BON SECOURS COLLEGE FOR WOMEN (AUTONOMOUS)

Accredited with A++ Grade by NAAC in Cycle II

Affiliated to Bharathidasan University, Tiruchirappalli

UGC Recognized 2(f) and 12(B) Institution

VILAR BYPASS, THANJAVUR - 613 006, TAMIL NADU

DEPARTMENT OF MATHEMATICS

PROGRAMME : M.SC., MATHEMATICS

SYLLABUS

FIRST SEMESTER

CORE THEORY I

ALGEBRA – 24PMA101

Course Outcome:

Unit	CO	Upon Completion of this Course the Students will be able to	Cognitive Level
Unit - I	CO 1	Remember in the basic concepts of group theory with the help of numerous examples	K1 – K5
Unit - II	CO 2	Explain Cayley's and Sylow's Theorem and its applications	K1 – K5
Unit - III	CO 3	Understand the polynomial rings, inner product spaces.	K1 – K5
Unit - IV	CO 4	Apply the concept roots of polynomial to find the roots of the polynomial.	K1 – K5
Unit - V	CO 5	Demonstrate knowledge that the rational numbers and real numbers can be ordered and that the complex numbers cannot be ordered, but that any polynomial equation with real coefficients can be solved in the complex field.	K1 – K5

K1 - Remember; **K2** – Understand; **K3** – Apply; **K4** – Analyze; **K5** – Evaluate

SYLLABUS

UNIT I:

Definition of a group – Some Examples of Groups - Subgroups – A counting Principle – Normal Subgroups and Quotient Groups.

UNIT II:

Cayley's Theorem – Permutation Groups – Another Counting Principle – Sylow's Theorem

UNIT III:

Definition and Examples of Rings – Some Special Classes of Rings – Homomorphisms – Ideals and Quotient Rings – More Ideals and Quotient Rings

UNIT IV:

Euclidean Rings – A Particular Euclidean Ring – Polynomial Rings – Polynomial over the Rational Field

UNIT V:

Extension Fields – Roots of Polynomials – More About Roots – The Elements of Galois Theory

Text Book :

1. Herstein I. N, Topics in Algebra, Second Edition, Wiley Eastern Limited.

    UNIT – I - Chapter 2: Sec 2.1,2.2,2.4,2.5,2.6

    UNIT – II - Chapter 2: Sec 2.9,2.10,2.11,2.12

    UNIT – III - Chapter 3: Sec 3.1,3.2,3.3,3.4,3.5

    UNIT - IV - Chapter 3: Sec 3.7,3.8,3.9,3.10

    UNIT - V - Chapter 5: Sec 5.1, 5.3, 5.5, 5.6

CORE THEORY II

REAL ANALYSIS – 24PMA102

Course Outcome:

Unit	CO	Upon Completion of this Course the Students will be able to	Cognitive Level
Unit - I	CO 1	Understand and utilize the concepts of perfect sets and connected sets in topological spaces.	K1 – K6
Unit - II	CO 2	Recognize and classify different types of discontinuities in functions.	K1 – K6
Unit - III	CO 3	Understand the relationship between a function's continuity and the continuity of its derivatives.	K1 – K6
Unit - IV	CO 4	Demonstrate an understanding the theory of function of bounded variations, Sequence of functions, Riemann Stieltjes Integral	K1 – K6
Unit - V	CO 5	Apply concepts such as uniform convergence to continuity and differentiation and utilize the Stone-Weierstrass Theorem to approximate functions.	K1 – K6

K1 - Remember; **K2** – Understand; **K3** – Apply; **K4** – Analyze; **K5** – Evaluate; **K6** - Create

SYLLABUS

UNIT I:

Basic Topology: Finite, Countable and uncountable Sets – Metric spaces – Compact sets – Perfect sets – Connected sets. Numerical Sequences and series: Sequences – Convergence – Subsequences – Cauchy Sequences – Upper and Lower Limits – Some Special Sequences – Tests of convergence – Power series – Absolute convergence – Addition and multiplication of series – Rearrangements.

UNIT II:

Continuity: Limits of functions – Continuous Functions – Continuity and compactness – Continuity and connectedness – Discontinuities – Monotonic Functions – Infinite Limits and Limits at Infinity.

UNIT III:

Differentiation: The Derivative of a Real Function – Mean Value Theorems – The Continuity of Derivatives – L'Hospital's Rule – Derivatives of Higher Order – Taylor's Theorem – Differentiation of Vector-valued Functions.

UNIT IV:

The Riemann – Stieltjes Integral: Definition and Existence of the Integral – Properties of the Integral – Integration and Differentiation – Integration of vector valued Functions.

UNIT V:

Sequences and series of functions: Uniform Convergence and Continuity – Uniform Convergence and Differentiation – Equicontinuous families of functions – The Stone – Weierstrass Theorem.

Text Book :

1. Walter Rudin, (1976), Principles of Mathematical Analysis, Third Edition, Mcgraw Hill

   UNIT – I Chapters 2 and 3

   UNIT – II Chapter 4

   UNIT – III Chapter 5

   UNIT – IV Chapter 6

   UNIT – V Chapter 7

CORE THEORY III

ORDINARY & PARTIAL DIFFERENTIAL EQUATIONS – 24PMA103

Course Outcome:

Unit	CO	Upon Completion of this Course the Students will be able to	Cognitive Level
Unit – I	CO 1	Understand the genesis of ordinary differential equations.	K1 – K5
Unit – II	CO 2	Learn various techniques of getting exact solutions of solvable first order Differential equations and linear differential equations of higher order.	K1 – K5
Unit - III	CO 3	Understand Picard's method of obtaining successive approximations of solutions of first order differential equations, passing through a given point in the plane and Power series method for higher order linear equations, especially in cases when there is no method available to solve such equations.	K1 – K5
Unit – IV	CO 4	Classify first order partial differential equations and their solutions.	K1 – K5
Unit – V	CO 5	Solve first order equations and nonlinear partial differential equations using various methods.	K1 – K5

K1 - Remember; **K2** – Understand; **K3** – Apply; **K4** – Analyze; **K5** – Evaluate

SYLLABUS

UNIT I:

The General solution of the homogeneous equation – The method of variation of parameters – Power series solutions. A review of power series – Series solutions of first order equations – Second order linear equations-Ordinary points.

UNIT II:

Regular Singular Points – Gauss's hyper geometric equation – The point at infinity – Legendre Polynomial – Bessel function – Properties of Legendre Polynomials and Bessel functions.

UNIT III:

Linear Systems of First Order Equations – Homogeneous Equations with Constant Coefficients – The Existence and Uniqueness of solutions of initial Value Problem for First Order Ordinary Differential Equations – The Method of Solutions of Successive Approximations and Picard's Theorem.

UNIT IV:

Partial differential equations – origins of first order partial differential equations – Cauchy's Problem for first order equations – Linear equations of the first order – Integral surfaces Passing through a Given curve – Surfaces Orthogonal to a given system of surfaces – Nonlinear Partial differential equations of the first order.

UNIT V:

Cauchy's method of characteristics – compatible systems of first order equations – Charpit's method – Special Types of first order equations – Solutions satisfying given conditions – Jacobi's method.

Text Books :

1. Simmons G.F, (1984), Differential Equations with Applications and Historical notes, THM, New Delhi
   UNIT – I – Chapter 3: Sections 15, 16, 19 and Chapter 5 : Sections 25 to 27
   UNIT – II – Chapter 5: Sections 28 to 31 and Chapter 6: Sections 32 to 5
   UNIT – III – Chapter 7: Sections 37, 38 and Chapter 11: Sections 55,56
2. Ian N. Sneddon, (2006), Elements of Partial differential equations, Dover Publication – INC
   UNIT – IV – Chapter II Sections 1 to 7.
   UNIT – V – Chapter III Sections 8 to 13.

CORE LABORATORY - I

OPTIMIZATION TECHNIQUES – 24PMA301

Course Outcome:

CO	Upon Completion of this Course the Students will be able to	Cognitive Level
CO 1	Understand the Cast engineering minima/maxima problems into optimization framework.	K1 – K6
CO 2	Learn efficient computational procedures to solve optimization problems.	K1 – K6
CO 3	Use Matlab to implement important optimization methods.	K1 – K6

K1 - Remember; **K2** – Understand; **K3** – Apply; **K4** – Analyze; **K5** – Evaluate; **K6** - Create

SYLLABUS

1. Matrix operations in Matlab
2. Differentiation of a vector in Matlab
3. Integration of a vector in Matlab
4. Simplex algorithm in Matlab
5. Implementation of Newton's method in Matlab
6. Implementation of Secant method in Matlab
7. Implementation of Lagrange multiplier method in Matlab
8. Implementation of KKT theorem in Matlab
9. Implementation of BFGS method in Matlab

ELECTIVE THEORY - I

FUZZY MATHEMATICS – 24PMA204

Course Outcomes:

Unit	CO	Upon Completion of this Course the Students will be able to	Cognitive Level
Unit - I	CO 1	Understand basic knowledge of the fuzzy sets, operations and their properties	K1 – K5
Unit - II	CO 2	Understand the fundamental concepts of Fuzzy functions and Fuzzy logic	K1 – K5
Unit - III	CO 3	Apply the concepts of Fuzzy sets in image processing, pattern reorganization and decision making.	K1 – K5
Unit - IV	CO 4	Apply the concepts of Fuzzy logic in image processing.	K1 – K5
Unit - V	CO 5	Demonstrate the applications of fuzzy sets.	K1 – K5

K1 - Remember; **K2** – Understand; **K3** – Apply; **K4** – Analyze; **K5** – Evaluate

SYLLABUS:

UNIT – I:

Crisp Sets – Basic Types - Basic Concepts – Additional Properties of α – Cuts – Representations of Fuzzy Sets.

UNIT – II:

Types of Operations – Fuzzy Complements – Fuzzy intersections t – Norms – Fuzzy Unions t- Co norms.

UNIT –III:

Fuzzy Numbers – Linguistic Variables – Arithmetic operations on Intervals – Arithmetic Operations on Fuzzy Numbers

UNIT – IV:

Binary Fuzzy Relations – Binary Relations on a Single Set – Equivalence Relations – Fuzzy Compatibility Relations

UNIT – V:

Fuzzy Measures – Evidence Theory – Possibility Theory – Fuzzy Sets and Possibility Theory.

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.

   Unit – I Chapter 1 Sec 1.3, 1.4, Chapter 2 Sec 2.1, 2.2

   Unit – II Chapter 3 Sec 3.1, 3.2, 3.3, 3.4

   Unit – III Chapter 4 Sec 4.1, 4.2, 4.3, 4.4

   Unit – IV Chapter 5 Sec 5.3, 5.4, 5.5, 5.6

   Unit – V Chapter 7 Sec 7.1, 7.2, 7.3, 7.4

ELECTIVE THEORY - II

MATHEMATICAL FOUNDATION FOR DATA SCIENCE – 24PMA210

Course Outcome:

Unit	CO	Upon Completion of this Course the Students will be able to	Cognitive Level
Unit - I	CO 1	Construct Mathematical arguments that relate to the study of Introductory Linear Algebra.	K1 – K5
Unit - II	CO 2	Use the definition and Properties of Linear Transformations and Matrices of linear transformations and change of basis.	K1 – K5
Unit - III	CO 3	Ability to use the Determinant concepts in the field of data science.	K1 – K5
Unit - IV	CO 4	Analyze finite and infinite dimensional vector spaces and subspaces over a field and their properties, including the basis structure of vector spaces.	K1 – K5
Unit - V	CO 5	Apply logical thinking to understand and solve the problem in context.	K1 – K5

K1 – Remember; **K2** – Understand; **K3** – Apply; **K4** – Analyze; **K5** – Evaluate

SYLLABUS:

UNIT – I:

System of Linear Equations: Introduction to System of Linear Equations – Row Reduction and Echelon Forms – Vector Equations – The Matrix Equation Ax=b - Solution Sets of Linear Systems - Applications of Linear Systems.

Unit – II:

Matrix Algebra: Matrix Operations – The Inverse of a Matrix – Characterization of Invertible Matrices – Partitioned Matrices – Matrix Factorizations.

Unit – III:

Determinants: Introduction to Determinants – Properties of Determinants – Cramer's Rule, Volume and Linear Transformations.

Unit – IV:

Vector Spaces: Vector Spaces and Subspaces – Null Spaces, Column Spaces, and Linear Transformations – Linearly Independent Sets: Bases – Coordinate Systems – The Dimension of a Vector Space.

Unit – V:

Eigen Values and Eigen Vectors: Eigen Vectors and Eigen Values – The Characteristic Equation – Diagonalization – Eigen Vectors Linear Transformations – Complex Eigen Values.

Text Book:

1. Linear algebra with Applications by David C Lay, Fifth edition Pearson, 2012.

   Unit – I: Chapter 1: Sec 1.1 – 1.6
   Unit – II: Chapter 2: Sec 2.1 – 2.5
   Unit – III: Chapter 3: Sec 3.1 – 3.3
   Unit – IV: Chapter 4: Sec 4.1 – 4.5
   Unit – V: Chapter 5: Sec 5.1 – 5.5

SECOND SEMESTER

CORE THEORY IV

TOPOLOGY - 24PMA106

Course Outcome:

Unit	CO	Upon Completion of this Course the Students will be able to	Cognitive Level
Unit - I	CO 1	Understand the topological Spaces, order topology, product topology	K1 – K6
Unit - II	CO 2	Recall the continuous function ,metric spaces	K1 – K5
Unit - III	CO 3	Apply the continuous function connectedness concepts on the real line	K1 – K6
Unit - IV	CO 4	Compare the Normal, Regular Hausdorff Spaces	K1 – K5
Unit - V	CO 5	Understand Countability and Separation axioms	K1 – K6

K1 - Remember; **K2** – Understand; **K3** – Apply; **K4** – Analyze; **K5** – Evaluate; **K6** - Create

Syllabus

UNIT I: TOPOLOGICAL SPACES

Topological spaces- Basic topology- The order topology- The product topology on $X \times Y$- The subspace topology-Closed sets and limit points.

UNIT II: CONTINUOUS FUNCTONS

Continuous functions- the product topology- The metric topology.

UNIT III: CONNECTEDNESS

Connected spaces - Connected subspaces of the Real line-components and local connectedness.

UNIT IV: COMPACTNESS

Compact spaces - compact subspaces of the Real line - Limit Point Compactness – Local Compactness.

UNIT V : COUNTABILITY AND SEPARATION AXIOMS

The Countability Axioms - The separation Axioms - Normal spaces - The Urysohn Lemma - The Urysohn metrization Theorem - The Tietz extension theorem- The Tychonoff Theorem

Text Book:

1. James R. Munkres, Topology (2nd Edition) Pearson Education Pvt. Ltd., New Delhi-2011 (Third Indian Reprint)

   UNIT – I -Chapter 2: Sections 12 to 17

   UNIT – II -Chapter 2 : Sections 18 to 21 (Omit Section 22)

   UNIT – III -Chapter 3 : Sections 23 to 25.

   UNIT – IV -Chapter 3 : Sections 26 to 29.

   UNIT – V -Chapter 4 : Sections 30 to 35.37

CORE THEORY V

COMPLEX ANALYSIS – 24PMA105

Course Outcome:

Unit	CO	Upon Completion of this Course the Students will be able to	Cognitive Level
Unit - I	CO 1	Understand the significance of differentiability and analyticity of complex functions	K1 – K5
Unit - II	CO 2	Evaluate out the role of Cauchy's theorem and Cauchy's integral formula in evaluation of contour integrals	K1 – K5
Unit - III	CO 3	Classify the nature of singularity, poles and residues	K1 – K5
Unit - IV	CO 4	Understand the concept of locally exact differentials and application of Cauchy residue theorem	K1 – K6
Unit - V	CO 5	Derive out Taylor and Laurent series expansion of analytic Functions	K1 – K5

K1 - Remember; **K2** – Understand; **K3** – Apply; **K4** – Analyze; **K5** – Evaluate; **K6** – Create

Syllabus :

UNIT I: Elementary Point Set Topology

Sets and Elements – Metric Spaces – Connectedness – Compactness – Continuous Functions – Topological Spaces; Conformality: Arcs and Closed Curves – Analytic Functions in Regions – Conformal Mapping – Length and Area; Linear Transformations: The Linear Group – The Cross Ratio – Symmetry.

UNIT II : **Fundamental theorems in complex integration**

Line Integrals – Rectifiable Arcs – Line Integrals as Functions of Arcs – Cauchy's Theorem for a Rectangle – Cauchy's Theorem in a Disk; Cauchy's Integral Formula: The Index of a Point with Respect to a Closed Curve – The Integral Formula – Higher Derivatives.

UNIT III : **Analytic Function**

Local Properties of Analytic Functions - Removable Singularities - Taylor's Theorem – Integral representation of the nth term - Zeros and Poles – Algebraic order of f(z) – Essential Singularity - The Local Mapping – The Open Mapping Theorem - The Maximum Principle.

UNIT IV : Cauchy's Theorem

The General Form of Cauchy's Theorem: Chains and Cycles – Simple Connectivity – Homology – The General Statement of Cauchy's Theorem – Proof of Cauchy's Theorem – Locally Exact Differentials – Multiply Connected Regions; The Calculus of

Residues: The Residue Theorem – The Argument Principle – Evaluation of Definite Integrals

UNIT V: Harmonic Functions

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.

Text Book:

1. Lars V. Ahlfors, Complex Analysis, Third Ed. McGraw-Hill Book Company, Tokyo.

UNIT – I - Chapter 3: 1.1-1.6, 2.1-2.4,3.1-3.3

UNIT – II - Chapter 4: 1.1-1.5, 2.1-2.3

UNIT – III - Chapter 4: 3.1, 3.2, 3.3,3.4

UNIT – IV - Chapter 4: 4.1-4.7, 5.1-5.3

UNIT – V - Chapter 4: 6.1-6.5 and Chapter 5: 1.1-1.3

CORE THEORY -VI

ADVANCED NUMERICAL ANALYSIS – 24PMA106

Course Outcome:

Unit	CO	Upon Completion of this Course the Students will be able to	Cognitive Level
Unit – I	CO 1	Solve the root finding problems with an arbitrary nonlinear Function	K1 – K6
Unit – II	CO 2	Use the direct and iterative techniques for the solution of systems of linear algebraic equations.	K1 – K5
Unit – III	CO 3	Discover the value of the interpolating polynomial at a single value of the independent variable.	K1 – K5
Unit – IV	CO 4	Apply the numerical techniques of differentiation and integration for engineering problems.	K1 – K5
Unit – V	CO 5	Analyse different methods of Numerical Solution of Ordinary Differential Equation	K1- K5

K1 - Remember; **K2** – Understand; **K3** – Apply; **K4** – Analyze; **K5** – Evaluate; **K6** – Create

Syllabus:

Unit I:

Transcendental and Polynomial equations Iteration methods based on second degree equation – Muller method, chebyshev method. Multi point iteration methods, Rate of convergence - Secant method, Newton-Raphson method, Cahebyshev method, Methods of multiple roots systems of non-linear equationNewton-Raphson method, Methods for complex roots polynomial equations – Descarte's rule of signs, Birge-vieta method, Bairstow method and graffe's roots squaring method.

Unit II:

System of linear algebraic equations and eigen value problems.. Linear systems of equations- Direct methods-Triangularization method, Cholesky method, Partition method-Error analysis for direct methods, Iteration methods-Convergence analysis of iterative methods, eigen values and eigen vectors- Jacobi methods for symmetric matrices, Givens methods for symmetric matrices, Power method.

Unit III:

Interpolation and approximation Higher order Interpolation, finite difference operators, interpolating polynomial using finite differences, Hermite interpolation, Piecewise and spline interpolation, Bivariate interpolation, least square approximation, Gram-schmidtorthogonalizing process, Legendre polynomials, Chebyshev polynomials.

Unit IV:

Differentiation and Integration: Numerical differentiation – Optimum choice of step length- Extrapolation method – Partial differentiation – Numerical integration – Methods based on interpolation, Method based on undermined coefficients – Trapezoidal method, Simpson's method, Gauss Legendre integration method, Gauss Chebyshev integration method, Raau, integration methods, Lobalto integration methods, composite integration methods – Romberg integration methods – Double integration.

Unit V:

Ordinary and Partial Differential Equations: Numerical methods – Single step methods – Multistep method – Predictor – corrector method – Boundary value problems – Introduction, Initial value problem method shooting methods, Finite difference method – Finite element method.

Text Book:

1.M.K. Jain, S.R.K. Iyengar and R.K. Jain, (2003), Numerical Methods for Scientific and Enginering Computation, New age International publishers.

Unit:1 Chapter 2: Sections 2.4, 2.5 (except muller method), 2.6 (methods of multiple rules only) 2.7. (Newton -Raphson method only) 2.8, 2.9

Unit:2 Chapter 3: Sections 3.2, 3.3, 3.4, 3.5, 3.7, 3.8, 3.9, 3.10, 3.11.

Unit:3 Chapter 4: Sections 4.2, 4.3, 4.4, 4.5, 4.6, 4.7, 4.9.

Unit:4 Chapter 5: Sections 5.2, 5.3, 5.4, 5.5, 5.6, 5.7, 5.8, 5.9, 5.10, 5.11.

Unit:5 Chapter 6: Sections 6.3, 6.4, 6.6, 6.7. Chapter 7: Sections 7.1, 7.2, 7.3, 7.4.

CORE THEORY -VII

INTEGRAL EQUATIONS AND CALCULUS OF VARIATIONS – 24PMA107

Course Outcome:

Unit	CO	Upon Completion of this Course the Students will be able to	Cognitive Level
Unit - I	CO 1	Understand the concepts of variation and its properties	K1 – K5
Unit - II	CO 2	Use Euler's equation to solve various types of variation problems with fixed boundaries.	K1 – K5
Unit - III	CO 3	Modify the Euler's formula for a class of curves with moving boundary points,Solve problems related with reflection and refraction, diffraction of light rays and derive sufficient conditions based on second variation.	K1 – K6
Unit - IV	CO 4	Classify Fredholm, Volterra and singular type integral equations and Solve integral equations using Fredholm theorem, Fredholm Alternative theorem and method of successive approximations.	K1 – K5
Unit - V	CO 5	Understand the classical Fredholm theory	K1 – K5

K1 - Remember; **K2** – Understand; **K3** – Apply; **K4** – Analyze; **K5** – Evaluate; **K6** – Create

Syllabus

Unit I :

Problems with fixed boundaries

Unit II :

Problems with moving boundaries - Externals with corners

Unit III:

Sufficient conditions for Extremum

Unit IV :

Linear Integral Equations - Definition, Regularity conditions - special kind of kernels - eigen values and eigen functions - convolution Integral - the inner and scalar product of two functions - Notation - reduction to a system of Algebraic equations - examples – Fredholm alternative - examples - an approximate method.

Unit V:

Method of successive approximations: Iterative scheme - examples - Volterra Integral equation - examples - some results about the resolvent kernel. Classical Fredholm Theory: the method of solution of Fredholm - Fredholm's first theorem - second theorem - third theorem.

Text Books:

1.L. Elsgolts, (2003), Differential equations and the calculus of variations, University Press of the Pacific.

UNIT – I - Chapter 6

UNIT – II - Chapter 7 upto sec 3

UNIT – III - Chapter 8

2.Ram. P. Kanwal - Linear Integral Equations Theory and Practice, Birkhauser Boston, 2012.

UNIT - IV - Chapter 1,2

UNIT - V - Chapter 3,4

CORE THEORY -VIII

GRAPH THEORY – 24PMA108

Course Outcome:

Unit	CO	Upon Completion of this Course the Students will be able to	Cognitive Level
Unit - I	CO 1	Understand and work on the fundamental concepts of graphs	K1 – K5
Unit - II	CO 2	Apply graph theory based tools in solving practical problems	K1 – K5
Unit - III	CO 3	Understand basic concepts in Trees	K1 – K5
Unit - IV	CO 4	Discuss matching problems and its applications elsewhere	K1 – K6
Unit - V	CO 5	Comprehend and work on the concepts of planarity	K1 – K5

K1 - Remember; **K2** – Understand; **K3** – Apply; **K4** – Analyze; **K5** – Evaluate; **K6** – Create

Syllabus:

UNIT – I: Fundamentals of Graph Theory

Basic Concepts - Subgraphs - Degrees of Vertices - Paths and Connectedness- Operations on Graphs - Directed Graphs: Basic Concepts – Tournaments.

UNIT – II: Trees

Connectivity: Vertex Cuts and Edge Cuts - Connectivity and Edge - Connectivity, Trees: Definitions, Characterization and Simple Properties - Counting the Number of Spanning Trees - Cayley's Formula.

UNIT – III: Matchings

Independent Sets and Matchings: Vertex Independent Sets and Vertex Coverings

- Edge Independent Sets -Matchings and Factors - Eulerian Graphs - Hamiltonian Graphs.

UNIT – IV: Graph Colouring

Graph Colourings: Vertex Colouring - Critical Graphs - Triangle - Free Graphs - Edge Colouringsof Graphs - Chromatic Polynomials.

UNIT – V: Planarity

Planar and Nonplanar Graphs - Euler Formula and its Consequences - K5 and K3,3 are Nonplanar Graphs - Dual of a Plane Graph - The Four-Colour Theorem and the Heawood Five-Colour Theorem-Kuratowski's Theorem.

Text Book :

1. R. Balakrishnan, K. Ranganathan, A Textbook of Graph Theory, SpringerInternational Edition, New Delhi, 2008.

UNIT I - Chapter I & II: 1.1 to 1.4, 1.7, 2.1, 2.2

UNIT II - Chapter III & IV: 3.1, 3.2, 4.1, 4.3 to 4.4

UNIT III - Chapter V & VI: 5.1 to 5.4, 6.1, 6.2

UNIT IV- Chapter VII: 7.1 to 7.4, 7.7

UNIT V - Chapter VIII: 8.1 to 8.6

THIRD SEMESTER

CORE THEORY - IX

STOCHASTIC PROCESSES – 24PMA109

Course Outcome:

Unit	CO	Upon completion of this course will be able to	Cognitive Level
Unit I	CO1	Understand basic notions of stochastic processes, including random variables, state space, and sample paths and sspecify stochastic processes clearly by defining their properties like time and state behavior.	K1-K6
Unit II	CO2	Apply the stability of a Markov system, understanding when and how a system reaches a steady-state (equilibrium behavior).	K1-K6
Unit III	CO3	Generalize and analyze the basic Poisson process to more complex models, such as non-homogeneous Poisson processes.	K1-K6
Unit IV	CO4	Analyze renewal processes in continuous time, applying them to real-world systems like maintenance and repair models. Formulate and solve the Renewal Equation to find expected values related to renewal events	K1-K6
Unit V	CO5	Evaluate the Non - Markovian Queuing Models, where arrivals or service times do not follow the Markov property.	K1-K6

K1 - Remember; **K2** – Understand; **K3** – Apply; **K4** – Analyze; **K5** – Evaluate; **K6** – Create

SYLLABUS

UNIT I: Markov Chain

Definitions and examples – Transition Matrix, Order of a Markov Chain, Markov Chain as Graphs- Higher Transition probabilities – Generalization of Independent Bernoulli trails – Sequence of chain – Dependent trains.

UNIT II: Classification of States and Chain

Markov chains: Classification of states and chains – Determination of Higher probabilities – stability of a Markov system – Reducible chains – Markov chains with continuous state space.

UNIT III: **Markov processes with Discrete state space : Poisson processes and its Extension**

Poisson Process – Postulates for Poisson Process Properties of Poisson Process– Poisson Process and related Distribution- Generalization of process- Birth and Death process – Markov processes with discrete state space (continuous time Markov Chains).

UNIT IV: Renewal Process and Theory

Renewal process – Renewal processes in continuous time – Renewal equation – stopping time – Wald's equation –Renewal theorems.

UNIT V: Application in Stochastic Models

Queuing system and Models - Birth and death Processes in Queueing Theory Markovian Models – Non-Markovian Queuing models .

Text Book:

1. Medhi, Stochastic Processes, Fourth edition, 2017, New Age international Publisher, New Delhi

   UNIT I Chapter II: Sec 2.1 to 2.3,

   UNIT II Chapter II: Sec 2.4 to.2.11 (Expect 2.7,2.8,2.10)

   UNIT III Chapter III: Sec 3.1 to 3.5

   UNIT IV Chapter VI: Sec 6.1 to 6.5

   UNIT V Chapter X: Sec 10.1 to 10.3 (omit sec 10.2.3 & 10.3.1)

CORE THEORY -X

CLASSICAL MECHANICS - 24PMA110

Course outcome:

Unit	CO	Upon completion of this course will be able to	Cognitive Level
Unit I	CO1	Recall and explain Newton's laws of motion and fundamental principles of mechanics	K1 – K5
Unit II	CO2	Understand and describe the concepts of work, energy and Momentum conservation.	K1 – K5
Unit III	CO3	Apply Newtonian and energy methods to solve problems involving particle and rigid body dynamics	K1 – K6
Unit IV	CO4	Analyze systems undergoing motion and oscillations under various force conditions	K1 – K5
Unit V	CO5	Evaluate the applicability of different mechanical principles to real-world and complex systems	K1 – K5

K1 – Remember; **K2** – Understand; **K3** – Apply; **K4** – Analyze; **K5** – Evaluate; **K6** – Create

SYLLABUS

Unit I: Survey of the Elementary Principles

Mechanics of a Particle – Mechanics of a System of Particles – Constraints – D'Alembert's Principle and Lagrange's Equations

Unit II: Variational Principles and Lagrange's Equations

Hamilton's Principles – Some Techniques of the Calculus of Variations – Derivations of Lagrange's Equations from Hamilton's Principle – Extending Hamilton's Principle to Systems with Constraints

Unit III: The Central Force Problem

Reduction to the Equivalent One-Body Problem – The Equations of Motion and First Integrals – The Equivalent One-Dimensional Problem and Classification of Orbits – The Virial Theorem

Unit IV: The Kinematics of Rigid Body Motion

The Independent Coordinates of a Rigid Body – Orthogonal Transformations – Formal Properties of the Transformation Matrix – The Euler Angles

Unit V: The Rigid Body Equations of Motion

Angular Momentum and Kinetic Energy of Motion about a Point – Tensors – The Inertia Tensor and the Moment of Inertia – The Eigenvalues of the Inertia Tensor and the Principal Axis Transformation

Text Books:

1. Herbert Goldstein Charles P. Poole John Safko, Classical Mechanics, 3rd Edition (2011), Pearson Education, New Delhi.

UNIT – I Chapter 1: Section 1.1 to 1.4

UNIT – II Chapter 2: Section 2.1 to 2.4

UNIT – III Chapter 3: Section 3.1 to 3.4

UNIT – IV Chapter 4: Section 4.1 to 4.4

UNIT – V Chapter 5: Section 5.1 to 5.4

ELECTIVE THEORY - III

24PMA205: FUZZY GRAPH

Course outcome:

Unit	CO	Upon completion of this course the students will be able to	Cognitive Level
Unit - I	CO 1	Understand the foundational principles of fuzzy set theory and how they extend classical graph concepts.	K1 – K3
Unit – II	CO2	Construct Various types of fuzzy graphs, including Fuzzy trees, cycles and complete graphs.	K1 – K6
Unit – III	CO3	Analyze bonds and cut bonds in fuzzy graphs, understanding their role in network stability and reliability.	K1 – K4
Unit-IV	CO4	Explore the concept of intervals in fuzzy graphs and apply them to assess fuzzy connectivity and reachability.	K1 – K4
Unit-V	CO5	Analyze the structural properties and relationships within interval-valued fuzzy graphs.	K1 – K6

K1 - Remember; **K2** – Understand; **K3** – Apply; **K4** – Analyze; **K5** – Evaluate; **K6** – Create

SYLLABUS

UNIT I: Fuzzy Graphs

Definition and Basic Properties-Connectivity in fuzzy graphs- Forests and trees- Fuzzy cut sets- Bridges- Cut sets and Blocks-Cycles and Trees.

UNIT II: Connectivity in Fuzzy Graphs

Strong Edges in Fuzzy Graphs-Types of Edges in Fuzzy Graphs-Vertex Connectivity and Edge Connectivity of Fuzzy graphs-Mengers Theorem for Fuzzy Graphs.

UNIT III: More on Connectivity and Distances

Connectedness and Acyclic level of fuzzy graphs – Cycle connectivity of fuzzy graphs – Bonds and Cut bonds in fuzzy graphs – Metrics in Fuzzy graphs.

UNIT IV: Sequences, Saturation, Intervals and Gates in Fuzzy Graphs

Special Sequences in Fuzzy Graphs – Saturation in Fuzzy Graphs – Intervals in Fuzzy Graphs.

UNIT V: Interval-Valued Fuzzy Graphs

Interval-Valued Fuzzy Sets – Operations on Interval – Valued Fuzzy Graphs – Isomorphisms of Interval-valued Fuzzy Graphs – Strong Interval-Valued fuzzy graphs.

Text Book:

1. Fuzzy Graph Theory, Sunil Mathew John N. Mordeson Davender S. Malik, Springer, Vol.683,2018

   Unit-I Chapter-2 Section:2.1 to 2.6

   Unit-II Chapter- 3 Section 3.1 to 3.4

   Unit-III Chapter -5 Section: 5.1 to 5.4

   Unit – IV Chapter -6 Section: 6.1 to 6.4

   Unit – V Chapter -7 Section 7.1 to 7.4

ELECTIVE THEORY - IV

24PMA211: STATISTICAL METHODS

Course Outcomes:

Unit	CO	Upon Completion of this Course the Students will be able to	Cognitive Level
Unit-I	CO1	Formulate and analyze multiple linear regression models for predicting response variables based on several explanatory variables.	K1–K6
Unit-II	CO2	Understand the fundamental principles of experimental design, including randomization, replication, and blocking.	K1–K6
Unit-III	CO3	Formulate appropriate experimental designs for comparing treatments under controlled conditions.	K1–K6
Unit-IV	CO4	Analyze data from completely randomized designs (CRD), randomized block designs (RBD), and Latin square designs (LSD) using ANOVA techniques	K1–K6
Unit-V	CO5	Evaluate the efficiency and validity of different experimental designs and recommend optimal designs for specific research objectives.	K1–K6

K1-Remember;**K2**–Understand;**K3**–Apply;**K4**–Analyze;**K5**–Evaluate;**K6**–Create

SYLLABUS

UNIT I: General Linear Model

General Linear Model- OLS Parameter Estimation- Correlation and Regression Analysis- Simple, Multiple, and Multivariate Regression- Moderated Regression- Curvilinear Regression- Curvilinear Regression of Repeated Observations- Symmetric Regression.

UNIT II: Single – Factor Experimental Design

Introduction-Completely Randomized Design- -Randomized Block Design-Latin Square Design-Balanced Incomplete Block Design.

UNIT III: Multifactor Experimental Design

Introduction-Two-Factor Factorial Design-Three-Factor Factorial Design-2^2 Factorial Design. 2^3 Factorial Design-Blocking and Confounding-Two level Fractional factorial Design.

UNIT IV: Response Surface Methodology

Introduction--Response surface Models-Multiple Linear Regression-Analysis of first order Model-Analysis of Second order Model-Response Surface Design-Multifactor optimization.

UNIT V: Acceptance Sampling:

Introduction- Acceptance Sampling-Single Sampling Plan for Attributes-Double Sampling Plan for Attributes-Sequential Sampling Plan for Attributes- Rectifying Sampling Plan for Attributes-Acceptance Sampling of Variables.

Text Books:

1. Alexander Von Eye, Wolfgang Wiedermann,"The General Linear Mode"l, Edition(2023), A Primer. Cambridge University Press.

   Unit-I: Chapter : 1,2,3 : Sec:3.1-3.5.

2. Selvamuthu, Dharmaraja, and Dipayan Das,"Introduction to probability, statistical methods, design of experiments and statistical quality control", Second Edition(2024), Springer.

   Unit-II: Chapter : 12 : Sec:12.1-12.5

   Unit-III: Chapter :13 : Sec: 13.1-13.7

   Unit-IV: Chapter :14 : Sec : 14.1-14.7

   Unit-V: Chapter : 15 : Sec : 15.1-15.7

CORE LABORATORY - II

24PMA302: FUNDAMENTALS IN LATEX LAB

Course Outcome:

CO	Upon Completion of this Course the Students will be able to	Cognitive Level
CO1	Construct tables, lists, and insert figures with professional-quality styling.	K1-K4
CO2	Design the references, citations, and bibliographies effectively using tools like BibTeX.	K1-K6
CO3	Design presentations using LaTeX-based packages such as Beamer.	K1-K6

K1 - Remember; **K2** – Understand; **K3** – Apply; **K4** – Analyze; **K5** – Evaluate; **K6** – Create

SYLLABUS

1. Creating and typesetting a simple LaTeX document
2. Creating Abstract, Chapters, Sections, References, Equation References,
3. Demonstrate Adding basic information to documents, Environments, Footnotes, Sectioning, Displayed material
4. Demonstrate Mathematical typesetting (elementary and advanced): Subscript/ Superscript,
5. Demonstrate Fractions, Roots, Ellipsis,
6. Demonstrate Mathematical symbols, Arrays, Delimiters, Multiline formulas,
7. Demonstrate Spacing and changing style in math model
8. Demonstrate Pictures and graphics in LaTeX
9. Demonstrate Text in Boxes: Boxes - Footnotes and marginal notes.
10. Constuct Tables: Tabular stops – Tables.

ABILITY ENHANCEMENT COURSES

24PMA401: CULTIVATING ANALYTIC AND PROFESSIONAL SKILLS

Course Outcome :

Unit	CO	Upon completion of this course the students will be able to	Cognitive level
Unit I	CO1	Solve problems related to averages, numbers, and ages with basic arithmetic reasoning.	K1- K2
Unit II	CO2	Apply knowledge of percentages, ratios, proportions, and solve problems involving pipes and cisterns.	K1 – K3
Unit III	CO3	Analyse problems on time and work, time and distance, and calendars to develop problem-solving strategies.	K1 – K4
Unit IV	CO4	Assess personal strengths and construct logical arguments for decision making and critical thinking.	K1 – K5
Unit V	CO5	Demonstrate teamwork, leadership, conflict resolution skills, and prepare professional resumes and writing assignments, Create the resumes.	K1 – K6

K1 – Remember; K2 – Understand; K3 – Apply; K4 – Analyze, K5- Evaluate , K6- Create

SYLLABUS

UNIT I: Number Sense

Average - Problems on numbers - Problems on ages.

UNIT II: Quantitative Skills

Percentage - Ratio and Proportion - Pipes and cisterns.

UNIT III: Time and Logic

Time and work - Time and distance - Calendar.

UNIT IV: Personal Growth

Personality Development and Critical Thinking – Self assessment tools – Decision making and logical argument construction.

UNIT V: Professional Skills

Team work and Writing Skills – Leadership styles and conflict Resolution – Crafting resumes.

Text Books:

1. Aggarwal, R. S., Quantitative Aptitude, S Chand Publishing (2017), New Delhi.
   Unit I: Part I: Sec. 6 - 8
   Unit II: Part I: Sec. 11, 13, 16
   Unit III: Part I: Sec. 17, 18, 27
2. Suresh Kumar E., Sreehari P., Savithri J., Communication Skills and Soft Skills - An Integrated Approach, Pearson Education (2011), Noida.
   Unit IV: Chapters 3 & 4
   Unit V: Chapters 6 & 8

FOURTH SEMESTER

CORE THEORY XI

24PMA111 - FUNCTIONAL ANALYSIS

Course Outcome

Unit	CO	Upon completion of this course the students will be able to	Cognitive level
Unit I	CO1	Define and recognize Banach spaces; analyze continuous linear transformations and apply the Hahn-Banach theorem.	K1- K5
Unit II	CO2	Understand and apply the natural embedding of normed spaces, the open mapping theorem, and operator conjugation.	K1 – K5
Unit III	CO3	Explain properties of Hilbert spaces and use orthogonal complements, orthonormal sets, and dual spaces.	K1 – K5
Unit IV	CO4	Apply the concepts of adjoint, self-adjoint, normal, and unitary operators, and projections in Hilbert spaces.	K1 – K6
Unit V	CO5	Examine Banach algebras; analyze spectra, spectral radius, and structure including radicals and semi-simplicity.	K1 – K6

K1 – Remember; K2 – Understand; K3 – Apply; K4 – Analyze, K5 – Evaluate; K6 – Create

SYLLABUS

UNIT I: Fundamentals of Banach Spaces

The definition and some examples - Continuous linear transformations – The Hahn Banach theorem

UNIT II: Imbedding and Operator Extensions

The natural imbedding of N in N** - The open mapping theorem – The conjugate of an Operator.

UNIT III: Foundations of Hilbert Spaces

The definition and some simple properties - Orthogonal complements–Ortho normal sets

UNIT IV: Operator Theory in Hilbert Spaces

The conjugate space H*- The adjoint of an operator – self-adjoint operators.

UNIT V: Normal and unitary operators

Normal and unitary operators – Projections.

Text Book:

1. G.F. Simmons, Introduction to Topology and Modern Analysis, Second Edition (2024), MEDTEC.

Unit I: Chapter 9- sec. 46 - 48.

Unit II: Chapter 9- sec. 49 - 51.

Unit III: Chapter 10- sec. 52 - 55.

Unit IV: Chapter 10- sec. 56 - 59.

Unit V: Chapter 12- sec. 64 - 65 & 67 - 69.

CORE THEORY – XII

24PMA112 – DIFFERENTIAL GEOMETRY

Course Outcomes:

			Cognitive

		Upon Completion of this Course the Students will be able to	Level
Unit – I	CO 1	Understand the Space Curve, Arc Length, Normal, Tangent and Binormal	K1 – K5
Unit - II	CO 2	Recall the Surface, curve on a surface, surface of revolution and concepts of Metric direction coefficient families of curves.	K1 – K5
Unit - III	CO 3	Apply the Geodesics, Canonical equations, Geodesics Curvature and Gauss Bonnet Theorem.	K1 – K5
Unit - IV	CO 4	Compare the principal curvature lines of curvature and developable.	K1 – K6
Unit – V	CO 5	Understand the Space Curve, Arc Length, Normal, Tangent and Binormal	K1 – K5

K1 - Remember; **K2** – Understand; **K3** – Apply; **K4** – Analyze; **K5** – Evaluate; **K6** – Create

SYLLABUS

UNIT I: Curves and Surfaces

Definitions – Arc length – Tangent, normal, and binormal – Curvature and torsion of a curve given as the intersection of two surfaces – Contact between curves and surfaces.

UNIT II: Geometry of Space Curves and Surfaces

Tangent, normal and binormal, Intrinsic Equations, Fundamental existence theorem for space curves – Helices – Definition of a surface – curves on a surface – Helicoids

UNIT III: Differential Geometry of Surfaces

Metric – Direction coefficients – Families of Curves – Isometric Correspondence – Intrinsic Properties – Geodesics – Canonical Geodesic Equations – Normal Property of Geodesics – Existence Theorems.

UNIT IV: Advanced topics in Differential Geometry

Geodesic Curvature – Gauss Bonnet Theorem – Gaussian Curvature – Surfaces of Constant Curvature – The Second Fundamental Form – Principles Curvature – Lines of Curvature.

UNIT V: Global Differential Geometry of Surfaces

Compact Surfaces whose points are umbilics – Hilbert's lemma – Compact Surfaces of constant Gaussian or mean curvature – Hilbert's theorem – Conjugate points on geodesics.

Text Book :

1. Willmore. T.J, An Introduction to Differential Geometry, Oxford University Press, New Delhi.

UNIT – I Chapter I Sections 2 to 6.

UNIT – II Chapter I Sections 7 to 9 & Chapter II Sections 1 to 4

UNIT – III Chapter II Sections 5 to 13

UNIT – IV Chapter II Sections 15 to 18 & Chapter III Sections 1 to 3

UNIT – V Chapter IV Sections 2 to 4 & Sections 7 and 8

ELECTIVE THEORY - V
FUZZY SETS & OPERATIONS RESEARCH

Course Outcomes:

Unit	CO	Upon completion of this course students will be able to	Cognitive Level

Unit I	CO1	Understand the basics of Fuzzy Expert Systems and how fuzzy logic helps in building systems that can make decisions in uncertain environments.	K1-K6
Unit II	CO2	Analyze how fuzzy systems can be integrated with neural networks, leading to the development of fuzzy neural networks that combine learning and reasoning capabilities.	K1-K6
Unit III	CO3	Analyze fuzzy-based systems for effective data storage and retrieval in real-world uncertain environments.	K1-K6
Unit IV	CO4	Design fuzzy decision-making models for both personal and group decision problems in real-world scenarios.	K1-K6
Unit V	CO5	Analyze fuzzy linear programming to optimize problems in uncertain environments.	K1-K6

K1 - Remember; **K2** – Understand; **K3** – Apply; **K4** – Analyze; **K5** – Evaluate; **K6** – Create

SYLLABUS

UNIT I: Fuzzy Expert System

Fuzzy Expert system: An Overview- Fuzzy Implications - Selection Of Fuzzy Implications- Multi conditional approximate Reasoning- The Role of Fuzzy Relation Equations-Interval valued Approximate reasoning

UNIT II: Fuzzy Systems

Fuzzy Systems- General Discussion- Fuzzy Controllers: An Over viwe- Fuzzy Controllers: An Example- Fuzzy Systems and Neural Networks- Fuzzy Neural Networks- Fuzzy Automata- Fuzzy Dynamic Systems

UNIT III: Fuzzy database

Fuzzy Database and Information Retrieval System- General Discussion-Fuzzy Database-Fuzzy information retrieval

UNIT IV: Fuzzy decision Making

Fuzzy Decision Making-General Discussion- Individual Decision Making- Multiperson Decisin Making.

UNIT V: Fuzzy Linear Programming

Multicriteria Decision Making-Multistage Decision Making-Fuzzy Ranking Methods.-Fuzzy Linear Programming.

Text Books:

1. George J.Klir And Bo Yuan, Fuzzy Sets And Fuzzy Logic Theory and Applications first edition 2015 , Pearson education India

UNIT I Chapter 11: Sec 11.1 to 11.6,

UNIT II Chapter 12: Sec 12.1 to12.7

UNIT III Chapter 14: Sec 14 .1 to 14.3

UNIT IV Chapter 15: Sec 15.1 to 15.3

UNIT V Chapter 15 : Sec 15.4 to 15.7

ELECTIVE THEORY – VI

DISCRETE STRUCTURES & AUTOMATA THEORY

Course Outcomes:

Unit	CO	Upon Completion of this Course the Students will be able to	Cognitive Level
Unit-I	CO1	Understand and apply the fundamentals of discrete mathematics.	K1–K6
Unit-II	CO2	Apply the foundations of logic and set theory.	K1–K6
Unit-III	CO3	Understand basic concepts in Lattices.	K1–K6
Unit-IV	CO4	Analyze and design finite automata for recognizing regular languages.	K1–K6
Unit-V	CO5	Explore regular languages and context-free languages.	K1–K6

K1 - Remember; **K2** – Understand; **K3** – Apply; **K4** – Analyze; **K5** – Evaluate; **K6** - Create

Syllabus:

UNIT – I:Mathematical Arguments:

Statements-Logicaloperations -Logical Equivalence-Logical Consequence-Formal Arguments-Predicates and Quantifiers-Nagations-Proofs.

UNIT – II:Proofs by Induction:

Perfect Squares-Bernoulli's Inequality-Fibonacci Numbers-Geometric Series-Binomial Theorem-Strong Induction-Well-founded Induction-Recursion-Recursively Defined Sets

UNIT – III:Partial orders and Lattices:

Partial orders-Strict order-Cover Relations and Hasse Diagrams-Dilworth's Theorem-Lower and Upper Bounds-Extensions of Partial orders-Monotonic Functions-Lattices

UNIT – IV:Finite Automata:

Logic-Sets and Languages-Relations and Translations-Graphs-Automata as Models of Computation-Automata as Language Models -Finite Automata-Definitions-Restrictions-Determinism-Regular Expressions.

UNIT – V:Automata and Their Grammatical Equivalents:

Pushdown Automata-Definitions-Determinism-Turing Machines-Definitions-Restrictions-Universality-Context-Free Grammars and Pushdown Automata-General Grammars and Turing Machines

Text Books:

1. Klappenecker, Andreas, and Hyunyoung Lee. "Discrete Structures.",Edition(2025), Springer. UNIT I -Chapter II : Sec 2.1-2.8.
UNIT II - Chapter IV : Sec 4.1-4.9. UNIT III - Chapter VI : Sec 6.1- 6.8.

2. Alexander Meduna,Tomas Kozar, "Automata theory,Trends,and Applications", Edition(2024) World Scientific Publishing Co. Pte. Ltd.
UNIT IV -Chapter I,II,III, : Sec 1.1-1.4, 2.1-2.2 & 3.1-3.4.
UNIT V -Chapter IV,V,VI : Sec 4.1-4.2,5.1-5.3 & 6.1-6.2.