing's Theorem – Chromatic Polynomials.

Unit V: Planar graphs **Hours: 18**

Planar and Nonplanar Graphs – Euler's Formula and its Consequences – K_5 and $K_{3,3}$ are Nonplanar graphs – Dual of a Plane Graph – The Four Color Theorem and the Heawood Five-Color Theorem – Hamiltonian plane graphs.

COURSE OUTCOMES

After completion of this course the student will be able to

1) Understand the basics of graph theory and their various properties.
2) Develop Models using graphs and to solve the problems algorithmically.
3) Apply graph theory concepts to solve real world applications like routing, TSP/traffic control, etc.
4) Analyse the significance of graph theory in different engineering disciplines.
5) Understand the applications of duality and planarity o graphs.

Text Books

1) R. Balakrishnan and K. Ranganathan, A Textbook of Graph Theory (Universitext), Second Edition, Springer, New York, 2012.

Supplementary Readings

1) Douglas B. West, Introduction to Graph Theory, Second Edition, PHI Learning Private Ltd, New Delhi, 2011.
2) J.A. Bondy and U.S.R. Murty, Graph Theory, Springer, 2008.
3) M.Murugan, Graph Theory and Algorithms, Second Edition, Muthali Publishing House, Annanagar, Chennai, 2018.

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	2	3
CO5	2	3	3	3	2

SEMESTER: IV PART: CORE ELECTIVE – 1	22PMATE44-1: PROGRAMMING in C++	CREDITS: 4 HOURS: 4/W

COURSE OBJECTIVES

The main objective of this course are

1) To learn the basic knowledge of C language as pre-requisites
2) To enable the students to write the C++ programs using classes, functions and interfaces
3) To develop programming skills in C++ with its object-oriented concepts
4) To make applications using C++ programs.

Unit I: (Tokens, Expressions and Control Structure) Hours: 12

Basic Concept of Object – Oriented Programming – Benefits of OOP – Applications of OOP – Tokens, Expressions and Control Structure: Introduction – Tokens – Keywords – Identifiers and Constants – Basic Data Types – User Defined Data Types – Storage Classes – Derived Data Types – Symbolic Constants – Type Compatibility – Declaration of Variables – Dynamic Initialization of Variables – Reference variables – Operators in C++ – Scope Resolution Operators – Operator Over Loading – Control Structures.

Unit II: (Functions C++) Hours: 12

Introduction – The Main Function – Function Prototyping – Call by Reference – Return by Reference – Inline Functions – Default Arguments – Const Arguments – Recursion – Function over Loading – Friend and Virtual Functions – Math Library Functions.

Unit III: (Classes and Objects & Constructors and Destructors) Hours: 12

Classes and Objects: Introduction – C Structures Revised – Specifying a Class – Defining Member Functions – C++ program with class – Making an Outside Function Inline – Nesting of Member Functions – Private Member Functions – Arrays Within a Class – Arrays of Objects – Objects as Function Arguments – Friendly Functions.

Constructors and Destructors: Introduction – Constructors – Parameterized Constructors – Multiple Constructors in a Class – Constructors with Default Arguments – Dynamic Initializations of Objects – Copy Constructors – Destructors.

Unit IV: (Operator Overloading, Inheritance and Extending Classes) Hours: 12

Operator Overloading: Introduction – Defining operators Overloading – Overloading Unary Operators – Overloading Binary Operators – Overloading Binary Operators Using Friends – Manipulating of Strings Using Operators – Rules for Overloading Operators.

Inheritance and Extending Classes: Introduction – Defining Derived Classes – Single Inheritance – Making a Private Member Inheritable – Multilevel Inheritance – Multiple Inheritance – Hierarchical Inheritance – Hybrid Inheritance – Virtual Base Classes – Abstract Classes.

Unit V: (Streams and Working with files) **Hours: 12**

Streams: Introduction – C++ Streams – C++ Stream Classes.

Working with files: Classes for File Stream Operations – Opening and Closing a File – Detecting End-of-File – File Modes – File Pointers and their Manipulations – Sequential Input and Output Operations – Random Access.

COURSE OUTCOMES

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

1) Understand and apply the C++ structure, tokens, expressions, control structures
2) Ability to declare various prototyping, friend and virtual functions
3) Create Classes, objects, arrays of objects, constructers, and Destructors
4) Analyze over loading operators and inheritance
5) Deliberate files, pointers and templates, create design and develop quality programs in C++.

Text Books

1) E. Balaguruswamy, Object – Oriented Programming with C++, 6th Edition, Tata McGraw – Hill Publishing Company Limited, New Delhi, 2013.

UNIT – I – Chapter I (Sections: 1.5, 1.6 and 1.8)
Chapter III (Sections: 3.1 to 3.15, 3.23 and 3.25)

UNIT – II – Chapter IV (Sections: 4.1 to 4.12)

UNIT – III – Chapter V (Sections: 5.1 to 5.9 and 5.13 to 5.15)
Chapter VI (Sections: 6.1 to 6.7 and 6.11)

UNIT – IV – Chapter VII (Sections: 7.1 to 7.6 and 7.8)
Chapter VIII (Sections: 8.1 to 8.10)

UNIT – V – Chapter X (Sections: 10.1 to 10.3)
Chapter XI (Sections: 11.1 to 11.8)

Supplementary Readings

1) Programming with C++ BY D. Ravichandran, Tata McGraw – Hill Publishing Company Limited New Delhi, 2006.
2) Object – Oriented Programming with C++ by S.S Vinod Chandra, New age.
3) H. Schildt, The Complete Reference of C++ , Tata – McGraw – Hill Publishing Company Limited, New Delhi, 2003.

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-IV CORE ELECTIVE- 2	22PMATE44-2: MATHEMATICAL MODELLING	CREDIT- 4 HOURS - 4/W

COURSE OBJECTIVES

1) To study the mathematical models through ODE and difference equations.
2) This course aims to train the students to get essential knowledge to develop mathematical models in real life problems.

Unit I: Mathematical Modelling : Need, Techniques, Classification and Simple Illustrations Hours:12

Simple Situations Requiring Mathematical Modelling-The Techniques of Mathematical Modelling- Classification of Mathematical Models-Some Characteristics of Mathematical Models-Mathematical Modelling Through Geometry-Mathematical Modelling Through Algebra- Mathematical Modelling Through Trigonometry- Mathematical Modelling through Calculus-Limitations of Mathematical Modelling .

Unit II: Mathematical Modelling through Ordinary Differential Equations of First Order Hours:12

Mathematical Modelling through Differential Equations- Linear Growth and Decay Models-Non- Linear Growth and Decay Models-Compartment Models-Mathematical Modelling in Dynamics Through Ordinary Differential Equations of First Order- Mathematical Modelling of Geometrical Problems Through Ordinary Differential Equations of First Order.

Unit III: Mathematical Modelling through Systems of Ordinary Differential Equations of the First Order Hours:12

Mathematical Modelling in Population Dynamics- Mathematical Modelling of Epidemics Through Systems of Ordinary Differential Equations of First Order-Compartment Models Systems of Ordinary Differential Equations- Mathematical Modelling in Economics through Systems of Ordinary Differential Equations of First Order- Mathematical Models in Medicine, Arms Race, Battles and International Trade in Terms of Systems of Ordinary Differential Equations-Mathematical Modelling in Dynamics Through Ordinary Differential Equations of First Order.

Unit IV: Mathematical Modelling Through Difference Equations. Hours:12

The need for Mathematical Modelling through Difference Equations: Some Simple Models- Basic Theory of Linear Difference Equations With Constant Coefficients- Mathematical Modelling through Difference Equations in Economics and Finance- Mathematical Modelling through Difference Equations in Population Dynamics and Genetics- Mathematical Modelling through Difference Equations in Probability Theory- Miscellaneous Examples of Mathematical Modelling through Difference Equations.

Unit V: Mathematical Modelling Through Functional Integral , Delay –Differential and Differential- Difference Equations Hours:12

Mathematical Modelling Through Functional Equations- Mathematical Modelling Through Integral Equations- V Mathematical Modelling Through Delay – Differential and Differential- Difference Equations.

COURSE OUTCOMES

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

1) To learn the concepts of Mathematical Modelling Techniques.
2) To understand the ideas of Mathematical Modelling through ODE of first order.
3) To develop the Mathematical Models through systems of ODE of first order.
4) To know the techniques of Mathematical Modelling through Difference equations.
5) To study the Mathematical Models through Differential - Difference equations

Text Boks

Mathematical Modelling –J.N.Kapur, Wiley Eastern Limited

Unit I- Chapter 1

Unit II- Chapter 2

Unit III- Chapter 3

Unit IV- Chapter 5

Unit V- Chapter 8

Supplementary Readings

1) Giordano,F.R.,Fox,W.P.& Horton, S.B., A First course in Mathematical Modelling, Cenage Learning, First Indian Reprint(2015).
2) Rutherford, A., Mathematical Modelling Techniques, Courier Corporation(2012).

OUTCOME MAPPING

PO/CO	PO1	PO2	PO3	PO4	PO5
CO1	3	3	3	3	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: IV PART: CORE ELECTIVE-3	22PMATE44-3: NUMERICAL METHODS	CREDIT: 4 HOURS: 4/W

COURSE OBJECTIVES

1) To introduce wide range of range of numerical methods for solving mathematical problems.
2) To explore the concepts of Derivation and Analysis in numerical methods.
3) To Solve system of linear algebraic equations and interpolations.
4) To learn Solving techniques in Numerical integration & differentiation.
5) To upgrade the students to learn Numerical solution of ordinary differential equations.

Unit I: The solution of Numerical Algebraic and Transcendental Equations:

Hours: 12

The Bisection Method or Bolzano's Method – Iteration Method or Method of Successive Approximations – The condition and order of convergence of an iterative process – The Regular Falsi Method or the Method of False Position – Newton Raphson's Method or Newton's Method.

Unit II: Solution of Simultaneous Linear Algebraic Equations: Hours: 12

Direct Methods: Gauss Elimination Method – Gauss-Jordon Elimination Method – Inverse of a matrix using Gauss Elimination Method - Method of Triangularisation (Method of Factorization) – Crout's Method. **Iterative methods**: Jacobi Method of Iteration (Gauss-Jacobi Method) – Gauss Seidel Method of Iteration.

Unit III: Interpolation Hours: 12

For Equal Intervals: Introduction – Linear interpolation – Gregory Newton Forward and Backward interpolation Formula – Equidistant terms with one or more missing values.

For unequal intervals: Introduction **–** Divided Differences – Properties of Divided differences – Lagrange's interpolation formula, Inverse interpolation.

Unit IV: Numerical Differentiation and Integration Hours: 12

Differentiation: Introduction – Newton's forward difference formula to compute the derivative – Newton's backward difference formula to compute the derivative - Derivatives using Stirling's formula.

Integration: The Trapezoidal Rule -Simpson's 1/3 rule and 3/8 rules – Practical Applications.

Unit V: Numerical Solution of Ordinary Differential Equations: Hours: 12

Solutions by Taylor Series – Euler's Method – Improved Euler Method – Modified Euler Method – Second order Runge-Kutta Method – Higher order Runge - Kutta method (III & IV order).

COURSE OUTCOMES

After completion of this course the student will be able to

1) Obtain numerical solution of algebraic and transcendental equation.
2) Learn about interpolation with evenly and unevenly spaced points.
3) Develop logical skills in Solving numerical differentiation and integration.
4) Obtain numerical solution of ordinary differential equations.
5) Develop and apply the appropriate Numerical techniques in various Science and Engineering problems, interpret the results and assess accuracy.

Text Books

1) P. Kandasamy, K. Thilagavathy and K. Gunavathi, Content and treatment as in the book Numerical Methods, S. Chand & Company Pvt. Ltd., New Delhi, 2013.

Supplementary Readings

1) M.K. Venkataraman, Content and treatment as in the book Numerical Methods in Science and Engineering, The National Publishing Company, Madras, 1991.
2) S.S. Sastry, Content and treatment as in the book Introductory Methods of Numerical Analysis by Prentice Hall of India (P) Ltd. 1994.
3) E. Balagurusamy, Numerical Methods, Tata McGraw-Hill Publishing Company Ltd, New Delhi, 2002.

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	2	3
CO5	2	3	3	3	2