M.Sc. Mathematics

Syllabus

AFFILIATED COLLEGES

Program Code: 32A

2023 – 2024 onwards

BHARATHIAR UNIVERSITY

(A State University, Accredited with "A++" Grade by NAAC,
Ranked 21st among Indian Universities by MHRD-NIRF)

Coimbatore - 641 046, Tamil Nadu, India

BHARATHIAR UNIVERSITY, COIMBATORE.
M. Sc. MATHEMATICS DEGREE COURSE (AFFILIATED COLLEGES)
(For the candidates admitted from the academic year 2023-24 onwards)

SCHEME OF EXAMINATIONS – CBCS PATTERN

Semester.	Study Components	Course title	Ins. hrs/week	Examinations				Credit
				Dur.Hrs.	*CIA*	*Marks*	Total Marks	
I	Paper 1	Abstract Algebra*	6	3	25	75	100	4
	Paper 2	Real Analysis	7	3	25	75	100	4
	Paper 3	Ordinary Differential Equations*	7	3	25	75	100	4
	Paper 4	Numerical Methods	6	3	25	75	100	4
	Elect. Paper I		4	3	25	75	100	4
II	Paper 5	Linear Algebra*	6	3	25	75	100	4
	Paper 6	Complex Analysis	7	3	25	75	100	4
	Paper 7	Partial differential equations*	7	3	25	75	100	4
	Paper 8	Mechanics	6	3	25	75	100	4
	Elect. Paper II		4	3	25	75	100	4
III	Paper 9	Topology	7	3	25	75	100	4
	Paper 10	Fluid Dynamics	7	3	25	75	100	4
	Paper 11	Mathematical Statistics*	6	3	25	75	100	4
	Paper 12	Graph Theory	6	3	25	75	100	4
	Elective Paper III		4	3	25	75	100	4
V	Paper 13	Functional Analysis	7	3	25	75	100	4
	Paper 14	Mathematical Methods	7	3	25	75	100	4
	Paper 15	Optimization Techniques*	6	3	25	75	100	4
	Paper 16	Computer Programming (C++ Theory)	4	3	25	75	100	4
	Practical	Computer Programming (C++ Practical)	2	3	40	60	100	4
	Elect. Paper IV		4	3	25	75	100	4
	Project						150@	6
		Total					2250	90

@ For Project report – 120 marks, Viva-voce – 30 marks.

The number of students for conducting Project Viva-voce is 10 per session. If the number of the remaining students exceeds 5 then the Viva-voce for them can be conducted in the next session.

LIST OF ELECTIVES

1. Number Theory*
2. Differential Geometry
3. Neural Networks
4. Magnetohydrodynamics
5. Fuzzy Logic and Fuzzy Sets*
6. Control Theory
7. Cryptography
8. MATLAB
9. LaTex
10. Elements of Stochastic Process*

*** New Course Added / Course Syllabus Modified**

Matlab, LaTex	**Theory**			20	55	100	
	Practical			10	15		

Note. Syllabi for all the papers for the students joining in the academic year 2023-24 are given below


First
Semester

Paper 1: ABSTRACT ALGEBRA

UNIT I:
Another Counting Principle, Sylow‟s Theorem: 1st, 2nd and 3rd parts of Sylow‟s Theorems – double coset – the normalizer of a group.

UNIT II:
Direct Products: External and Internal direct Products, Euclidean Rings, A Particular Euclidean Rings, Polynomial rings.

UNIT III:
Polynomials over rational fields – extension fields – roots of polynomials – splitting fields.

UNIT IV:
More about roots – simple extension – fixed fields – symmetric rational functions – normal extension - Galois group – fundamental theorem of Galois theory.

UNIT V:
Solvability by radicals: Solvable group – the commutator subgroup – Solvability by radicals - Finite fields.

TEXT BOOK:

1. I.N. Herstein, Topics in Algebra, 2nd Edition, John Wiley and Sons, New York, 1975.

UNIT I:	Chapter 2	: Sections 2.11, 2.12
UNIT II:	Chapter 2	: Sections 2.13
	Chapter 3	: Section 3.7 - 3.9
UNIT III:	Chapter 3	: Section 3.10
	Chapter 5	: Sections 5.1,5.3
UNIT IV:	Chapter 5	: Sections 5.5,5.6
UNIT V:	Chapter 5	: Section 5.7
	Chapter 7	: Section 7.1

REFERENCE BOOKS:

1. S. Lang, *“Algebra*”, 3rd Edition, Addison-Wesley, Mass, 1993.
2. John B. Fraleigh, *“A First Course in Abstract Algebra”,* Addison Wesley, Mass, 1982.
3. M. Artin, *“Algebra”,* Prentice-Hall of India, New Delhi, 1991.

PAPER 2: REAL ANALYSIS

UNIT I:

RIEMANN STILTJES INTEGRAL: Definition and Existence of the Integral – properties of the integral – Integration and differentiation – Integration of vector valued function – rectifiable curves.

UNIT II:

SEQUENCES AND SERIES OF FUNCTIONS: Uniform convergence and continuity – uniform convergence and integration - uniform convergence and differentiation – equicontinuous families of functions – The Stone Weierstrass theorem.

UNIT III:

FUNCTIONS OF SEVERAL VARIABLES: Linear transformation – contraction principle – Inverse function theorem – Implicit function theorem.

UNIT IV:

LEBESGUE MEASURE: Outer measure – Measurable sets and Lebesgue measure – Measurable functions –Littlewood‟s Theorem

UNIT V:

LEBESGUE INTEGRAL: The Lebesgue integral of bounded functions over a set of finite measure – integral of a non – negative function – General Lebesgue Integral.

Text Book:

1. Principles of Mathematical Analysis by W. Rudin, McGraw Hill, New York, 1976.
   Unit I &II : Chapter 6 & 7.
   Unit III : Chapter 9 (Pages 204 to 227)

2. Real Analysis by H.L. Roydon, Third Edition, Macmillan, New York, 1988.

   Unit IV : Chapter 3 (except Section – 4)
   Unit V :Chapter 4 (Sections 2, 3 & 4 only)

Reference Books:

1.R.G.Bartle, Elements of Real Analysis, 2nd Edition, John Wily and Sons, New York, 1976.
2.W.Rudin, Real and Complex Analysis, 3rd Edition, McGraw-Hill, New York, 1986.

Paper 3: ORDINARY DIFFERENTIAL EQUATIONS

UNIT I: LINEAR EQUATIONS WITH CONSTANT COEFFICIENTS

Introduction - Second order homogenous equations - Initial value problem for second order equations - Linear dependence and independence - A formula for Wronskian

UNIT II: LINEAR EQUATIONS WITH CONSTANT COEFFICIENTS (Cont'd.):

The Non- homogenous equations of order two-homogenous and Non - homogenous equations of order n - Initial value problems for n^{th} order equations- Annihilator method to solve non-Homogenous equation.

UNIT III: LINEAR EQUATIONS WITH VARIABLE COEFFICIENTS

Initial value problem - Existence and uniqueness theorem - The Wronskian and linear independence - Reduction of the order of a homogenous equation - The non- Homogenous equation - Homogenous equations with analytic coefficients - The Legendre equations

UNIT IV: LINEAR EQUATIONS WITH REGULAR SINGULAR POINTS

The Euler equations - Second order equations with regular singular points - Exceptional cases - The Bessel equation – The Bessel equation contd.

UNIT V: EXISTENCE AND UNIQUENESS OF SOLUTIONS TO FIRST ORDER EQUATIONS: Equations with variable separated - Exact equations - The method of successive approximation - The Lipschitz Condition - Convergence of the successive approximation - Non-local existence of solutions - Approximations and uniqueness of solutions.

TEXT BOOK:

Earl A. Coddington, An Introduction to Ordinary Differential Equations – Prentice – Hall of India Private Limited, New Delhi 2008.

UNIT I:	Chapter 2	: Sections 2.1 – 2.5.
UNIT II:	Chapter 2	: Sections 2.6 – 2.8, 2.10,2.11.
UNIT III:	Chapter 3	: Sections 3.1 – 3.8
UNIT IV:	Chapter 4	: Sections 4.1 – 4.4, 4.6 – 4.8
UNIT V:	Chapter 5	: Sections 5.1 – 5.8

REFERENCE BOOKS:

1. Williams E. Boyce and Richard C. Diprima Elementary Differential Equations and Boundary Value Problems, 10th edition John Wiley and Sons, New York 2012.
2 . S.G.Deo and V.Raghavendra., Ordinary Differential Equations and Stability Theory, Tata McGraw-Hill, New Delhi 1980.
3. George F. Simmons, Differential Equations with Application and Historical Notes, Tata McGraw Hill, New Delhi 1974

Paper 4: NUMERICAL METHODS

UNIT I:

SOLUTION OF NONLINEAR EQUATIONS: Newton‟s method – Convergence of Newton‟s method – Bairstow”s Method for quadratic factors.

NUMERICAL DIFFERENTIATION AND INTEGRATION: Derivatives from Differences tables – Higher order derivatives – Divided difference, Central- Difference formulas– Composite formula of Trapezoidal rule – Romberg integration – Simpson‟s rules.

UNIT II:

SOLUTION OF SYSTEM OF EQUATIONS: The Elimination method – Gauss and Gauss Jordan methods – LU Decomposition method – Matrix inversion by Gauss- Jordan method – Methods of Iteration – Jacobi and Gauss Seidal Iteration – Relaxation method – Systems of Nonlinear equations.

UNIT III:

SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS: Taylor series method – Euler and Modified Euler methods – Runge-kutta methods – Multistep methods – Milne‟s method – Adams Moulton method.

UNIT IV:

BOUNDARY VALUE PROBLEMS AND CHARACTERISTIC VALUE PROBLEMS: The shooting method – solution through a set of equations – Derivative boundary conditions – Characteristic value problems – Eigen values of a matrix by Iteration – The power method.

UNIT V:

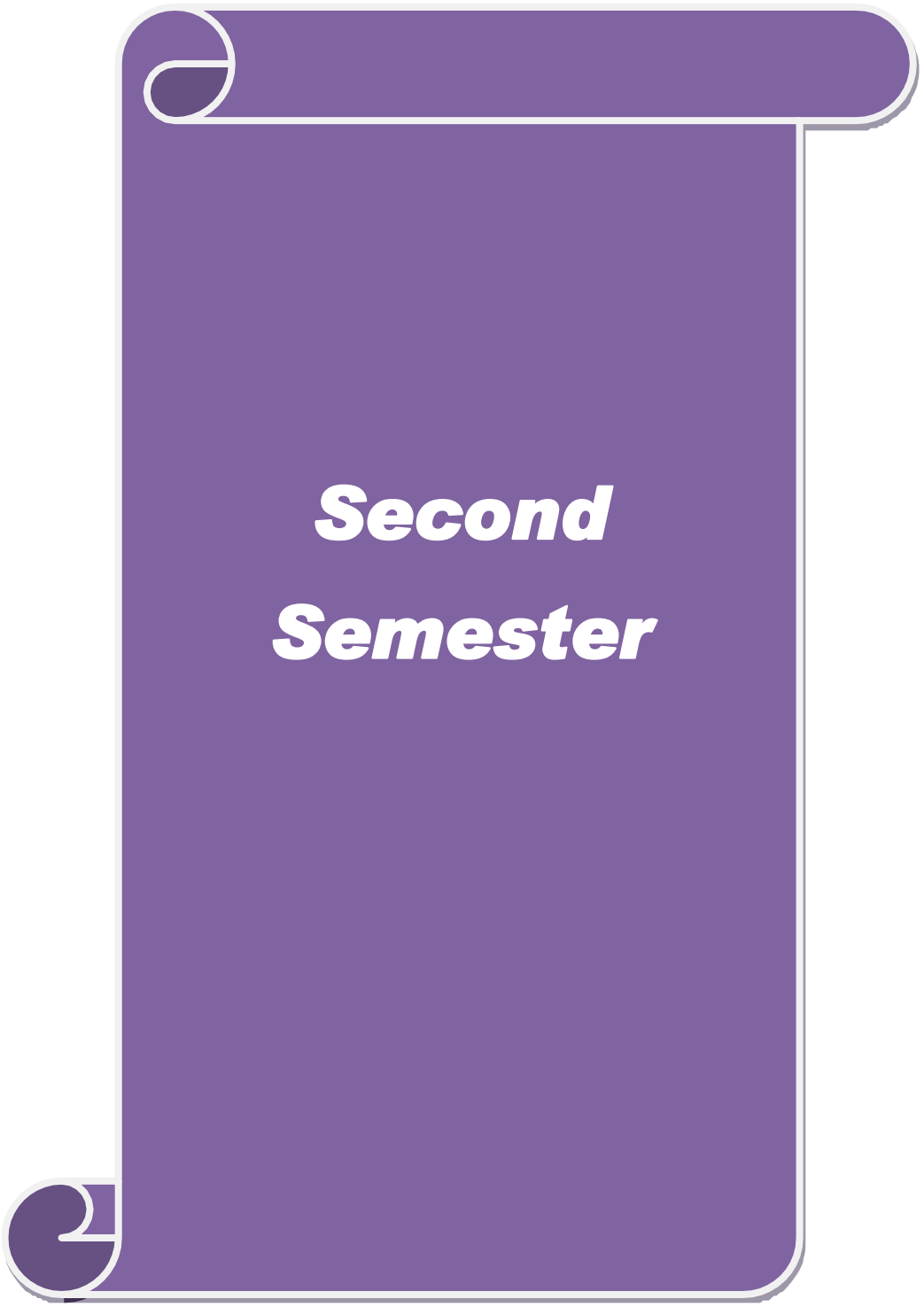
NUMERICAL SOLUTION OF PARTIAL DIFFERENTIAL EQUATIONS: (Solutions of Elliptic, Parabolic and Hyperbolic partial differential equations) Representation as a difference equation – Laplace‟s equation on a rectangular region – Iterative methods for Laplace equation – The Poisson equation – Derivative boundary conditions – Solving the equation for time-dependent heat flow (i) The Explicit method (ii) The Crank Nicolson method – solving the wave equation by Finite Differences.

Text Book:

APPLIED NUMERICAL ANALYSIS by C.F.Gerald and P.O.Wheatley, Fifth Edition, Addison Wesley, (1998).

Reference Books:

1. S.C. Chapra and P.C. Raymond: Numerical Methods for Engineers, Tata McGraw Hill, New Delhi, (2000)
2 .S.S. Sastry: Introductory methods of Numerical Analysis, Prentice Hall of India, New Delhi, (1998).
3 .P.Kandasamy et al., Numerical Methods, S.Chand & Co.Ltd., New Delhi(2003)


Second
Semester

Paper 5: LINEAR ALGEBRA

UNIT I: Linear transformations

Linear transformations – Isomorphism of vector spaces – Representations of linear transformations by matrices – Linear functionals.

UNIT II: Algebra of polynomials

The algebra of polynomials –Polynomial ideals - The prime factorization of a polynomial - Determinant functions.

UNIT III: Determinants

Permutations and the uniqueness of determinants – Classical adjoint of a (square) matrix – Inverse of an invertible matrix using determinants – Characteristic values – Annihilating polynomials.

UNIT IV: Diagonalization

Invariant subspaces – Simultaneous triangulations – Simultaneous diagonalization – Direct-sum decompositions – Invariant direct sums – Primary decomposition theorem.

UNIT V: The Rational and Jordan forms

Cyclic subspaces – Cyclic decompositions theorem (Statement only) – Generalized Cayley – Hamilton theorem - Rational forms – Jordan forms.

TEXT BOOK:

Kenneth M Hoffman and Ray Kunze, Linear Algebra, 2nd Edition, Prentice-Hall of India Pvt. Ltd, New Delhi, 2013.

UNIT I:	Chapter 3	: Sections 3.1-3.5
UNIT II:	Chapter 4	: Sections 4.1, 4.2, 4.4, 4.5
	Chapter 5	: Sections 5.1, 5.2
UNIT III:	Chapter 5	: Sections 5.3, 5.4
	Chapter 6	: Sections 6.1-6.3
UNIT IV:	Chapter 6	: Sections 6.4 - 6.8
UNIT V:	Chapter 7	: Sections 7.1 – 7.3

REFERENCE BOOKS:

1. M. Artin, *"Algebra"*, Prentice Hall of India Pvt. Ltd., 2005.
2. S.H. Friedberg, A.J. Insel and L.E Spence, *"Linear Algebra*", 4th Edition, Pritice-Hall of India Pvt. Ltd., 2009.
3. I.N. Herstein, *"Topics in Algebra*", 2nd Edition, Wiley Eastern Ltd, New Delhi, 2013.

Paper 6: COMPLEX ANALYSIS

UNIT I:

Introduction to the concept of analytic function: Limits and continuity – Analytic functions – Polynomials – Rational functions

Conformality: Arcs and closed curves – Analytic functions in regions – Conformal Mapping – Length and Area.

Linear Transformations: The Linear group – The Cross ratio – Elementary Riemann Surfaces.

UNIT II:

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 Removable singularities, Taylor‟s Theorem – Zeros and Poles – The Local Mapping– The Maximum principle – chains and cycles.

UNIT III:

The Calculus of Residues: The Residue theorem – The Argument principle – Evaluation of definite integrals.

Harmonic functions: The Definitions and basic Properties – Mean value property – Poisson‟s Formula.

UNIT IV:

Series and Product Developments: Weierstrass Theorem – The Taylor Series – The Laurent Series.

Partial fractions and Factorization: Partial Fractions – Infinite Products – Canonical Products.

UNIT V:

Elliptic functions

Simply Periodic Functions : Representation by Exponentials-The Fourier Development - Functions of Finite Order.

Doubly Periodic Functions: The Period Module-Unimodular Transformations - The Caninical Basis-General Properties of Elliptic Functions.

Weierstrass Theory: The Weierstrass $\wp$-function

Text Book:

Complex Analysis by L.V. Ahlfors, McGraw Hill, New York, 1979.

Unit I:	Chapter – 2	Sections 1.1 – 1.4
	Chapter – 3	Sections 2.1 – 2.4, 3.1, 3.2 and 3.4
Unit II:	Chapter – 4	Sections 1.1 – 1.5, 2.1 – 2.3, 3.1 - 3.4 and 4.1
Unit III:	Chapter – 4	Sections 5.1 – 5.3, 6.1 – 6.3
Unit IV:	Chapter – 5	Sections 1.1 – 1.3, 2.1 – 2.3
Unit V:	Chapter – 7	Sections 1.1 – 3.3

Paper 7: PARTIAL DIFFERENTIAL EQUATIONS

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UNIT I: PARTIAL DIFFERENTIAL EQUATIONS OF THE FIRST ORDER:

Partial Differential Equations – Origins of First Order Differential Equations – Cauchy‟s Problem for first order equations – Linear Equations of the first order – Nonlinear partial differential equations of the first order – Cauchy‟s method of characteristics – Compatible system of First order Equations – Solutions satisfying Given Condition, Jacobi‟s method

UNIT II: PARTIAL DIFFERENTIAL EQUATIONS OF THE 2nd ORDER:

The Origin of Second Order Equations – Linear partial Differential Equations with constant coefficients – Equations with variable coefficients – Separation of variables – The method of Integral Transforms – Non – linear equations of the second order.

UNIT III: LAPLACE'S EQUATION:

Elementary solutions of Laplace equation – Families of Equipotential Surfaces – Boundary value problems – Separation of variables – Surface Boundary Value Problems – Separation of Variables – Problems with Axial Symmetry – The Theory of Green‟s Function for Laplace Equation.

UNIT IV: THE WAVE EQUATION:

The Occurrence of the wave equation in Physics – Elementary Solutions of the One – dimensional Wave equations – Vibrating membrane, Application of the calculus of variations – Three dimensional problem – General solutions of the Wave equation.

UNIT V: THE DIFFUSION EQUATION:

Elementary Solutions of the Diffusion Equation – Separation of variables – The use of Integral Transforms – The use of Green‟s functions

TEXT BOOK:

Ian Sneddon – Elements of Partial Differential Equations – McGraw Hill International Book Company, New Delhi, 1983

REFERENCE BOOKS:

1. M.D. Raisinghania Advanced Differential Equations S. Chand and Company Ltd., New Delhi, 2001
2. K. Sankara Rao, Introduction to Partial Differential Equations, Second edition – Prentice – Hall of India, New Delhi 2006
3. J.N. Sharma & K. Singh Partial Differential Equations for Engineers & Scientists, Narosa Publishing House, 2001

Paper 8: MECHANICS

UNIT-I:

INDRODUCTORY CONCEPTS: Mechanical system – Generalized Coordinates – Constraints – Virtual Work – Energy and Momentum.

UNIT-II:

LAGRANGE'S EQUATIONS: Derivations of Lagrange‟s Equations: Derivations of Lagrange‟s Equations – Examples – Integrals of Motion.

UNIT-III:

HAMITON'S EQUATIONS: Hamilton‟s Principle – Hamilton‟s Equations.

UNIT-IV:

HAMILTON – JACOBI THEORY: Hamilton‟s Principle function – Hamilton – Jacobi Equation – Separability.

UNIT-V:

CANONICAL TRANSFORMATIONS: Differential forms and Generating Functions – Lagrange and Poisson Brackets.

Text Book:

D.T.Greenwood, Classical Dynamics, Dover Publication, New York, 1997.

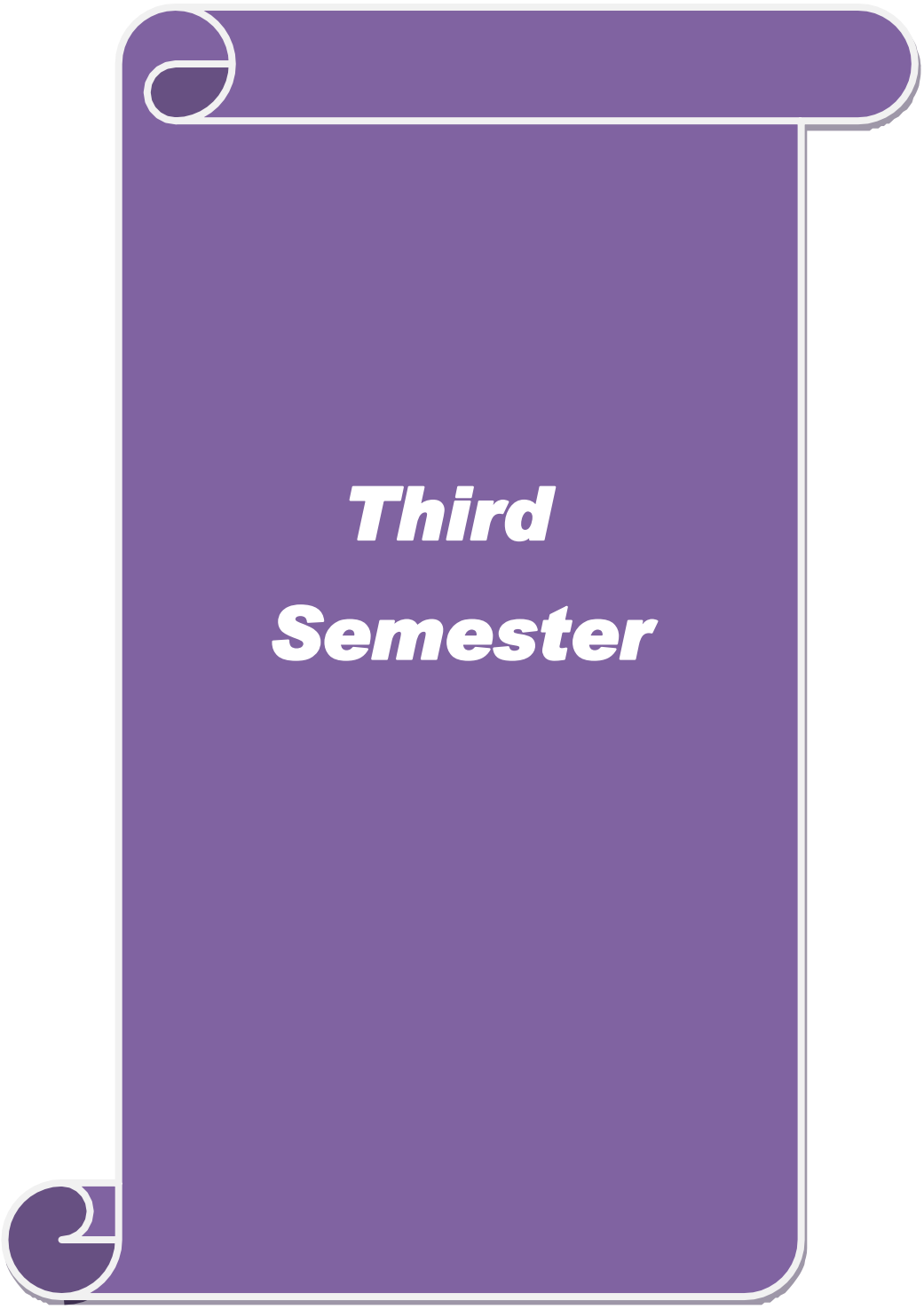
Unit-I:	Chapter 1:	Sections 1.1 – 1.5
Unit-II:	Chapter 2:	Sections 2.1 – 2.3
Unit-III:	Chapter 4:	Sections 4.1 – 4.2
Unit-IV:	Chapter 5:	Sections 5.1 – 5.3
Unit-V:	Chapter 6:	Sections 6.1, 6.3

Reference Books:

1.F. Gantmacher, Lectures in Analytic Mechanics, MIR Publishers, Moscow, 1975.

2.I.M. Gelfand and S.V. Fomin, Calculus of Variations, Prentice Hall.

3.S.L. Loney, An Elementary Treatise on Statics, Kalyani Publishers, New Delhi, 1979.


Third
Semester

Paper 9: TOPOLOGY

UNIT I:

Types of Topological Spaces and Examples - Basics for a topology - The order topology - The product topology on X x Y - The subspace topology - Closed sets and limits points - Continuous functions.

UNIT II:

The Product Topology - The metric topology - Sequence lemma- Uniform limit theorem- Connected spaces - Connected subspaces of the real line - Components and Local connectedness.

UNIT III:

Compact spaces - Compact subspaces of the real line -Uniform continuity theorem - Limit Point Compactness – complete metric spaces –compactness in metric spaces.

UNIT IV:

First and Second countable spaces - Lindeloff and Separable spaces - Countability axioms - The separation axioms - Normal spaces - The Uryshon‟s lemma.

Unit V:

The Urysohn Metrization Theorem - Tietze Extension Theorem - The Tychonoff theorem – Stone Cech compactifications.

TEXT BOOK:

James R.Munkres, Topology (Second Edition), Prentice – Hall of India, Private Ltd, New Delhi (2006).

REFERENCE BOOKS:

1. G.F.Simmons, Introduction to Topology and Modern Analysis, Tata McGraw-Hill Edition, New Delhi (2004).
2. Fred H.Croom, Principles of Topology, Cengage India Pvt Ltd, New Delhi (2009)
3. Seymour Lipschutz, Theory and Problems of General Topology, McGraw-Hill Edition,New Delhi (2006).

PAPER 10: FLUID DYNAMICS

UNIT I:

Introductory Notions – Velocity – Stream Lines and Path Lines – Stream Tubes and Filaments – Fluid Body – Density – Pressure. Differentiation following the Fluid – Equation of continuity – Boundary conditions – Kinematical and physical – Rate of change of linear momentum – Equation of motion of an inviscid fluid.

UNIT II:

Euler‟s momentum Theorem – Conservative forces – Bernoulli‟s theorem in steady motion – energy equation for inviscid fluid – circulation – Kelvin‟s theorem – vortex motion – Helmholtz equation.

UNIT III:

Two Dimensional Motion – Two Dimensional Functions – Complex Potential – basic singularities – source – sink – Vortex – doublet – Circle theorem. Flow past a circular cylinder with circulation – Blasius Theorem – Lift force. (Magnus effect)

UNIT IV:

Viscous flows – Navier-Stokes equations – Vorticity and circulation in a viscous fluid – Steady flow through an arbitrary cylinder under pressure – Steady Couettc flow between cylinders in relative motion – Steady flow between parallel planes.

UNIT V:

Laminar Boundary Layer in incompressible flow: Boundary Layer concept – Boundary Layer equations – Displacement thickness, Momentum thickness – Kinetic energy thickness – integral equation of boundary layer – flow parallel to semi infinite flat plate – Blasius equation and its solution in series.

TEXT BOOKS:

For Units I and II: Theoretical Hydro Dynamics by L.M. Milne Thomson, Macmillan Company, 5th Edition (1968).

Chapter I	:	Sections 1.0 – 1.3., 3.10-3.41 (omit 3.32)
Chapter III	:	Sections 3.42 – 3.53 (omit 3.44)

For Units III, IV and V: Modern Fluid Dynamics (Volume I) by N. Curlea and H.J. Davies, D Van Nostrand Company Limited., London (1968).

Chapter III	:	Sections 3.1	– 3.7.5 (omit 3.3.4, 3.4, 3.5.2,3.6)
Chapter V	:	Sections 5.1	– 5.3.3
Chapter VI	:	Sections 6.1	– 6.3.1 (omit 6.2.2., 6.2.5)

References:

1. F.Chorlton, Textbook of Fluid Dynamics, CBS Publishers, New Delhi, 2004.
2.A.J.Chorin and A.Marsden, A Mathematical Introduction to Fluid Dynamics, Springer-Verlag, New York, 1993.

Paper 11: MATHEMATICAL STATISTICS

UNIT– I:
Probability and Distributions: Introduction - Set Theory - The Probability Set Function - Conditional Probability and Independence –Random Variables - Discrete Random Variables- Continuous Random Variables.

UNIT – II:
Probability and Distributions (continued): Expectation of a Random Variables - Some Special Expectations - Important Inequalities.

Multivariate Distributions: Distributions of Two Random Variables - Transformations: Bivariate Random Variables - Conditional Distributions and Expectations - Independent Random Variables.

UNIT – III:
Some Special Distributions: The Binomial and Related Distributions - The Poisson Distribution - The Γ, $\chi 2$, and β Distributions - The Normal Distribution.

UNIT – IV:
Some Special Distributions (continued): t and F-Distributions.

Unbiasedness, Consistency and Limiting Distributions: Expectations of Functions - Convergence in Probability - Convergence in Distribution - Central Limit Theorem.

UNIT– V:
Some Elementary Statistical Inferences: Sampling and Statistics – More on Confidence Intervals - Introduction to Hypothesis Testing - Additional Comments About Statistical Tests - Chi-Square Tests – The Method of Monte Carlo.

Text Book:

Introduction to Mathematical Statistics By Robert V. Hogg, Allen T. Craig and Joseph W. McKean. Pearson, 6th Edn.(2005).
Unit-I: 1.1 – 1.7, Unit-II: 1.8 – 1.10, 2.1 – 2.3, 2.5, Unit-III: 3.1 – 3.4, Unit-IV: 3.6, 4.1 – 4.4, Unit-V: 5.1, 5.4 – 5.8.

Reference Books:

1. The R Book By Michael J. Crawley. John Wiley & Sons, 2nd Edn. (2013).
2. Probability Theory and Mathematical Statistics By Marek Fisz. John Wiley.
3. Statistical Inference By M. Rajagopalan and P. Dhanavanthan. PHI Learning Pvt. Ltd., New Delhi (2012).
4. An Introduction to Probability and Statistics By Vijay K. Rohatgi and A.K. Md. Ehsanes Saleh. Wiley India, 2nd Edn. (2001).

PAPER 12: GRAPH THEORY

UNIT I:

Graphs, Subgraphs: Graphs and Simple Graphs– Graph Isomorphism – The Incidence and Adjacency matrices, Subgraphs – Vertex Degrees – paths and Connection – Cycles.

Trees: Trees – Cut edges and Bonds – cut vertices – Cayley‟s formula

UNIT II:

Connectivity: Connectivity – Blocks.

Euler tours and Hamilton Cycles: Euler tours - Hamilton Cycles

UNIT III:

Matchings: Matchings coverings in Bipartite Graphs – Perfect Matchings.

Edge colourings: Edge chromatic number – Vizing‟s theorem.

UNIT IV:

Independent sets, Cliques: Independent sets – Ramsey‟s theorem.

Vertex Colourings: Chromatic Number – Brook‟s Theorem – Hajo‟s Conjecture – Chromatic Polynomials – Girth and Chromatic number.

UNIT V:

Planar Graphs: Plane and planar Graphs – Dual Graphs – Euler‟s formula – Brides – Kuratowski‟s theorem (Proof omitted) – The Five Colour Theorem and the Four Colour Conjecture

Directed Graphs: Directed Graphs

Simple problems in the exercise of all units can also be included.

Text Book:

J.A.Bondy and U.S.R.Murty, Graph Theory with Applications, American Elsevier Publishing Company Inc., New York, 1976.

Unit-I:	Sections:	1.1	– 1.7 and 2.1 – 2.4.
Unit-II:	Sections:	3.1	– 3.2 and 4.1 – 4.2
Unit-III:	Sections:	5.1	– 5.3 and 6.1 – 6.2
Unit-IV:	Sections:	7.1	-7.2 and 8.1 – 8.5
Unit-V:	Sections:	9.1	–9.6 and 10.1

REFERENCE BOOKS:

1. Harary F , Graph Theory, Addison –Wesley , Reading Mass, 1969.
2. M.Murugan, Graph Theory and Algorithms, Second Edition, Muthali Publishing House, Chennai, 2018.
3. K.R.Parthasarathy, Basic Graph Theory, Tata McGraw Hill, New Delhi,1994.
4. D.B.West, Introduction to graph theory, Prentice Hall of India, 2001.


Fourth
Semester

Paper 13: FUNCTIONAL ANALYSIS

UNIT I:

Banach spaces – The definition and some examples – Continuous linear transformations – The Hahn-Banach theorem –Dual spaces- The natural imbedding of N in N** - The open mapping theorem - Closed Graph theorem.

UNIT II:

The conjugate of an operator – Uniform boundedness Principal - Hilbert spaces – The definition and some simple properties – Orthogonal complements and complements - Orthonormal sets and sequences – Maximal Othonormal sets.

UNIT III:

The Conjugate space H* - Representation of functional on Hilbert spaces -The adjoint of an operator – Self-adjoint operators – Normal and unitary operators – Projections.

UNIT IV:

Matrices – Determinants and the spectrum of bounded operator – The spectral theorem.

UNIT V:

The definition and some examples of Banach algebra – Regular and singular elements – Topological divisors of zero – The spectrum – The formula for the spectral radius.

Text Book:

G.F. Simmons, Introduction to Topology and Modern Analysis, McGraw–Hill Book Company, London, 1963.

Unit I:	Sections: 46 – 50.
Unit II:	Sections: 51 – 54.
Unit III:	Sections: 55 – 59.
Unit IV:	Sections: 60 – 63.
Unit V:	Sections: 64 – 68.

Reference Books:

1.C. Goffman and G. Pedrick, A First Course in Functional Analysis, Prentice Hall of India, New Deli, 1987.

2.G. Bachman and L. Narici, Functional Analysis, Academic Press, New York, 1966.

3.L.A. Lusternik and V.J. Sobolev, Elements of Functional Analysis, Hindustan Publishing Corporation, New Delhi, 1971.

Paper 14: MATHEMATICAL METHODS

UNIT I: INTEGRAL EQUATIONS: Types of Integral equations – Integral Fredholm Alternative - Approximate method – Equation with separable Kernel - Volterra integral equations – Fredholm‟s theory.

UNIT II: APPLICATION OF INTEGRAL EQUATIONS TO ORDINARY INTEGRAL EQUATIONS and SINGULAR INTEGRAL EQUATIONS: Initial value problems Boundary value problems – singular integral equations – Abel Integral equation

UNIT III: FOURIER TRANSFORMS: Fourier Transforms, Fourier sine and cosine transforms – Fourier transforms of derivatives - convolution integral – Parseval‟s Theorem - Solution of Laplace Equations by Fourier transform.

UNIT IV: HANKEL TRANSFORMS: Properties of Hankel Transforms – Hankel transformation of derivatives of functions - The Parseval‟s relation – relation between Fourier and Hankel transforms - Axisymmetric Dirichlet problem for a half space - Axisymmetric Dirichlet problem for a thick plate.

UNIT V: CALCULUS OF VARIATIONS: Variation and its properties – Euler‟s(Euler Lagrange‟s) equation – functionals dependent on the functions of several independent variables – variational problems in parametric form –applications.

TEXT BOOKS:

1. Linear Integral Equations Theory and Technique by R.P.Kanwal, Academic Press, New York, 1971.

Unit I	:	Chapter 2:	2.4 - 2.7, 2.9 – 2.10, 2.16 – 2-(a).(c) 2.16.
Unit II	:	Chapter 5:	5.2 – 5.4, 5.6 – 5.7, 5.10 – 5.12.

2. The Use of Integral Transforms by I.N.Sneddon, McGraw-Hill, NewYork, 1972.

Unit III	:Chapter 2:	2.3 - 2.5,	Chapter 3:	3.3- 3.4.
Unit IV	:Chapter 5:	5.1 – 5.2,	Chapter 8:	8.1– 8.2.

3. Differential Equations and Calculus of Variations by L.Elsgolts, Mir Publishers, Moscow, 1970.

Unit V	:	Chapter 6:	6.1-6.3,6.4-6.7

Paper 15: OPTIMIZATION TECHNIQUES

PRE REQUISITES: The learner should have basic knowledge from linear programming, simplex and dual simplex method and graphical method**.**

UNIT I: INTEGER PROGRAMMING: Introduction – Integer Programming Formulations – Gomory‟s construction–Fractional cut method(all integer)–The Cutting – Plane Algorithm – Branch–and–Bound Technique – Zero–One Implicit Enumeration Algorithm.

UNIT II: DYNAMIC PROGRAMMING: Introduction – Application of Dynamic Programming: Capital Budgeting Problem – Reliability Improvement Problem – Stage–coach Problem – Cargo Leading Problem – Minimizing Total Tardiness in Single Machine Scheduling Problem – Optimal Subdividing Problem – Solution of Linear Programming Problem through Dynamic Programming.

UNIT III: INVENTORY: Introduction–Inventory Decisions–Cost Associated– with Inventories –Factors Affecting inventory–Economic Order Quantity–Deterministic Inventory Problems with No Shortages–Deterministic inventory Models with shortages–EOQ with Price Breaks–Multi Item Deterministic problems–Inventory Problems with Uncertain Demand.

UNIT IV: QUEUING THEORY: Introduction–Queuing System–Elements Of Queuing System–Operating Characteristics of Queuing System–Classification of Queuing Models–Model–I(M/M/1):(∞/FIFO),Model–II(M/M/1) : (N/FIFO),Model–III(M/M/C):(∞/FIFO), Model–IV(M/M/C):(N/FIFO).Problems in above four models.

UNIT V: NON LINEAR PROGRAMMING: Introduction – Lagrangean Method –Jacobi Method– Kuhn–Tucker Method – Quadratic Programming – Separable Programming – Chance–Constrained Programming or Stochastic Programming.

TEXT BOOK:

Hamdy A. Taha, Operations Research(sixth edition) Prentice–Hall of India private Limited, New Delhi,1997.

REFERENCE BOOKS:

1. Kanti Swarup, P.K. Gupta, Man Mohan, Operations Research, Sultan Chand & Sons, Educational Publishers, New Delhi.
2. Panneerselvam.R, Operations Research, 2nd Edition, PHI Learning Private Limited, Delhi, 2015
3. Hiller.F.S & Lieberman.J Introduction to Operation Research ,7th Edition, Tata– MCGraw Hill Publishing Company, NewDelhi, 2001.
4. Prem Kumar Gupta.Er, Hira.D.S. Operations Research,7th Edition,S.Chand & Company Pvt.Ltd.2014.
5. I.Griva, S.G.Nash and A.Sofer, Linear and Nonlinear Optimization, SIAM Publication, Universities Press(India) Pvt Ltd,2018.

PAPER 16: COMPUTER PROGRAMMING (C++ THEORY)

UNIT I:

Basic Concept of Object-Oriented Programming: Benefits of OOP – Object-Oriented Languages –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 – Operations in C++ - Scope Resolution Operator – Member Dereferencing Operators – Memory Management Operators – Manipulators – Type Cast Operator – Expressions and Their Types – Special Assignment Expressions – Implicit Conversions – Operator Over Loading – Operator Precedence –Control Structures.

UNIT II:

Functions in C++: 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.

Managing Console I/O Operations: Introduction – C++ Streams – C++ Stream Classes – Unformatted I/O Operations - Formatted I/O Operations – Managing Output with Manipulators.

UNIT III:

Classes and Objects: Introduction – C Structures Revisited – Specifying a Class – Defining Member Functions – A C++ Program with Class – Making An Outside Function Inline –Nesting Of Member Functions – Private Member Functions – Arrays Within A Class – Memory Allocation for Objects – Static Data Members – Static Member Functions – Arrays of Objects – Objects as Function Arguments – Friendly Functions – Returning Objects – const Member Functions.

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

UNIT IV:

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

Inheritance - 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 – Constructors in Derived Classes – Member Classes: Nesting of Classes.

UNIT-V:

Working with Files: Introduction – Classes for File Stream Operations - Opening and Closing a File – Detecting End-of-File – More about open( ): File Modes – File Pointers and their Manipulations – Sequential Input and Output Operations – Updating a File: Random Access – Error Handling During File Operations.

Text Book:

Object–Oriented Programming with C++ by E. Balaguruswamy, Tata McGraw-Hill Publishing Company Limited, Sixth Edition.

Unit I : 1.4 – 1.6 and 3.1 – 3.25
Unit II : 4.1 – 4.12 and 10.1 – 10.6
Unit III : 5.1 – 5.17, 6.1 – 6.7 and 6.10 – 6.11
Unit IV : 7.1 – 7.8 and 8.1 – 8.12
Unit V : 11.1 – 11.9

PRACTICAL - COMPUTER PROGRAMMING (C++ PRACTICAL)

1. friend FUNCTION usage: Create two classes to store the value of distances in meters-centimetres and feet-inches. Write a program that can create the values of the class objects and add one object with another. Use a friend function to carry out addition operation. The result may be stored in any object depending on the units in which results are required. The display should be in the order of meters & centimetre and feet & inches depending on the order of display.

2. OVERLOADING OBJECTS: Create a class that contains one float data member. Overload all the four arithmetic operators so that operate on the objects of the class.

3. OVERLOADING CONVERSIONS: Design a class **Polar** which describes a point in a plane using polar co-ordinates **radius** and **angle**. Use the overloaded + operator to add two objects of **Polar**. Note that we cannot add polar values of two points directly. This requires first the conversion of points into rectangular co-ordinates and finally converting the result into polar co-ordinates. You need to use following trigonometric formulae: *= r * cos (a); = r * sin (a);= ; = ∗ + ∗ .*

4. OVERLOADING VECTOR: Define a class for Vector containing scalar values. Apply overloading concepts for Vector Addition, Multiplication of a Vector by a scalar quantity, replace the values in a Position Vector.

5. OVRELOADING MATRIX:
Create a class **MAT** of size m * n. Define all possible matrix operations for **MAT** type objects. Verify the identity: $(A-B)^2 = A^2+B^2 - 2AB$.

6. INHERITANCE: Create three classes: **alpha, beta** and **gamma**, each containing one data member. The class **gamma** should be inherited from both **alpha** and **beta**. Use a constructor function in the class **gamma** to assign values to the data members of all the classes. Write a program to print the value of data members of all the three classes.

7. FILE HANDLING: Write a program to create a disk file containing the list of names and telephone numbers in two columns, using a class object to store each set of data. Design an interactive menu to access the file created and to implement the following tasks:
(a) Determine the telephone number of the specified person.
(b) Determine the name if a telephone number is known.
(c) Update the telephone number, whenever there is a change.


Elective
Course

ELECTIVE PAPERS

Elective 1: NUMBER THEORY

UNIT I: Divisibility and Euclidean algorithm.

UNIT II: Congruences, Euler‟s theorem, Wilson‟s Theorem. Solutions of congruences, Congruences of Degree 1. Chinese Remainder Theorem, The functions $\phi(n)$, Congruences of higher degree

UNIT III: Prime power moduli, Prime modulus. Quadratic residues.- Quadratic reciprocity.

UNIT IV: The Jacobi symbol – Greatest integer function - Arithmetic functions – The Moebius Inversion formula

UNIT V: Multiplication of arithmetic functions, Linear Diophantine equations – The equation $x^2 + y^2 = z^2$ - The equation $x^4 + y^4 = z^2$.

Text Book:

.An Introduction to Theory of Numbers by Ivan Nivan and Herberts Zucherman. Third Edition, 1972, Wiley Eastern Limited, New Delhi.

Unit-I:	Chapter I:	Sections 1.1 – 1.3
Unit-II:	Chapter II:	Section: 2.1 – 2.5
Unit-III:	Chapter II:	Section: 2.6 – 2.7
	Chapter III:	Sections: 3.1 – 3.2
Unit-IV:	Chapter III:	Sections: 3.3
	Chapter IV:	Sections:4.1-4.3
Unit-V:	Chapter IV:	Sections:4.4
	Chapter V:	Section: 5.1-5.6

Reference Books:

1.T.M. Apostol, Introduction to Analytic Number Theory, Springer Verlag, 1976.

2.Kennath and Rosan, Elementary Number Theory and its Applications, Addison Wesley Publishing Company, 1968.

3.George E. Andrews, Number Theory, Hindustan Publishing, New Delhi, 1989.

ELECTIVE 2: DIFFERENTIAL GEOMETRY

UNIT I:

Curves: Analytic representation - Arc Length – Osculation plane.

UNIT II:

Curvature torsion – Formulas of Frenet - Contact – Natural equations – Helices – General solutions of Natural equations.

UNIT III:

Evolutes and Involutes - Elementary theory of surface: Analytic representation.

UNIT IV:

First fundamental form – Normal, Tangent plane – Developable surfaces - Second fundamental form.

UNIT V:

Meusnier‟s theorem – Euler‟s Theorem – Dupin‟s indicatrix – Some surfaces.

Text Book:

D. Struik, Lectures on Classical Differential Geometry, Addison Wesley Publishing Company, 1961.

ELECTIVE 3: NEURAL NETWORKS

UNIT I:

Mathematical Neuron Model- Network Architectures- Perceptron-Hamming Network- Hopfield Network-Learning Rules.

UNIT II:

Perceptron Architectures and Learning Rule with Proof of Convergence. Supervised Hebbian Learning -Linear Associator.

UNIT III:

The Hebb Rule-Pseudo inverse Rule-Variations of Hebbian Learning-Back Propagation - Multilayer Perceptrons.

UNIT IV:

Back propagation Algorithm-Convergence and Generalization - Performances Surfaces and Optimum Points-Taylor series.

UNIT V:

Directional Derivatives - Minima-Necessary Conditions for Optimality-Quadratic Functions-Performance Optimizations-Steepest Descent-Newton‟s Method-Conjugate Gradient.

Text Book:

Martin T.Hagan, Howard B. Demuth and Mark Beale, Neural Network Design,Vikas Publishing House, New Delhi,2002.

Reference Books:

1. James A. Freeman, David M. Skapura, Neural Networks Algorithms, Applications and Programming Techniques, Pearson Education, 2003.
2. Robert J. Schalkoff, Artificial Neural Network, McGraw-Hill International Edition, 1997.

ELECTIVE 4: MAGNETOHYDRODYNAMICS

UNIT I:

Electromagnetism – Fundamental Laws – Electrostatic Energy – Electrodynamics Ampere‟s Law – Lorentz force on a moving charge – Magnetostatic Energy – Faraday‟s Law of Induction – Poynting stresses.

UNIT II:

Electromagnetic Equations with respect to moving axes – boundary conditions of electric and magnetic fields. Kinematics of fluid motion – equation of continuity – Stress tensor – Navier-stokes equations – boundary condition – Velocity Magneto fluid dynamic equations.

UNIT III:

MHD approximation – equation of Magnetic diffusion in a moving conducting medium – Magnetic Reynolds number.

UNIT IV:

Alfven‟s theorem Law of isorotation - Magneto hydrostatics – Force-free field – Alfven waves in incompressible MHD.

UNIT V:

Incompressible viscous flows in the presence of magnetic field – Hartmann Flow – unsteady Hartmann flow – Magneto fluid dynamic pipe flow.

Text Books:

1. Crammer K.R. and Pai S.I, Magneto Fluid Dynamics for Engineers and Applied Physicists, McGraw Hill, 1973.
2. Ferraro, VCA and Plumpton, Introduction to Magneto Fluid Dynamics, Oxford, 1966.

ELECTIVE 5: FUZZY LOGIC AND FUZZY SETS

UNIT-I: CRISP SETS AND FUZZY SETS

Introduction-Crisp sets: An over view-The Notion of Fuzzy Sets-basic concepts of Fuzzy Sets – Classical Logic: complement-Fuzzy Union-Fuzzy interaction – Combination of operations – General aggregation of operations.

UNIT-II: FUZZY RELATIONS

Crisp and Fuzzy relations – Binary relations – Binary relations on a single set – Equivalence and similarity relations – Compatibility on Tolerance Relations-Orderings – Morphism – Fuzzy relations Equations.

UNIT-3: FUZZY MEASURES

General discussion – Belief and plausibility Measures –Probability measures – Possibility and Necessity measures .

UNIT-4: FUZZY MEASURES, UNCERTAINTY

Relationship among classes of fuzzy measures - Types of Uncertainty – Measures of Fuzziness-Classical Measures of Uncertainty .

UNIT-5: UNCERTAINTY AND INFORMATION

Measures of Dissonance-Measures of Confusion – Measures of Non-Specificity – Uncertainty and Information – Information and Complexity – Principles of Uncertainty and information.

Text Book:

George J. Klir and Tina A. Folger - Fuzzy Sets, Uncertainty and Information. Prentice Hall of India Private Limited [Fourth printing. June 1995].

Unit-I: 1.1 – 1.5, 2.2 - 2.6, Unit-II: 3.1 – 3.8, Unit-III: 4.1 – 4.4, Unit-IV: 4.5, 5.1 – 5.3, Unit-V: 5.4 – 5.9.

Reference Book:

1. George J. Klir and Boyuan - Fuzzy Sets and Fuzzy Logic - Theory and Applications, Prentice-Hall of India Private Limited

ELECTIVE 6: CONTROL THEORY

UNIT I:

OBSERVABILITY: Linear Systems – Observability Grammian – Constant coefficient systems – Reconstruction kernel – Nonlinear Systems

UNIT II:

CONTROLLABILITY: Linear systems – Controllability Grammian – Adjoint systems – Constant coefficient systems – steering function – Nonlinear systems

UNIT III:

STABILITY: Stability – Uniform Stability – Asymptotic Stability of Linear Systems.

UNIT IV:

Linear time varying systems – Perturbed linear systems – Nonlinear systems

UNIT V:

STABILIZABILITY: Stabilization via linear feedback control – Bass method – Controllable subspace – Stabilization with restricted feedback

Text Book:

Elements of Control Theory by K.Balachandran and J.P.Dauer, Narosa, New Delhi, 1999.

Reference Books:

1. Linear Differential Equations and Control by R.Conti, Academic Press, London, 1976.
2. Functional Analysis and Modern Applied Mathematics by R.F.Curtain and A.J.Pritchard, Academic Press, New York, 1977.
3. Controllability of Dynamical Systems by J.Klamka, Kluwer Academic Publisher, Dordrecht, 1991.
4. Mathematics of Finite Dimensional Control Systems by D.L.Russell, Marcel Dekker, New York, 1979.
5. E.B. Lee and L. Markus, Foundations of optimal Control Theory, John Wiley, New York, 1967

ELECTIVE 7: CRYPTOGRAPHY

UNIT I:

Introduction – Encryption and Secrecy – The objective of Cryptography - Number Theory – Introduction – Modular Arithmetic.

UNIT II:

Integer factorization problem – Pollard‟s rho factoring – Elliptic curve factoring – Discrete logarithm problem

UNIT III:

Finite fields – Basic properties – Arithmetic of polynomials –Factoring polynomials over finite fields – Square free factorization

UNIT IV:

Symmetric key encryption – Stream ciphers – Block Ciphers – DES

UNIT V:

Public key cryptography – Concepts of public key cryptography – Modular arithmetic – RSA – Discrete logarithm – Elliptic curve cryptography

Reference Books:

1. Hans Delfs, Helmut Knebl, Introduction to Cryptography, Springer Verlag, 2002
2. Alfred J. Menezes, Paul C. Van Oorschot, Scott A. Vanstone, Handbook of Applied Cryptography, CRC Press, 2000
3. William Stallings, Cryptography and Network Security, Prentice Hall of India, 2000

ELECTIVE 8 : MATLAB

Unit – I:
STARTING WITH MATLAB: Starting MATLAB, MATLAB Windows - Working in the Command Window - Arithmetic Operations with Scalars - Display Formats - Elementary Math Built-In Functions - Defining Scalar Variables - Useful Commands for Managing Variables - Script Files - Examples of MATLAB Applications.

CREATING ARRAYS: Creating a One-Dimensional Array (Vector) - Creating a Two-Dimensional Array (Matrix) - Notes about Variables n MATLAB - The Transpose Operator - Array Addressing - Using a Colon : In Addressing Arrays - Adding Elements to ExistingVariables - Deleting Elements - Built-In Functions for Handling Arrays - Strings and Strings as Variables.

Unit – II:
MATHEMATICAL OPERATIONS WITH ARRAYS: Addition and Subtraction - Array Multiplication - Array Division - Element-By-Element Operations - Using Arrays In MATLAB Built-In Math Functions - Built-In Functions For Analyzing Arrays - Generation Of Random Numbers - Examples Of MATLAB Applications.

USING SCRIPT FILES AND MANAGING DATA: The MATLAB Workspace and the Workspace Window - Input To A Script File - Output Commands - The Save And Load Commands - Importing And Exporting Data - Examples Of MATLAB Applications.

Unit – III:
TWO-DIMENSIONAL PLOTS: The plot Command - The fplot Command - Plotting Multiple Graphs in the Same Plot - Formatting a Plot - Plots With Logarithmic Axes - Plots With Error Bars - Plots With Special Graphics - Histograms - Polar Plots - Putting Multiple Plots on the Same Page - Multiple Figure Windows - Examples of MATLAB Applications.

THREE-DIMENSIONAL PLOTS: Line Plots - Mesh and Surface Plots - Plots With Special Graphics - The View Command - Examples owMatlab Applications.

Unit – IV:
PROGRAMMING IN MATLAB: Relational and Logical Operators - Conditional Statements - The Switch-Case Statement - Loops - Nested Loops and Nested Conditional Statements - The Break and Continue Commands - Examples of MATLAB Applications.

USER-DEFINED FUNCTIONS AND FUNCTION FILES: Creating A Function File - Structure of a Function File - Local And Global Variables - Saving A Function File - Using A User- Defined Function - Examples of Simple User-Defined Functions - Comparison Between Script Files and Function Files - Anonymous And Inline Functions - Function Functions - Subfunctions
- Nested Functions - Examples Of MATLAB Applications.

Unit – V:
POLYNOMIALS, CURVE FITTING, AND INTERPOLATION: Polynomials - Curve Fitting - Interpolation - The Basic Fitting Interface - Examples of MATLAB Applications.

APPLICATIONS IN NUMERICAL ANALYSIS: Solving an Equation with One Variable - Finding a Minimum or a Maximum of a Function - Numerical Integration - Ordinary Differential Equations - Examples of MATLAB Applications.

Treatment as in:
MATLAB An Introduction with Applications By AmosGilat. JOHN WILEY & SONS, INC., 2011.

Reference Books:

1. Getting Started with MATLAB – A Quick Introduction for Scientists and EngineersBy RUDRA PRATAP. Oxford University Press.
2. Introduction to MATLAB 7 for Engineers By William John Palm. McGraw-Hill Professional, 2005.
3. Introduction to MATLAB 7 By Dolores M. Etter, David C. Kuncicky, Printice Hall, 2004.

ELECTIVE 8: MATLAB

List of Practical Problems

1. Solve the following system of five linear equations:

$$3u + 1.5v + w + 0.5x + 4y = -11.75$$
$$-2u + v + 4w - 3.5x + 2y = 19$$
$$6u - 3v + 2w + 2.5x + y = -23$$
$$u + 4v - 3w + 0.5x - 2y = -1.5$$
$$3u + 2v - w + 1.5x - 3y = -3.5$$

Verify the solution by substituting in all the 5 equations.

2. Create a script file to write a program for saving the output in two files using „fprintf" command. The program should generate two unit conversion tables. One table converts velocity units from miles per hour to kilometres per hour, and the other table converts force units from pounds to newtons. Save each conversion table to a different text file.

3(a) Plot the function $f(x)=\cos x \sin(2x)$ and its derivative, both on the same plot, for $\pi \le x \le \pi$. Plot the function with a solid line, and the derivative with a dashed line. Add a legend and label the axes.

(b) Plot the function, $r = 3\cos^2(0.5\theta) + \theta$ for $0 \le \theta \le 2\pi$ using „polar" command.

4. Write a program in a script file that determines e^x by using the Taylor series representation. The program calculates e^x by adding terms of the series and stopping when the absolute value of the term that was added last is smaller than 0.0001. Use a „`while-end`" loop, but limit the number of passes to 30. If in the 30th pass the value of the term that is addedis not smaller than 0.0001, the program stops and displays a message that more than 30 terms are needed. Use the program to calculate e^2, e^{-4}, and e^{21}.

5. Write a programmeinascript file that determines the real roots of a quadratic equation $ax^2 + bx + c = 0$. Name the file „quadroots". When the file runs, it asks the user to enter the values of the constants *a*, *b*, and *c*. To calculate the roots of the equation theprogram calculates the discriminant *D*, given by:

$$D = b^2 - 4ac.$$

If $D > 0$, the program displays message "The equation has two roots," and the roots are displayed in the next line.

If $D = 0$, the program displays message "The equation has one root," and the root is displayed in the next line.

If $D < 0$, the program displays message "The equation has no real roots."

Run the script file in the Command Window three times to obtain solutions to the following three equations:

(*a*) $2x^2 + 8x + 8 = 0$, (*b*) $-5x^2 + 3x - 4 = 0$, (*c*) $-2x^2 + 7x + 4 = 0$.

6. The following data points, which are points of the function $f(x) = 1.5^x \cos(2x)$, are given. Use „linear", „spline", and „pchip" interpolation methods to calculate the value of *y* between the points. Make a figure for each of the interpolation methods. In the figure show the points, a plot of the function, and a curve that corresponds to the interpolation method.

X	0	1	2	3	4	5
Y	1.0	–0.6242	–1.4707	3.2406	–0.7366	–6.3717

Also, use the „Basic Fitting Interface Tool" to show the equation, plot residuals, norm of residuals and the fit.

7. Solve: $\frac{dy}{dx} = \sqrt{x} + \frac{x^2\sqrt{y}}{4}$ for $1 \le x \le 5$ with $y(1) = 1$. Plot the solution.

ELECTIVE 9: LaTex

UNIT I:

Text formatting, TEX and its offspring, What‟s different in LATEX 2ϵ, Distinguishing LaTex 2ϵ, Basics of a LaTex file.

UNIT II:

Commands and Environments–Command names and arguments, Environments, Declarations, Lengths, Special Characters – Spaces and carriage returns, Quotation marks, Hyphens and dashes, Printing command characters, The date, Exercises.

UNIT III:

Document Layout and Organization – Document class, Page style, Parts of the document, Table of contents – Automatic entries, Printing the table of contents, Fine-Tuning text – Line breaking, Page breaking. Displayed Text – Changing font – Emphasis, Choice of font size, Font attributes, Centering and indenting, Lists.

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UNIT IV:

Tables, Printing literal text, Footnotes and marginal notes.

UNIT V:

Mathematical Formulas – Mathematical environments, Main elements of math mode, Mathematical symbols – Greek letters, function names, Additional elements, Fine–tuning mathematics – Horizontal spacing, Selecting font size in formulas.

Text book:

A Guide to LATEX by H. Kopka and P.W. Daly, - Third Edition, Addison – Wesley, London,1999.

Unit I : Chapter 1 : Sections : 1.1-1.3, 1.4.1, 1.5.
Unit II : Chapter 2 : Sections : 2.1-2.4, 2.5.1-2.5.4, 2.5.9, 2.7.
Unit III : Chapter 3 : Sections : 3.1-3.3, 3.4.1, 3.4.2, 3.5.2, 3.5.5,
Chapter 4 : 4.1.1-4.1.3, 4.2, 4.3
Unit IV : Chapter 4 : Sections : 4.8-4.10.
Unit V : Chapter 5: Sections : 5.1, 5.2, 5.31, 5.3.8, 5.4, 5.4.1 – 5.4.8, 5.5.1, 5.5.2.

Reference Book:

Fundamentals of Latex for Mathematicians, Physicists and Engineers

- by Velusamy Kavitha and Mani Mallikarjunan [LAP LAMBERT Academy Publishing, Germany, 2013.]

ELECTIVE 9: LaTex – List of Practical Problems

(Students has to attend two questions - one from each group)

Group - A

A1. Type the following paragraph in LaTex, using the {quote} environment. Format the paragraph with the following: Text height - 9.5inches, Text width - 6.3 Inches, Left margin – 0.1 Inch, Right margin – 0.12 Inch, Top margin - 0.6 Inch, Line space – 1.5 Inches. Also, include a Footnote.

Today (<Current Date>) the rate of exchange between the American dollar and Indian rupee is $1 = ₹65, an increase of 10% over the last year.

A2. Produce a document in LaTex, using two-columns. Insert a title centred for the two columns.

A3. Produce a title page in LaTex, with the following:

(i) Title of the page, (ii) Name and Addresses of two authors, (iii) Footnotes for the telephone members of each author, (iv) Date.

A4. Create a document in LaTex to produce the bibliographic information, using the {bibliography} environment.

Group – B

B1. Create a blank form produced as a framed table. Use the commands *struts* and *\hspace*.

B2. Create the following table using LaTeX:

S.No.	Register Number	Name of the Student	Percentage of Marks	Rank
1	xxxxxx	xxxxxx	xxxxx	xxxx
2	xxxxxx	xxxxxxx	xxxx	xxxx
3	xxxxxx	xxxxxx	xxxx	xxxxx

B3. Using LaTeX, generate the following formula:

$$a_0 + \cfrac{1}{a_1 + \cfrac{1}{a_2 + \cfrac{1}{a_3 + \cfrac{1}{a_4}}}} + \begin{pmatrix} a & b \\ c & d \end{pmatrix} + \sum_{\alpha=0}^{\infty} (\beta^{\alpha} + \Gamma^{\alpha})$$

B4. Using LaTeX, generate the following with {eqnarray} environment:

$$(x + y)(x - y) = x^2 - xy + xy - y^2$$

$$= x^2 - y^2 \tag{1.1}$$

$$(x + y)^2 = x^2 + 2xy + y^2 \tag{1.2}$$

$$x_n u_1 + \cdots + x_{n+t-1}\, u_t = x_n u_1 + (a\, x_n + c) u_2 + \cdots + a^{t-1} x_n + c(a^{t-2} + \cdots + 1)\, u_t$$

$$= (u_1 + a\, u_2 + \cdots + a^{t-1} u_t)\, x_n + h\,(u_1, \ldots, u_t)$$

10 - ELEMENTS OF STOCHASTIC PROCESSES

UNIT I: Continuous Time Markov Chain, Examples, Transient Analysis, Occupancy Times, Limiting Behaviour

UNIT II: Renewal Process, Cumulative Process, Semi-Markov Process, Examples and Long term Analysis

UNIT III: Queueing Systems, Single-Station Queues, Birth and Death queues with Finite and Infinite Capacity

UNIT IV: M/G/1 and G/M/1 Queues and Network of Queues

UNIT V: Standard Brownian Motion, Brownian Motion and First Passage Times

REFERENCE BOOKS:

1. V.G. Kulkarni, Introduction to Modelling and Analysis of Stochastic Systems, Second Edition, Springer (2011)
2. J. Medhi, Stochastic Processes, NEW AGE (2009).
3. S. M. Ross, Stochastic Processes, Wiley Series in Probability and Statistics (1996).

M. Sc. Mathematics

Syllabus

AFFILIATED COLLEGES

Program Code: 32A

2021 – 2022 onwards

BHARATHIAR UNIVERSITY

(A State University, Accredited with "A" Grade by NAAC,
Ranked 13th among Indian Universities by MHRD-NIRF,
World Ranking: Times -801-1000,Shanghai -901-1000, URAP - 982)

Coimbatore - 641 046, Tamil Nadu, India

Instruction : PEOs are:

- **Statement of areas or fields where the graduates find employment**
- **Preparedness of graduates to take up higher studies**

Program Educational Objectives (PEOs)	
The **M. Sc. Mathematics** program describe accomplishments that graduates are expected to attain within five to seven years after graduation	
PEO1	Provide a strong foundation in different areas of Mathematics, so that the students can compete with their contemporaries and excel in the various careers in Mathematics.
PEO2	Motivate and prepare the students to pursue higher studies and research, thus contributing to the ever-increasing academic demands of the country.
PEO3	Enrich the students with strong communication and interpersonal skills, broad knowledge and an understanding of multicultural and global perspectives, to work effectively in multidisciplinary teams, both as leaders and team members.
PEO4	Facilitate integral development of the personality of the student to deal with ethical and professional issues, and also to develop ability for independent and lifelong learning.

Instruction : : Program Specific Outcomes (PSOs)

These are what the students should be able to do at the time of graduation. The PSOs are program specific. PSOs are written by the department offering the program. There usually are five to seven PSOs for a department.

Program Specific Outcomes (PSOs)	
After the successful completion of **M. Sc. Mathematics** program, the students are expected to	
PSO1	Communicate concepts of Mathematics and its applications.
PSO2	Acquire analytical and logical thinking through various mathematical tools and techniques.
PSO3	Investigate real life problems and learn to solve them through formulating mathematical models.
PSO4	Attain in-depth knowledge to pursue higher studies and ability to conduct research. Work as mathematical professional.
PSO5	Achieve targets of successfully clearing various examinations/interviews for placements in teaching, banks, industries and various other organizations/services.

Program Outcomes (POs)	
On successful completion of the M. Sc. Mathematics program, the students will be able to	
PO1	Demonstrate in-depth knowledge of Mathematics, both in theory and application.
PO2	Attain the ability to identify, formulate and solve challenging problems in Mathematics.
PO3	Know the various specialised areas of advanced mathematics and its applications.
PO4	Analyze complex problems in Mathematics and propose solutions using research-based knowledge.
PO5	Obtain the accurate solutions for the community oriented problems via various mathematical models.
PO6	Work individually or as a team member or leader in uniform and multidisciplinary settings.
PO7	Crack lectureship and fellowship exams affirmed by UGC like CSIR-NET and SET.
PO8	Apply the Mathematical concepts, in all the fields of learning including higher research, and recognize the need and prepare for lifelong learning.
PO9	Know the use of computers both as an aid and as a tool to study problems in Mathematics.
PO10	Inculcate the knowledge of formulation and apply the mathematical concepts which are suitable for real life applications.

BHARATHIAR UNIVERSITY, COIMBATORE 641 046

M. Sc., Mathematics (CBCS PATTERN)

(Affiliated Colleges)

*(For the students admitted from the academic year **2021 – 22** onwards)*

Course Code	Title of the Course	Credits	Hours		Maximum Marks		
			Theory	Practical	CIA	ESE	Total
FIRST SEMESTER							
	Abstract Algebra	4	6	–	50	50	100
	Real Analysis	4	7	–	50	50	100
	Ordinary Differential Equations	4	7	–	50	50	100
	Numerical Methods	4	6	–	50	50	100
	Elective-I	4	4	–	50	50	100
		20	30	–	250	250	**500**
SECOND SEMESTER							
	Linear Algebra	4	6	–	50	50	100
	Complex Analysis	4	7	–	50	50	100
	Partial Differential Equations	4	7	–	50	50	100
	Mechanics	4	6	–	50	50	100
	Elective-II	4	4	–	50	50	100
	Total	**20**	30	–	250	250	**500**
THIRD SEMESTER							
	Topology	4	7	–	50	50	100
	Fluid Dynamics	4	7	–	50	50	100
	Mathematical Statistics	4	6	–	50	50	100
	Graph Theory	4	6	–	50	50	100
	Elective-III	4	4	–	50	50	100
	Total	**20**	30	–	250	250	**500**
FOURTH SEMESTER							
	Functional Analysis	4	7	–	50	50	100
	Mathematical Methods	4	7	–	50	50	100
	Optimization Techniques	4	6	–	50	50	100
	Computer Programming (C++ Theory)	4	4	–	50	50	100
	Computer Programming (C++ Practical)	4	–	2	50	50	100
	Elective-IV	4	4	–	50	50	100
	Project	6	–	–	50	100	150
	Total	**30**	**28**	2	350	400	**750**
	Grand Total	**90**					**2250**

For Elective Practical:

Matlab, LaTex (Elective)	**Theory**	25	50	100
	Practical	10	15	

First Semester

Course code		Paper 1: ABSTRACT ALGEBRA	L	T	P	C
Core/Elective/Supportive		Core	6	0	0	4
Pre-requisite		Basic knowledge in Modern Algebra at Undergraduate level.	Syllabus Version	20-21		

Course Objectives:

The main objectives of this course are to:

1. To provide deep knowledge about various algebraic structures.
2. To introduce Galois Theory and to see its application to the solvability of polynomial equations by radicals.

Expected Course Outcomes:

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

1	Understand Sylows theorem and its applications	K3
2	Formulate some special types of rings and their properties.	K6
3	Acquire knowledge on extension fields and roots of polynomials	K4
4	Analyze the elements of Galois theory and Galois Groups over the rationals	K4
5	Understand the basic concepts of solvability by radicals and finite fields.	K2

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

Unit:1	Group Theory	18 hours

Another Counting Principle, Sylow's Theorem: 1st, 2nd and 3rd parts of Sylow's Theorems – double coset – the normalizer of a group.

Unit:2	Group Theory (contd) and Ring Theory	17 hours

Direct Products: External and Internal direct Products, Euclidean Rings, A Particular Euclidean Rings, Polynomial rings.

Unit:3	Ring Theory (contd) and Fields	18 hours

Polynomials over rational fields – extension fields – roots of polynomials – splitting fields.

Unit:4	Fields (contd)	18 hours

More about roots – simple extension – fixed fields – symmetric rational functions – normal extension - Galois group – fundamental theorem of Galois theory.

Unit:5	Fields (contd) and Selected Topics	17 hours

Solvability by radicals: Solvable group – the commutator subgroup – Solvability by radicals - Finite fields.

Unit:6	Contemporary Issues	2 hours

Expert lectures, online seminars - webinars

	Total Lecture hours	90 hours

Text Book(s)	
1	I.N. Herstein, Topics in Algebra, Secnd Edition, John Wiley and Sons, New York, 1975. UNIT I: Chapter 2 : Sections 2.11, 2.12 UNIT II: Chapter 2 : Section 2.13 Chapter 3 : Sections 3.7 - 3.9 UNIT III: Chapter 3 : Section 3.10 Chapter 5 : Sections 5.1,5.3 UNIT IV: Chapter 5 : Sections 5.5,5.6 UNIT V: Chapter 5 : Section 5.7 Chapter 7 : Section 7.1
Reference Books	
1	Serge Lang, Algebra, Third Edition, Addison-Wesley, Mass, 1993.
2	John B. Fraleigh, A First Course in Abstract Algebra, Addison Wesley, Mass, 1982.
3	M. Artin, Algebra, Prentice-Hall of India, New Delhi, 1991.
4	V. K. Khanna and S.K. Bhambri, A Course in Abstract Algebra, Vikas Publishing House Pvt Limited, 1993.
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	https://nptel.ac.in/content/storage2/111/106/111106113/MP4/mod08lec44.mp4
2	https://nptel.ac.in/content/storage2/111/106/111106113/MP4/mod08lec45.mp4
3	https://nptel.ac.in/content/storage2/111/106/111106131/MP4/mod08lec39.mp4
4	https://nptel.ac.in/content/storage2/111/106/111106131/MP4/mod08lec42.mp4
Course Designed By: D. Saravanan	

Mapping with Programme Outcomes

COs / POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	M	L	L	L	M	S	L	S	M	M
CO2	S	S	M	L	L	S	L	S	M	S
CO3	M	L	S	M	S	M	M	L	L	S
CO4	M	L	S	S	S	M	M	L	L	S
CO5	L	M	M	S	M	L	S	M	S	M

*S-Strong; M-Medium; L-Low

Course code		PAPER 2: REAL ANALYSIS	L	T	P	C
Core/Elective/Supportive		Core	7	0	0	4
Pre-requisite		Basic knowledge in Undergraduate Analysis.	Syllabus Version		20-21	

Course Objectives:

The main objectives of this course are to:

1. Evaluate integral of a function of a real variable in the sense of Riemann Stieltjes integral and gain its properties.
2. Acquire Knowledge and demonstrate understanding the statement and proof of convergence theorems and its applications.
3. Understand the requirement and concept of Lebesgue measure, Measurable functions and Lebesgue integral.

Expected Course Outcomes:

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

1	Apply the Riemann Stieltjes integral and bring its properties and rectifiable curves.	K3
2	Remembering of sequences and series along with its properties	K1
3	Analyze the concept of linear transformation and find the extreme values of implicit functions.	K4
4	Understand the fundamental concept of Lebesgue measure.	K2
5	Evaluate the complex integration and the benefits of Lebesgue Integral	K5

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

Unit:1	Riemann Stiltjes Integral	21 hours

Definition and Existence of the Integral – properties of the integral – Integration and differentiation – Integration of vector valued function – rectifiable curves.

Unit:2	Sequences and Series of Functions	21 hours

Uniform convergence and continuity – uniform convergence and integration - uniform convergence and differentiation – equicontinuous families of functions – The Stone Weierstrass theorem.

Unit:3	Functions of Several Variables	21 hours

Linear transformation – contraction principle – Inverse function theorem – Implicit function theorem.

Unit:4	Lebesgue Measure	20 hours

Outer measure – Measurable sets and Lebesgue measure – Measurable functions –Littlewood's Theorem.

Unit:5	Lebesgue Integral	20 hours

The Lebesgue integral of bounded functions over a set of finite measure – integral of a non – negative function – General Lebesgue Integral.

Unit:6	**Contemporary Issues**	**2 hours**
Convergence in Measure – https://www.youtube.com/watch?v=_wThvhkiH5M		
	Total Lecture hours	**105 hours**

Text Book(s)	
1	Principles of Mathematical Analysis, McGraw Hill, New York, 1976. Unit I &II : Chapter 6 & 7. Unit III : Chapter 9 (Pages 204 to 227)
2	Real Analysis by H.L. Roydon, Third Edition, Macmillan, New York, 1988. Unit IV : Chapter 3 (except Section – 4) Unit V :Chapter 4 (Sections 2, 3 & 4 only)
Reference Books	
1	R. G. Bartle, Elements of Real Analysis, 2nd Edition, John Wily and Sons, New York, 1976.
2	Walter Rudin, Real and Complex Analysis, 3rd Edition, McGraw-Hill, New York, 1986.
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	https://www.youtube.com/watch?v=DO0Dzz07DNI
2	https://nptel.ac.in/courses/111/101/111101100/
3	https://www.youtube.com/watch?v=Y5yEMXZnzYw
4	https://youtu.be/msIZz8ydzcM
Course Designed By: Dr. V Jeyanthi	

Mapping with Programme Outcomes										
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	**L**	**S**	**S**	**M**	**S**	**M**	**S**	**S**	**S**	**S**
CO3	**S**	**M**	**M**	**L**	**S**	**S**	**S**	**L**	**L**	**L**
CO3	**L**	**M**	**S**	**L**	**M**	**M**	**M**	**S**	**M**	**S**
CO4	**L**	**M**	**S**	**L**	**M**	**S**	**S**	**S**	**M**	**M**
CO5	**M**	**L**	**S**	**M**	**S**	**L**	**M**	**M**	**L**	**L**

*S-Strong; M-Medium; L-Low

Course code		ORDINARY DIFFERENTIAL EQUATIONS	L	T	P	C
Core/Elective/Supportive		Core	7	0	0	4
Pre-requisite		Basic knowledge in differential equations at Undergraduate level.	Syllabus Version		20-21	

Course Objectives:

The main objectives of this course are to:

1. Study Solutions of Linear differential equations with constant and variable coefficients.
2. Understand and able to apply various theoretical ideas that underlined in existence and uniqueness theorems, Linear independence and dependence, Wronskian etc.,
3. Enables the students to develop the strong background on modeling, formulating, solving and interpreting physical problems.

Expected Course Outcomes:

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

1	Recall the types of linear homogeneous equations of second order equations with constant coefficients and apply the method to solve.	K1
2	Analyze non-homogeneous ODE using the method of undermined coefficients and annihilator method to solve the same.	K4
3	Understand and Apply the theorems on Initial value problem to ordinary differential equations.	K2 & K3
4	Comprehend the Euler equations, the Bessel's equation and Regular, Singular points at infinity and to evaluate.	K5
5	Identify the research problem where differential equation can be used to model the problem.	K6

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

Unit:1	Linear Equations with Constant Coefficients	20 hours

Introduction - Second order homogenous equations - Initial value problem for second order equations - Linear dependence and independence - A formula for Wronskian..

Unit:2	Linear Equations with Constant Coefficients (Contd)	21 hours

The Non- homogenous equations of order two-homogenous and Non - homogenous equations of order n - Initial value problems for n^{th} order equations- Annihilator method to solve non-Homogenous equation.

Unit:3	Linear Equations with Variable Coefficients	21 hours

Initial value problem - Existence and uniqueness theorem - The Wronskian and linear independence - Reduction of the order of a homogenous equation - The non- Homogenous equation - Homogenous equations with analytic coefficients - The Legendre equations.

Unit:4	Linear Equations with Regular Singular Points	20 hours

The Euler equations - Second order equations with regular singular points - Exceptional cases - The Bessel equation – The Bessel equation contd.

Unit:5	Existence and Uniqueness of Solutions to First Order Equations	21 hours
Equations with variable separated - Exact equations - The method of successive approximation - The Lipschitz Condition - Convergence of the successive approximation - Non-local existence of solutions - Approximations and uniqueness of solutions.		
Unit:6	**Contemporary Issues**	**2 hours**
Expert lectures, online seminars - webinars		
	Total Lecture hours	**105 hours**

Text Book(s)

1 Earl A. Coddington, An Introduction to Ordinary Differential Equations, Prentice-Hall of India Private Limited, New Delhi 2008.

UNIT I: Chapter 2 : Sections 2.1 – 2.5.
UNIT II: Chapter 2 : Sections 2.6 – 2.8, 2.10,2.11.
UNIT III: Chapter 3 : Sections 3.1 – 3.8
UNIT IV: Chapter 4 : Sections 4.1 – 4.4, 4.6 – 4.8
UNIT V: Chapter 5 : Sections 5.1 – 5.8

Reference Books

1 Williams E. Boyce and Richard C. Diprima, Elementary Differential Equations and Boundary Value Problems, 10th edition, John Wiley and Sons, New York 2012.

2 S. G. Deo and V. Raghavendra, Ordinary Differential Equations and Stability Theory, Tata McGraw-Hill, New Delhi 1980.

3 George F. Simmons, Differential Equations with Application and Historical Notes, Tata McGraw Hill, New Delhi 1974.

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

1 https://nptel.ac.in/courses/111/104/111104031/#

2 https://nptel.ac.in/courses/122/107/122107037/

Course Designed By: Dr. V. Jeyanthi

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	M	M	S	L	S	M	S	L
CO3	M	S	S	M	S	S	S	S	S	M
CO3	L	M	S	S	S	S	S	S	S	S
CO4	M	S	L	M	S	M	S	S	L	S
CO5	L	M	S	S	S	M	S	S	L	M

*S-Strong; M-Medium; L-Low

Course code		NUMERICAL ANALYSIS	L	T	P	C
Core/Elective/Supportive		Core	6	0	0	4
Pre-requisite		Basic Knowledge in numerical methods at Undergraduate level.	Syllabus Version		20-21	

Course Objectives:

The main objectives of this course are to:

1. To make the students understand solving Algebraic and Transcendental equations.
2. To know about how and when to use various interpolation function finding the various numerical differentiation and integration formulae and using them to solve problems.
3. To understand the methods of finding solution to the differential equations of various orders.

Expected Course Outcomes:

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

1	Solve problems in numerical differentiation and integration	K3
2	Solve system of equations using various methods.	K3
3	Apply various methods to find numerical solution of first and second order ordinary differential equations.	K3
4	Explain the various methods for solving Boundary Value Problems and Characteristic Value Problems	K2
5	Understand the Explicit method and the Crank Nicolson method for solving partial differential equations.	K2

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

Unit:1	Solution of Nonlinear Equations, Numerical Differentiation and Integration	18 hours

Solution of Nonlinear Equations: Newton's method – Convergence of Newton's method – Bairstow"s Method for quadratic factors.

Numerical Differentiation and Integration: Derivatives from Differences tables – Higher order derivatives – Divided difference, Central-Difference formulas– Composite formula of Trapezoidal rule – Romberg integration – Simpson's rules.

Unit:2	Solution of System of Equations	17 hours

The Elimination method – Gauss and Gauss Jordan methods – LU Decomposition method – Matrix inversion by Gauss-Jordan method – Methods of Iteration – Jacobi and Gauss Seidal Iteration – Relaxation method – Systems of Nonlinear equations.

Unit:3	Solution of Ordinary Differential Equations	17 hours

Taylor series method – Euler and Modified Euler methods – Runge-kutta methods – Multistep methods – Milne's method – Adams Moulton method.

Unit:4	Boundary Value Problems and Characteristic Value Problems	18 hours

The shooting method – solution through a set of equations – Derivative boundary conditions – Characteristic value problems – Eigen values of a matrix by Iteration – The power method.

Unit:5	**Numerical Solution of Partial Differential Equations**	**18 hours**
Representation as a difference equation – Laplace's equation on a rectangular region – Iterative methods for Laplace equation – The Poisson equation – Derivative boundary conditions – Solving the equation for time-dependent heat flow (i) The Explicit method (ii) The Crank Nicolson method – solving the wave equation by Finite Differences.		
Unit:6	**Contemporary Issues**	**2 hours**
Expert lectures, online seminars - webinars		
	Total Lecture hours	**90 hours**

Text Book(s)

1	Curtis F. Gerald, Patrick O. Wheatley, Applied Numerical Analysis, Fifth Edition, Addison Wesley, (1998).

Reference Books

1	S. C. Chapra and P. C. Raymond: Numerical Methods for Engineers, Tata McGraw Hill, New Delhi, 2000.
2	S.S. Sastry: Introductory methods of Numerical Analysis, Prentice Hall of India, New Delhi, 1998.
3	P. Kandasamy et al., Numerical Methods, S.Chand & Co.Ltd., New Delhi, 2003.

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

1	https://nptel.ac.in/courses/111/107/111107105/
2	https://freevideolectures.com/course/3504/numerical-methods-of-ordinary-and-partial/1
3	https://www.classcentral.com/course/swayam-numerical-methods-for-engineers-14213

Course Designed By: Dr. N. Mala

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	L	S	S	M	L	S	M	M
CO3	S	M	L	S	S	M	L	S	M	M
CO3	S	M	L	S	S	M	L	S	M	M
CO4	S	S	S	S	M	S	S	M	L	L
CO5	S	S	S	S	M	S	S	M	L	L

*S-Strong; M-Medium; L-Low

Second Semester

Course code		LINEAR ALGEBRA	L	T	P	C
Core/Elective/Supportive		Core	6	0	0	4
Pre-requisite		A good familiarity with Calculus and Modern Algebra.	Syllabus Version		20-21	

Course Objectives:

The main objectives of this course are to:

1. Develop a strong foundation in linear algebra that provide a basic for advanced studies.
2. Study of Linear Transformations, Algebra of Polynomials, Invariant space and their properties.
3. Give particular attention to canonical forms of linear transformations, diagonalizations of linear transformations, matrices and determinants.

Expected Course Outcomes:

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

1	Understand the basic concepts of Linear transformations, characteristic roots and matrices of linear transformation and its applications.	K3
2	Explain about the algebra of polynomials, polynomial ideals and prime factorization of a polynomial.	K4
3	Understand the basic concepts of determinants and its additional properties.	K3
4	Recognize the concepts of Invariant subspaces and diagonalization process.	K2
5	Analyze canonical Form, Jordan Form and Rational canonical Form.	K4

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

Unit:1	Linear Transformations	18 hours

Linear transformations – Isomorphism of vector spaces – Representations of linear transformations by matrices – Linear functionals.

Unit:2	Algebra of Polynomials	17 hours

The algebra of polynomials –Polynomial ideals - The prime factorization of a polynomial - Determinant functions.

Unit:3	Determinants	18 hours

Permutations and the uniqueness of determinants – Classical adjoint of a (square) matrix – Inverse of an invertible matrix using determinants – Characteristic values – Annihilating polynomials.

Unit:4	Diagonalization	18 hours

Invariant subspaces – Simultaneous triangulations – Simultaneous diagonalization – Direct-sum decompositions – Invariant direct sums – Primary decomposition theorem.

Unit:5	The Rational and Jordan Forms	17 hours

Cyclic subspaces – Cyclic decompositions theorem (Statement only) – Generalized Cayley – Hamilton theorem - Rational forms – Jordan forms.

Unit:6	**Contemporary Issues**	**2 hours**
Inner Product Spaces – https://www.youtube.com/watch?v=ERfbtPBEYVA		
	Total Lecture hours	**90 hours**

Text Book(s)

1 Kenneth M Hoffman and Ray Kunze, Linear Algebra, Second Edition, Prentice-Hall of India Pvt. Ltd, New Delhi, 2013.

UNIT I:	Chapter 3	: Sections 3.1-3.5
UNIT II:	Chapter 4	: Sections 4.1, 4.2, 4.4, 4.5
	Chapter 5	: Sections 5.1, 5.2
UNIT III:	Chapter 5	: Sections 5.3, 5.4
	Chapter 6	: Sections 6.1-6.3
UNIT IV:	Chapter 6	: Sections 6.4 - 6.8
UNIT V:	Chapter 7	: Sections 7.1 – 7.3

Reference Books

1 M. Artin, Algebra, Prentice-Hall of India Pvt. Ltd., 2005.

2 S. H. Friedberg, A. J. Insel and L. E. Spence, Linear Algebra, Fourth Edition, Prentice-Hall of India Pvt. Ltd., 2009.

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

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

1 https://www.khanacademy.org/math/linear-algebra/vectors-and-spaces

2 https://nptel.ac.in/courses/111/106/111106051/

Course Designed By: Prof. D. Saravanan

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	M	L	M	S	S	S	M	M
CO2	M	S	S	M	L	S	S	S	M	M
CO3	S	S	M	L	M	S	S	S	M	M
CO4	L	M	L	S	M	S	M	M	L	L
CO5	M	S	S	M	L	S	S	S	M	M

*S-Strong; M-Medium; L-Low

Course code		COMPLEX ANALYSIS	L	T	P	C
Core/Elective/Supportive		Core	7	0	0	4
Pre-requisite		Basic knowledge in complex analysis at Undergraduate level.	Syllabus Version		20-21	

Course Objectives:

The main objectives of this course are to:

1. Define and recognize the basic properties of the complex numbers
2. Enable the students to the differentiability of complex functions and the results related on the study.
3. Study Cauchy's integral formula, local properties of analytic functions, general form of Cauchy's theorem and evaluation of definite integral.

Expected Course Outcomes:

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

1	Remembering the concept of Analytic function and as a mapping on the plane and understand Mobius Transformation.	K1
2	Understand Cauchy's Integral Formula on open sets on the plane and know about poles , residues and singularities.	K2
3	Apply the Cauchy's integral formula in residue theorems and in evaluation of definite integrals.	K3 & K4
4	Analyze and represent the sum function of a power series as an Analytic Function.	K5
5	Study and Understand periodic function, Weierstrass $\wp$ function and its applications.	K6

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

Unit:1	Introduction to the Concept of Analytic Function, Conformality, Linear Transformations	20 hours

Introduction to the concept of analytic function: Limits and continuity – Analytic functions – Polynomials – Rational functions.

Conformality: Arcs and closed curves – Analytic functions in regions – Conformal Mapping – Length and Area.

Linear Transformations: The Linear group – The Cross ratio – Elementary Riemann Surfaces.

Unit:2	Complex Integration and Cauchy's Integral Formula	20 hours

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 Removable singularities, Taylor's Theorem – Zeros and Poles – The Local Mapping– The Maximum principle – chains and cycles.

Unit:3	The Calculus of Residues and Harmonic Functions	21 hours

The Calculus of Residues: The Residue theorem – The Argument principle – Evaluation of definite integrals.

Harmonic functions: The Definitions and basic Properties – Mean value property – Poisson's Formula.

Unit:4	Series and Product Developments, Partial fractions and Factorization	21 hours

Series and Product Developments: Weierstrass Theorem – The Taylor Series – The Laurent Series.
Partial fractions and Factorization: Partial Fractions – Infinite Products – Canonical Products.

Unit:5	Elliptic Functions	21 hours

Simply Periodic Functions: Representation by Exponentials-The Fourier Development - Functions of Finite Order.
Doubly Periodic Functions: The Period Module-Unimodular Transformations - The Canonical Basis-General Properties of Elliptic Functions.
Weierstrass Theory: The Weierstrass $\wp$-function.

Unit:6	Contemporary Issues	2 hours

Expert lectures, online seminars - webinars

	Total Lecture hours	105 hours

Text Book(s)

1. L. V. Ahlfors, Complex Analysis, McGraw Hill, New York, 1979.
   - UNIT I: Chapter 2 : Sections 1.1 – 1.4
     Chapter 3 : Sections 2.1 – 2.4, 3.1, 3.2 and 3.4
   - UNIT II: Chapter 4 : Sections 1.1 – 1.5, 2.1 – 2.3, 3.1 – 3.4 and 4.1
   - UNIT III: Chapter 4 : Sections 5.1 – 5.3, 6.1 – 6.3
   - UNIT IV: Chapter 5 : Sections 1.1 – 1.3, 2.1 – 2.3
   - UNIT V: Chapter 7 : Sections 1.1 – 1.3

Reference Books

1. S. Ponnusamy and H. Silverman, A Complex Variable with applications, Birkhauser, Boston, 2006.
2. Karunakaran V, Complex Analysis, Narosa Publishing House Pvt. Ltd, Second Edition, New Delhi, 2006.
3. Roopkumar R, Complex Analysis, Dorling Kinderley Pvt. Ltd, New Delhi, 2015.

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

1. https://nptel.ac.in/courses/111/103/111103070/
2. https://nptel.ac.in/courses/111/106/111106084/
3. https://youtu.be/sJcpfmF5oHo

Course Designed By: Dr. V. Jeyanthi

Mapping with Programme Outcomes

COs \ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	M	L	L	M	M	M	L	M
CO2	M	S	M	L	M	M	M	M	L	M
CO3	M	S	M	S	M	M	S	S	M	M
CO4	M	S	S	S	M	S	S	M	L	S
CO5	S	M	S	S	M	S	S	M	M	S

*S-Strong; M-Medium; L-Low

Course code		PARTIAL DIFFERENTIAL EQUATIONS	L	T	P	C
Core/Elective/Supportive		Core	7	0	0	4
Pre-requisite		Knowledge in Undergraduate differential equations.	Syllabus Version		20-21	

Course Objectives:

The main objectives of this course are to:

1. Introduce different methods to solve partial differential equation.
2. Acquire knowledge in classification of partial differential equations and the methods to solve.
3. Enables the students to find the solution of Partial Differential Equation of practical application like in Engineering, Physics, etc.,

Expected Course Outcomes:

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

1	Understand and remember the physical situations with real world problems to construct mathematical models using partial differential equations and study the methods to solve.	K1 &K 2
2	Analyze the type of partial differential equations and different methods to solve.	K4
3	Evaluate Laplace equation and analyze its applications.	K5
4	Apply variable separable method to solve Laplace and Diffusion equation	K3
5	Finding the appropriate method to solve the partial differential equations	K6

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

Unit:1	Partial Differential Equations of the First Order	21 hours

Partial Differential Equations – Origins of First Order Differential Equations – Cauchy's Problem for first order equations – Linear Equations of the first order – Nonlinear partial differential equations of the first order – Cauchy's method of characteristics – Compatible system of First order Equations – Solutions satisfying Given Condition, Jacobi's method.

Unit:2	Partial Differential Equations of the Second Order	21 hours

The Origin of Second Order Equations – Linear partial Differential Equations with constant coefficients – Equations with variable coefficients – Separation of variables – The method of Integral Transforms – Non – linear equations of the second order.

Unit:3	Laplace's Equation	21 hours

Elementary solutions of Laplace equation – Families of Equipotential Surfaces – Boundary value problems – Separation of variables – Surface Boundary Value Problems – Separation of Variables – Problems with Axial Symmetry – The Theory of Green's Function for Laplace Equation.

Unit:4	The Wave Equation	21 hours

The Occurrence of the wave equation in Physics – Elementary Solutions of the One – dimensional Wave equations – Vibrating membrane, Application of the calculus of variations – Three dimensional problem.

Unit:5	The Diffusion Equation	19 hours
Elementary Solutions of the Diffusion Equation – Separation of variables – The use of Integral Transforms – The use of Green's functions.		
Unit:6	**Contemporary Issues**	**2 hours**
Expert lectures, online seminars - webinars		
	Total Lecture hours	**105 hours**

Text Book(s)

1	Ian Sneddon, Elements of Partial Differential Equations, McGraw Hill International Book Company, New Delhi, 1983.

Reference Books

1	M. D. Raisinghania, Advanced Differential Equations, S. Chand and Company Ltd., New Delhi, 2001.
2	K. Sankara Rao, Introduction to Partial Differential Equations, Second edition, Prentice-Hall of India, New Delhi, 2006.
3	J. N. Sharma and K. Singh, Partial Differential Equations for Engineers and Scientists, Narosa Publishing House, 2001.

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

1	https://www.youtube.com/watch?v=bPPWp65qpIA
2	When do PDE NOT have solutions? https://www.youtube.com/watch?v=BmTFbUAOeec&list=PLGCj8f6sgswntUil8yzohR_qazOfYZCg_&index=49

Course Designed By: Dr. V. Jeyanthi

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	M	M	M	L	M	M	M	S	L	M
CO2	M	M	S	M	S	S	S	S	M	L
CO3	L	S	M	S	S	S	M	S	L	L
CO4	M	S	M	S	S	S	S	S	L	L
CO5	M	S	M	S	S	S	M	S	M	M

*S-Strong; M-Medium; L-Low

Course code		MECHANICS	L	T	P	C
Core/Elective/Supportive		Core	6	0	0	4
Pre-requisite		To know the basic concepts of Statics and Dynamics at Undergraduate level.	Syllabus Version		20-21	

Course Objectives:

The main objectives of this course are to:

1. understand the concepts of generalized coordinates, virtual work, Lagrange's equations and Hamilton's Principle. To discuss the applications of the above concepts with suitable examples.
2. Proficient in derivation and application of Hamilton-Jacobi equations
3. gain knowledge about canonical transformations, Lagrange and Poisson brackets.

Expected Course Outcomes:

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

1	understand the basic concepts of the mechanical system, generalized coordinates, work, energy and momentum.	K1
2	solve and analyze the Lagrange's equations and integrals of motion with examples.	K3
3	understand the Hamilton's Principle and other variational principles and gain ability to analyze those principles to the problems arising in practical situations	K4
4	understand and develop the Hamilton's Principal function and Hamilton Jacobi equation	K5
5	Get familiar with canonical transformations, conditions of canonicity of a transformation in terms of Lagrange and Poisson brackets.	K6

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

Unit:1	**Introductory Concepts**	**18 hours**

Mechanical system – Generalized Coordinates – Constraints – Virtual Work – Energy and Momentum.

Unit:2	**Lagrange's Equations**	**18 hours**

Derivations of Lagrange's Equations: Derivations of Lagrange's Equations – Examples – Integrals of Motion.

Unit:3	**Hamilton's Equations**	**17 hours**

Hamilton's Principle – Hamilton's Equations.

Unit:4	**Hamilton – Jacobi Theory**	**18 hours**

Hamilton's Principle function – Hamilton – Jacobi Equation – Separability.

Unit:5	**Canonical Transformations**	**17 hours**

Differential forms and Generating Functions – Lagrange and Poisson Brackets.

Unit:6	**Contemporary Issues**	**2 hours**

Infinitesimal Canonical Transformation – https://www.youtube.com/watch?v=jSt1RS4QbEk

	Total Lecture hours	**90 hours**

Text Book(s)	
1	D. T. Greenwood, Classical Dynamics, Dover Publications, New York, 1997. Unit-I: Chapter 1: Sections 1.1 – 1.5 Unit-II: Chapter 2: Sections 2.1 – 2.3 Unit-III: Chapter 4: Sections 4.1 – 4.2 Unit-IV: Chapter 5: Sections 5.1 – 5.3 Unit-V: Chapter 6: Sections 6.1, 6.3
Reference Books	
1	F. Gantmacher, Lectures in Analytic Mechanics, MIR Publishers, Moscow, 1975.
2	I. M. Gelfand and S. V. Fomin, Calculus of Variations, Prentice-Hall of India, New Delhi, 1963.
3	S. L. Loney, An Elementary Treatise on Statics, Kalyani Publishers, New Delhi, 1979.
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	http://math.ucr.edu/home/baez/classical/texfiles/2005/book/classical.pdf.
2	https://nptel.ac.in/courses/115/103/115103115/
4	https://www.youtube.com/watch?v=G6OX1NpToaw
Course Designed By: Prof. D. Saravanan	

Mapping with Programme Outcomes										
Cos	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	**S**	**M**	**S**	**M**	**S**	**M**	**S**	**L**	**S**	**L**
CO2	**M**	**S**	**M**	**S**	**S**	**L**	**M**	**S**	**L**	**M**
CO3	**S**	**S**	**M**	**S**	**S**	**L**	**S**	**S**	**M**	**L**
CO4	**S**	**S**	**M**	**S**	**S**	**M**	**M**	**S**	**L**	**S**
CO5	**S**	**S**	**M**	**S**	**S**	**M**	**M**	**S**	**L**	**S**

*S-Strong; M-Medium; L-Low

Third Semester

Course code		TOPOLOGY	L	T	P	C
Core/Elective/Supportive		Core	7	0	0	4
Pre-requisite		Know the basic concepts of Real Analysis at Undergraduate level.	Syllabus Version		20-21	

Course Objectives:

The main objectives of this course are to:

1. To introduce the concepts of point-set topology with emphasis on continuous functions, homeomorphism ,connectedness, compactness, countability and separation axioms.

Expected Course Outcomes:

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

1	Acquire knowledge about various types of topological spaces and their properties	K1
2	Discuss connected spaces, the components of a space	K2
3	Apply the properties and derive the proofs of theorems.	K3
4	Construct a variety of examples and counter examples in topology	K3
5	Understand the properties of the compact spaces and analyse the different types of compactness.	K4

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

Unit:1	Topological Spaces and Continuous functions	21 hours

Types of Topological Spaces and Examples - Basics for a topology - The order topology -The product topology on X x Y - The subspace topology - Closed sets and limits points - Continuous functions.

Unit:2	Topological Spaces and Continuous functions (Contd) and Connectedness	21 hours

The Product Topology - The metric topology - Sequence lemma- Uniform limit theorem- Connected spaces - Connected subspaces of the real line - Components and Local connectedness.

Unit:3	Compactness	20 hours

Compact spaces - Compact subspaces of the real line -Uniform continuity theorem - Limit Point Compactness – complete metric spaces –compactness in metric spaces.

Unit:4	Countability and Separation Axioms	20 hours

First and Second countable spaces - Lindeloff and Separable spaces - Countability axioms - The separation axioms - Normal spaces - The Uryshon's lemma.

Unit:5	Countability and Separation Axioms and Tychonoff Theorem	21 hours

The Urysohn Metrization Theorem - Tietze Extension Theorem - The Tychonoff theorem – Stone Cech compactifications.

Unit:6	Contemporary Issues	2 hours

Expert lectures, online seminars - webinars

	Total Lecture hours	105 hours

Text Book(s)	
1	James R. Munkres, Topology, Second Edition, Prentice-Hall of India, New Delhi, 2006.
Reference Books	
1	G. F. Simmons, Introduction to Topology and Modern Analysis, Tata McGraw-Hill Edition, New Delhi, 2004.
2	Fred H. Croom, Principles of Topology, Cengage India Pvt Ltd, New Delhi, 2009.
3	Seymour Lipschutz, Schaum's Outline of Theory and Problems of General Topology, McGraw-Hill Edition, New Delhi, 2006.
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	https://nptel.ac.in/content/storage2/courses/111106054/Topology%20complete%20course.pdf
2	https://www.youtube.com/watch?v=Oe3Qjk3t0go&lc=UghijV07WCAwpHgCoAEC
3	https://www.youtube.com/watch?v=2OMPmrHEO2M
Course Designed By: Dr. C. Janaki	

Mapping with Programme Outcomes										
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	**L**	**M**	**S**	**L**	**M**	**M**	**S**	**L**	**M**	**S**
CO2	**S**	**M**	**M**	**L**	**L**	**S**	**S**	**M**	**S**	**M**
CO3	**S**	**M**	**S**	**L**	**M**	**S**	**S**	**S**	**M**	**S**
CO4	**S**	**S**	**S**	**M**	**L**	**S**	**S**	**S**	**M**	**S**
CO5	**S**	**M**	**S**	**M**	**M**	**S**	**S**	**S**	**M**	**S**

*S-Strong; M-Medium; L-Low

Course code		FLUID DYNAMICS	L	T	P	C
Core/Elective/Supportive		Core	7	0	0	4
Pre-requisite		Knowledge in Kinematics and Differential equations at Undergraduate level.	Syllabus Version		20-21	

Course Objectives:

The main objectives of this course are to:

1. able to know the fundamental concepts of fluids and its properties.
2. develop the problems solving skill in fluid dynamics.
3. know the real-life applications of fluid dynamics.

Expected Course Outcomes:

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

1	Recall the basic concepts of velocity, density and curvilinear co-ordinates.	K1
2	Understand the concepts and equations of fluid dynamics	K2
3	Analyze and understand the concepts of the force experienced by a two-dimensional fixed body in a steady irrotational flow.	K2& K4
4	Analyze the approximate solutions of the Navier – Stokes equation.	K4& K5
5	Analyze and apply the appropriate method to solve integral equation of boundary layer, Blasius equation and its series solution.	K3& K4

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

Unit:1	Bernoulli's Equation and Equations of Motion	20 hours

Introductory Notions – Velocity – Stream Lines and Path Lines – Stream Tubes and Filaments – Fluid Body – Density – Pressure. Differentiation with respect to the time – Equation of continuity – Boundary conditions – Kinematical and physical – Rate of change of linear momentum – Equation of motion of an inviscid fluid.

Unit:2	Equations of Motion (Contd)	20 hours

Euler's momentum Theorem – Conservative forces – Bernoulli's theorem in steady motion – energy equation for inviscid fluid – circulation – Kelvin's theorem – vortex motion – Helmholtz equation.

Unit:3	Two-Dimensional Motion	21 hours

Two Dimensional Motion – Two Dimensional Functions – Complex Potential – basic singularities – source – sink – Vortex – doublet – Circle theorem. Flow past a circular cylinder with circulation – Blasius Theorem – Lift force. (Magnus effect)

Unit:4	Dynamics of Real Fluids	21 hours

Viscous flows – Navier-Stokes equations – Vorticity and circulation in a viscous fluid – Steady flow through an arbitrary cylinder under pressure – Steady Couette flow between cylinders in relative motion – Steady flow between parallel planes.

Unit:5	The Laminar Boundary Layer in Incompressible Flow	21 hours

Boundary Layer concept – Boundary Layer equations – Displacement thickness, Momentum thickness – Kinetic energy thickness – integral equation of boundary layer – flow parallel to semi infinite flat plate – Blasius equation and its solution in series.

Unit:6	**Contemporary Issues**	**2 hours**
Expert lectures, online seminars - webinars		
	Total Lecture hours	**105 hours**

Text Book(s)

1. **Units I and II:** L. M. Milne Thomson, Theoretical Hydro Dynamics, Macmillan Company, 5th Edition (1968).
   Chapter I : Sections 1.0 – 1.3., 3.10-3.41 (omit 3.32)
   Chapter III : Sections 3.42 – 3.53 (omit 3.44)
2. **Units III, IV and V:** Modern Fluid Dynamics Volume I, N. Curle and H. J. Davies, D. Van Nostrand Company Limited., London, 1968.
   Chapter III : Sections 3.1 – 3.7.5 (omit 3.3.4, 3.4, 3.5.2,3.6)
   Chapter V : Sections 5.2.1– 5.3.3
   Chapter VI : Sections 6.1 – 6.3.1 (omit 6.2.2., 6.2.5)

Reference Books

1. F. Chorlton, Textbook of Fluid Dynamics, CBS Publishers, New Delhi, 2004.
2. A. J. Chorin and A. Marsden, A Mathematical Introduction to Fluid Dynamics, Springer-Verlag, New York, 1993.

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

1. https://nptel.ac.in/courses/112/106/112106200/
2. https://nptel.ac.in/courses/112/105/112105171/

Course Designed By: Dr. V. Jeyanthi

Mapping with Programme Outcomes

COs \ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	M	S	M	M	M	L	L	M	M	S
CO2	M	S	M	M	S	M	S	M	M	S
CO3	L	M	M	M	S	M	S	S	M	S
CO4	M	M	S	S	M	M	S	S	M	S
CO5	L	M	S	M	M	M	S	S	M	S

*S-Strong; M-Medium; L-Low

Course code		MATHEMATICAL STATISTICS	L	T	P	C
Core/Elective/Supportive		Core	6	0	0	4
Pre-requisite		Basic Knowledge in Statistics and Probability theory.	Syllabus Version		20-21	

Course Objectives:

The main objectives of this course are to:

1. Enables to learn different aspects of statistics.
2. Acquire knowledge about moments and properties of theoretical distributions.
3. Study unbiasedness and consistency of limiting distributions.

Expected Course Outcomes:

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

1	Remembering the understanding the basic concepts such as statistics, probability and random variables.	K1 & K2
2	Applying the concepts and methods to find the moments of the distributions.	K3
3	Study multivariate distributions and the independence of random variables. Further evaluating the marginal distributions from bivariate distributions.	K5
4	Analyze and study the properties of some discrete as well as continuous distributions	K4
5	Understand the convergence of distributions and central limit theorem.	K2

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

Unit:1	Probability and Distributions	18 hours

Introduction - Set Theory - The Probability Set Function - Conditional Probability and Independence –Random Variables - Discrete Random Variables- Continuous Random Variables.

Unit:2	Probability and Distributions (continued) and Multivariate Distributions	17 hours

Probability and Distributions: Expectation of a Random Variables - Some Special Expectations - Important Inequalities.

Multivariate Distributions: Distributions of Two Random Variables - Transformations: Bivariate Random Variables - Conditional Distributions and Expectations - Independent Random Variables.

Unit:3	Some Special Distributions	18 hours

The Binomial and Related Distributions - The Poisson Distribution - The Γ, $\chi 2$, and β Distributions - The Normal Distribution.

Unit:4	Some Special Distributions (continued), Unbiasedness, Consistency and Limiting Distributions	17 hours

Some Special Distributions (continued): t and F-Distributions.

Unbiasedness, Consistency and Limiting Distributions: Expectations of Functions - Convergence in Probability - Convergence in Distribution - Central Limit Theorem.

Unit:5	**Some Elementary Statistical Inferences**	**18 hours**
Sampling and Statistics – More on Confidence Intervals - Introduction to Hypothesis Testing - Additional Comments About Statistical Tests - Chi-Square Tests – The Method of Monte Carlo.		
Unit:6	**Contemporary Issues**	**2 hours**
Expert lectures, online seminars - webinars		
	Total Lecture hours	**90 hours**

Text Book(s)

1	Robert V. Hogg, Allen T. Craig and Joseph W. McKean, Introduction to Mathematical Statistics, Sixth Edition, Pearson Education, 2005. Unit-I: 1.1 – 1.7 Unit-II: 1.8 – 1.10, 2.1 – 2.3, 2.5 Unit-III: 3.1 – 3.4 Unit-IV: 3.6, 4.1 – 4.4 Unit-V: 5.1, 5.4 – 5.8

Reference Books

1	Michael J. Crawley, The R Book, John Wiley & Sons, Second Edition (2013).
2	Marek Fisz, Probability Theory and Mathematical Statistics, John Wiley.
3	Vijay K. Rohatgi and A.K. Md. Ehsanes Saleh, An Introduction to Probability and Statistics, Wiley India, Second Edition (2001).
4	M. Rajagopalan and P. Dhanavanthan, Statistical Inference, PHI Learning Pvt. Ltd., New Delhi (2012).

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

1	https://nptel.ac.in/courses/111/104/111104032/#
2	https://nptel.ac.in/courses/111/105/111105090/

Course Designed By: Dr. V. Jeyanthi

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	M	L	L	M	S	S	S	S
CO2	M	S	M	L	S	S	M	S	S	S
CO3	S	M	S	M	M	S	S	M	L	S
CO4	M	M	S	M	M	S	M	S	M	S
CO5	M	M	L	M	S	M	S	S	S	S

*S-Strong; M-Medium; L-Low

Course code		GRAPH THEORY	L	T	P	C
Core/Elective/Supportive		Core	6	0	0	4
Pre-requisite		Basic knowledge in Graph Theory at Undergraduate level.	Syllabus Version		2020-2021	

Course Objectives:

The main objectives of this course are to:

1. To provide deep knowledge about fundamental concepts of Graphs and Trees.
2. To introduce Matchings, Coloring, and Chromatic Number and to see its application in higher order thinking.

Expected Course Outcomes:

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

1	Understand the basic concepts of Graphs and Trees	K2
2	Analyze vertex and edge connectivity concepts	K4
3	Acquire knowledge in Matching and Colourings	K4
4	Apply Chromatic Number	K3
5	Determining the planar, non-planar, and directed graphs	K3

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

Unit:1	Graphs, Subgraphs and Trees	18 hours

Graphs, Subgraphs: Graphs and Simple Graphs– Graph Isomorphism – The Incidence and Adjacency matrices, Subgraphs – Vertex Degrees – paths and Connection – Cycles.
Trees: Trees – Cut edges and Bonds – cut vertices – Cayley's formula.

Unit:2	Connectivity, Euler tours and Hamilton Cycles	17 hours

Connectivity: Connectivity – Blocks.
Euler tours and Hamilton Cycles: Euler tours - Hamilton Cycles.

Unit:3	Matchings and Edge Colourings	18 hours

Matchings: Matchings coverings in Bipartite Graphs – Perfect Matchings.
Edge colourings: Edge chromatic number – Vizing's theorem.

Unit:4	Independent sets, Cliques and Vertex Colourings	18 hours

Independent sets, Cliques: Independent sets – Ramsey's theorem.
Vertex Colourings: Chromatic Number – Brook's Theorem – Hajo's Conjecture – Chromatic Polynomials – Girth and Chromatic number.

Unit:5	Planar Graphs and Directed Graphs	17 hours

Planar Graphs: Plane and planar Graphs – Dual Graphs – Euler's formula – Brides – Kuratowski's theorem (Proof omitted) – The Five Colour Theorem and the Four Colour Conjecture.
Directed Graphs: Directed Graphs.

Unit:6	Contemporary Issues	2 hours

Interval graphs, chordal graphs – https://www.youtube.com/watch?v=Tg2_YO4CCNc

	Total Lecture hours	90 hours

Text Book(s)	
1	J. A. Bondy and U. S. R. Murty, Graph Theory with Applications, American Elsevier Company Inc., New York, 1976. Unit-I: Sections: 1.1 – 1.7, 2.1 – 2.4 Unit-II: Sections: 3.1 – 3.2, 4.1 – 4.2 Unit-III: Sections: 5.1 – 5.3, 6.1 – 6.2 Unit-IV: Sections: 7.1 – 7.2, 8.1 – 8.5 Unit-V: Sections: 9.1 – 9.6, 10.1
Reference Books	
1	Frank Harary, Graph Theory, Addison-Wesley, Reading, 1969.
2	M.Murugan, Graph Theory and Algorithms, Second Edition, Muthali Publishing House, Chennai, 2018.
3	K. R. Parthasarathy, Basic Graph Theory, Tata McGraw Hill, New Delhi, 1994.
4	Douglas B. West, Introduction to Graph Theory, Prentice Hall of India, 2001.
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	https://nptel.ac.in/courses/111/106/111106050/
2	https://nptel.ac.in/courses/106/108/106108054/
Course Designed By: Dr. R. Buvaneswari	

Mapping with Programme Outcomes										
COs / POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	**L**	**M**	**M**	**L**	**M**	**M**	**M**	**S**	**M**	**S**
CO2	**M**	**S**	**S**	**M**	**M**	**L**	**L**	**S**	**M**	**S**
CO3	**S**	**S**	**S**	**M**	**L**	**L**	**L**	**M**	**L**	**M**
CO4	**L**	**M**	**S**	**S**	**M**	**L**	**M**	**S**	**M**	**M**
CO5	**M**	**L**	**S**	**M**	**M**	**M**	**M**	**S**	**M**	**S**

*S-Strong; M-Medium; L-Low

Fourth Semester

Course code		FUNCTIONAL ANALYSIS	L	T	P	C
Core/Elective/Supportive		Core	7	0	0	4
Pre-requisite		Know the basic concepts of Real Analysis and Linear Algebra at Undergraduate level	Syllabus Version		20-21	

Course Objectives:

The main objectives of this course are to:

1. To get an overview of normed spaces and familiarize on Banach space, Hilbert space , conjugate space ,bounded linear operators and spectral theory.

Expected Course Outcomes:

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

1	Familiarize with the concepts of normed linear spaces and operators on normed linear space	K1
2	Demonstrate an understanding of the concepts of Hilbert spaces and Banach spaces, and their role in mathematics	K2
3	Apply the theorems.	K3
4	Obtain Orthogonal complements, Orthonormal sets and conjugate space.	K4
5	Understand the concepts of linear operators, self adjoint, unitary operators , isometric isomorphism on Hilbert spaces ,Determinants ,the spectrum of an operator, Banach algebra .	K2

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

Unit:1	Banach Spaces	21 hours

Banach spaces – The definition and some examples – Continuous linear transformations – The Hahn-Banach theorem –Dual spaces- The natural imbedding of N in N** - The open mapping theorem - Closed Graph theorem.

Unit:2	Hilbert spaces	21 hours

The conjugate of an operator – Uniform boundedness Principal - Hilbert spaces – The definition and some simple properties – Orthogonal complements and complements - Orthonormal sets and sequences – Maximal Orthonormal sets.

Unit:3	Hilbert spaces (Contd)	21 hours

The Conjugate space H* - Representation of functional on Hilbert spaces -The adjoint of an operator – Self-adjoint operators – Normal and unitary operators – Projections.

Unit:4	Finite-Dimensional Spectral Theory	20 hours

Matrices – Determinants and the spectrum of bounded operator – The spectral theorem.

Unit:5	General Preliminaries on Banach Algebras	20 hours

The definition and some examples of Banach algebra – Regular and singular elements – Topological divisors of zero – The spectrum – The formula for the spectral radius.

Unit:6	Contemporary Issues	2 hours

Commutative Banach Algebras – https://www.youtube.com/watch?v=SW-GuE0waxM

	Total Lecture hours	105 hours

Text Book(s)	
1	G. F. Simmons, Introduction to Topology and Modern Analysis, McGraw-Hill Book Company, London, 1963. Unit I: Sections: 46 – 50. Unit II: Sections: 51 – 54. Unit III: Sections: 55 – 59. Unit IV: Sections: 60 – 63. Unit V: Sections: 64 – 68.
Reference Books	
1	C. Goffman and G. Pedrick, A First Course in Functional Analysis, Prentice Hall of India, New Deli, 1987.
2	G. Bachman and L. Narici, Functional Analysis, Academic Press, New York, 1966.
3	L. A. Lusternik and V.J. Sobolev, Elements of Functional Analysis, Hindustan Publishing Corporation, New Delhi, 1971.
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	https://nptel.ac.in/courses/111/105/111105037/
2	https://ocw.mit.edu/courses/mathematics/18-102-introduction-to-functional-analysis-spring-2009/lecture-notes/
Course Designed By: Dr. C. Janaki	

Mapping with Programme Outcomes										
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	**S**	**S**	**S**	**M**	**M**	**M**	**S**	**L**	**M**	**S**
CO2	**S**	**S**	**M**	**M**	**L**	**S**	**S**	**M**	**S**	**M**
CO3	**M**	**M**	**L**	**S**	**S**	**S**	**S**	**S**	**M**	**S**
CO4	**S**	**M**	**S**	**L**	**L**	**S**	**S**	**S**	**M**	**S**
CO5	**S**	**S**	**S**	**L**	**M**	**S**	**S**	**M**	**S**	**M**

*S-Strong; M-Medium; L-Low

Course code		MATHEMATICAL METHODS	L	T	P	C
Core/Elective/Supportive		Core	7	0	0	4
Pre-requisite		Basic Knowledge in Calculus and Differential equations.	Syllabus Version		20-21	

Course Objectives:

The main objectives of this course are to:

1. Give an introduction to mathematical methods for solving application-oriented problems
2. Able to know the concepts line Integral Transforms, Integral Equations and calculus of variations.
3. Develop the alternatives to solve the real-life problems.

Expected Course Outcomes:

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

1	Understand and Apply various transforms and Integral equations to solve problems in all respects.	K2 & K3
2	Recognize and solve the special cases of Volterra Integral equations by the method of resolvent kernel, method of successive approximations and by using transforms.	K1& K5
3	Understand the relations between the Hankel, Fourier transform and their applications in evaluating the equations.	K2& K5
4	Understand the formulation of variational problems, the variation of functional and its properties.	K2
5	Demonstrate and apply the methods in all application problems in day-today life.	K5& K6

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

Unit:1	Integral Equations	21 hours

Types of Integral equations – Integral Fredholm Alternative - Approximate method – Equation with separable Kernel - Volterra integral equations – Fredholm's theory.

Unit:2	Application of Integral Equations to Ordinary Integral Equations and Singular Integral Equations	21 hours

Initial value problems Boundary value problems – singular integral equations – Abel Integral equation.

Unit:3	Fourier Transforms	20 hours

Fourier Transforms, Fourier sine and cosine transforms – Fourier transforms of derivatives - convolution integral – Parseval's Theorem - Solution of Laplace Equations by Fourier transform.

Unit:4	Hankel Transforms	20 hours

Properties of Hankel Transforms – Hankel transformation of derivatives of functions - The Parseval's relation – relation between Fourier and Hankel transforms - Axisymmetric Dirichlet problem for a half space - Axisymmetric Dirichlet problem for a thick plate.

Unit:5	Calculus of Variations	21 hours

Variation and its properties – Euler's(Euler Lagrange's) equation – functionals dependent on the functions of several independent variables – variational problems in parametric form –applications.

Unit:6	Contemporary Issues	2 hours
Z-transform and inverse Z-transform – http://www.digimat.in/nptel/courses/video/111107098/L39.html		
	Total Lecture hours	**105 hours**

Text Book(s)

1	**Units I and II:** Ram P. Kanwal, Linear Integral Equations Theory and Technique, Academic Press, New York, 1971. Unit I: Chapter 2: 46 – 50. Unit II: Chapter 3: 51 – 54.
2	**Units III and IV:** I. N. Sneddon, The Use of Integral Transforms, McGraw-Hill, New York, 1972. Unit III: Chapter 2: 2.3 – 2.5, Chapter 3: 3.3 – 3.4. Unit IV: Chapter 5: 5.1 – 5.2, Chapter 8: 8.1 – 8.2.
3	**Unit V:** L. Elsgolts, Differential Equations and Calculus of Variations, Mir Publishers, Moscow, 1970. Unit V: Chapter 6: 6.1 – 6.3, 6.4 – 6.7.

Reference Books

1	Calculus of Variations, A.S. Gupta, Prentice Hall of India, New Delhi, 2005.
2	Integral Equations and Boundary value problems, M.D. Raisinghania, S. Chand and Company, 2007.
3	M.L. Krasnov, Problems and Exercises in Integral Equations, Mir Publication Moscow 1971.

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

1	https://nptel.ac.in/courses/111/107/111107103/
2	https://nptel.ac.in/courses/111/107/111107098/(Lec 51 to 55)
3	https://youtu.be/tfRZqIflEfQ

Course Designed By: Dr. V. Jeyanthi

Mapping with Programme Outcomes

COs ~~Pos~~	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	M	M	L	M	M	M	M	S	L	S
CO2	M	M	L	M	M	L	S	M	M	M
CO3	L	M	M	M	L	L	S	M	M	M
CO4	L	M	M	L	M	L	M	S	M	S
CO5	M	M	M	S	M	M	S	S	L	S

*S-Strong; M-Medium; L-Low

Course code		OPTIMIZATION TECHNIQUES	L	T	P	C
Core/Elective/Supportive		Core	6	0	0	4
Pre-requisite		Basic knowledge in Operation Research at Undergraduate level.	Syllabus Version		20-21	

Course Objectives:

The main objectives of this course are to:

1. To make the students understand solving LPP using various methods.
2. To understand the application of queuing theory in real life situation and methods of solving related problems.
3. To understand the concept of Kuhn tucker method.

Expected Course Outcomes:

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

1	Explain various techniques to solve real life problems expressed in terms of LPP.	K2
2	Solving LPP through Dynamic Programming	K3
3	Apply the fundamental concept of Inventory control.	K3
4	Understanding the queuing theory	K2
5	Solving NLPP using Kuhn–Tucker Method	K3

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

Unit:1	Integer Programming	18 hours

Introduction – Integer Programming Formulations – Gomory's construction–Fractional cut method(all integer)–The Cutting – Plane Algorithm – Branch–and–Bound Technique – Zero–One Implicit Enumeration Algorithm.

Unit:2	Dynamic Programming	18 hours

Introduction – Application of Dynamic Programming: Capital Budgeting Problem – Reliability Improvement Problem – Stage–coach Problem – Cargo Leading Problem – Minimizing Total Tardiness in Single Machine Scheduling Problem – Optimal Subdividing Problem – Solution of Linear Programming Problem through Dynamic Programming.

Unit:3	Inventory	17 hours

Introduction–Inventory Decisions–Cost Associated– with Inventories – Factors Affecting inventory – Economic Order Quantity–Deterministic Inventory Problems with No Shortages–Deterministic inventory Models with shortages–EOQ with Price Breaks–Multi Item Deterministic problems–Inventory Problems with Uncertain Demand.

Unit:4	Queuing Theory	17 hours

Introduction – Queuing System–Elements of Queuing System – Operating Characteristics of Queuing System – Classification of Queuing Models– Model–I (M/M/1):(∞/FIFO), Model–II (M/M/1) : (N/FIFO), Model–III (M/M/C):(∞/FIFO), Model–IV (M/M/C):(N/FIFO). Problems in above four models.

Unit:5	Nonlinear Programming	18 hours

Introduction – Lagrangian Method –Jacobi Method– Kuhn–Tucker Method – Quadratic Programming – Separable Programming – Chance–Constrained Programming or Stochastic Programming.

Unit:6	**Contemporary Issues**	**2 hours**
Goal Programming – https://freevideolectures.com/course/2678/advanced-operations-research/9		
	Total Lecture hours	**90 hours**

Text Book(s)

1	Hamdy A. Taha, Operations Research, Sixth edition, Prentice–Hall of India private Limited, New Delhi,1997.

Reference Books

1	Kanti Swarup, P. K. Gupta, Man Mohan, Operations Research, Sultan Chand & Sons, Educational Publishers, New Delhi.
2	Prem Kumar Gupta, D. S. Hira Operations Research, Seventh Edition, S. Chand & Company Pvt. Ltd, 2014.
3	F. S. Hillier and J. Lieberman, Introduction to Operation Research, Seventh Edition, Tata–McGraw-Hill Publishing Company, New Delhi, 2001.
4	R. Panneerselvam, Operations Research, Second Edition, PHI Learning Private Limited, Delhi, 2015.
5	I. Griva, S. G. Nash and A. Sofer, Linear and Nonlinear Optimization, SIAM Publication, 2018.

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

1	https://www.youtube.com/watch?v=WmeUT0jQdwc
2	https://www.youtube.com/watch?v=FTEMe5oUrds&list=PLLy_2iUCG87Bq8RGMTdeFZiB-87V4i9p1&index=28
3	https://www.youtube.com/watch?v=2aPlzhsEsIw
4	https://www.youtube.com/watch?v=PavZX3hAL6I

Course Designed By: Dr. N. Mala

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	M	L	S	M	M	S	S	S	S	S
CO2	S	M	S	S	S	S	M	S	L	S
CO3	S	M	S	S	S	S	M	S	L	S
CO4	M	L	S	M	M	S	S	S	S	S
CO5	S	M	S	S	S	S	M	S	L	S

*S-Strong; M-Medium; L-Low

Course code		COMPUTER PROGRAMMING (C++ THEORY)	L	T	P	C
Core/Elective/Supportive		Core	4	0	0	4
Pre-requisite		Basic knowledge in C++ Programming such as Tokens, Expressions, Control Structure, Classes and Objects.	Syllabus Version		20-21	

Course Objectives:

The main objectives of this course are to:

1. To give the students an awareness of the object oriented programming.
2. To enable the students to write the C++ programs using classes, functions and interfaces.
3. To make applications using C++ programs.

Expected Course Outcomes:

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

1	Understand and apply the C++ structure, tokens, expressions, control structures	K2, K3
2	Ability to declare various prototyping, friend and virtual functions	K3
3	Create Classes, objects, arrays of objects, constructors, and Destructors	K3, K4
4	Analyze over loading operators and inheritance	K4
5	Deliberate files, pointers and templates. Create, design and develop quality programs in C++	K4, K5

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

Unit:1	Tokens, Expressions and Control Structure	12 hours

Basic Concept of Object-Oriented Programming- Basic Concept of OOPS-Benefits of OOP – Applications of OOP. **Tokens, Expressions and Control Structure:** Introduction – Tokens – Keywords – Identifiers and Constants – Basic Data Types – User Defined Data Types – Derived Data Types – Declaration of Variables – Dynamic Initialization of Variables – Reference Variables – Operators - Scope Resolution Operator- Control Structures.

Unit:2	Functions in C++	12 hours

Functions in C++: 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:3	Classes and Objects & Constructors and Destructors	12 hours

Classes and Objects: Introduction – C Structures Revisited – Specifying a Class –Defining Member Functions – A 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 – Friend Functions.

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

Unit:4	Operator Overloading, Inheritance and Extending Classes	11 hours

Operator Overloading: Introduction – Defining Operator Overloading – Overloading Unary Operators – Overloading Binary Operators – Overloading Binary Operators Using Friends – Manipulating of Strings Using Operators – Rules for Overloading Operators.
Inheritance - 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:5	Streams and Working with files	11 hours

Streams: Introduction – C++ Streams – C++ Stream Classes. **Working with files:** Classes for File Stream Operations - Opening and Closing a File – File Modes – File Pointers and their Manipulations – Sequential Input and Output Operations –Random Access.

Unit:6	Contemporary Issues	2 hours

Expert lectures, online seminars - webinars

	Total Lecture hours	60 hours

Text Book(s)

1. E. Balaguruswamy, Object–Oriented Programming with C++, Sixth Edition, Tata McGraw-Hill Publishing Company Limited.
   Unit I : 1.4 – 1.6, 3.1 – 3.14 and 3.24
   Unit II : 4.1 – 4.11
   Unit III : 5.1 – 5.9, 5.13 – 5.15, 6.1 – 6.7 and 6.11
   Unit IV : 7.1 – 7.7 and 8.1 – 8.10
   Unit V : 10.1 – 10.3 and 11.1 – 11.8

Reference Books

1. Programming with C++ by D. Ravichandran, -Tata McGraw Hill publishing company limited, New Delhi.
2. Object Oriented Programming with C++ by S.S.Vinod Chandra, New age.

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

1. https://nptel.ac.in/courses/106/105/106105151/
2. https://youtu.be/1rJZb_Ugc4E

Course Designed By: Prof. D.Saravanan.

Mapping with Programme Outcomes

COs / Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	S	M	M	S	L	M	S	S
CO2	M	S	S	M	S	S	L	M	S	S
CO3	M	M	L	S	M	M	L	S	S	M
CO4	M	S	S	L	M	S	M	S	S	M
CO5	M	M	L	L	S	S	M	S	S	M

*S-Strong; M-Medium; L-Low

Course code		COMPUTER PROGRAMMING (C++ PRACTICAL)	L	T	P	C
Core/Elective/Supportive		Core	0	0	2	4
Pre-requisite		basic knowledge in programming in C++	Syllabus Version		20-21	

Course Objectives:

The main objectives of this course are to:

1. To enable the students to solve problems in C++ using different numerical methods.
2. To make the mathematical calculations simpler.

1. friend FUNCTION usage: Create two classes to store the value of distances in meters-centimetres and feet-inches. Write a program that can create the values of the class objects and add one object with another. Use a friend function to carry out addition operation. The result may be stored in any object depending on the units in which results are required. The display should be in the order of meters & centimetre and feet & inches depending on the order of display.

2. OVERLOADING OBJECTS: Create a class that contains one float data member. Overload all the four arithmetic operators so that operate on the objects of the class.

3. OVERLOADING CONVERSIONS: Design a class **Polar** which describes a point in a plane using polar co-ordinates **radius** and **angle**. Use the overloaded + operator to add two objects of **Polar**. Note that we cannot add polar values of two points directly. This requires first the conversion of points into rectangular co-ordinates and finally converting the result into polar co-ordinates. You need to use following trigonometric formulae: *= r * cos (a);* *= r * sin (a);*= ; = ∗ + ∗ .

4. OVERLOADING VECTOR: Define a class for Vector containing scalar values. Apply overloading concepts for Vector Addition, Multiplication of a Vector by a scalar quantity, replace the values in a Position Vector.

5. OVRELOADING MATRIX:
Create a class **MAT** of size m * n. Define all possible matrix operations for **MAT** type objects. Verify the identity: $(A-B)^2 = A^2+B^2 - 2AB$.

6. INHERITANCE: Create three classes: **alpha, beta** and **gamma**, each containing one data member. The class **gamma** should be inherited from both **alpha** and **beta**. Use a constructor function in the class **gamma** to assign values to the data members of all the classes. Write a program to print the value of data members of all the three classes.

7. FILE HANDLING: Write a program to create a disk file containing the list of names and telephone numbers in two columns, using a class object to store each set of data. Design an interactive menu to access the file created and to implement the following tasks:
(a) Determine the telephone number of the specified person.
(b) Determine the name if a telephone number is known.
(c) Update the telephone number, whenever there is a change.

Elective Courses

Course code		Elective 1: NUMBER THEORY	L	T	P	C
Core/Elective/Supportive		Elective	4	0	0	4
Pre-requisite		Basic knowledge in Number system, divisibility and some related functions.	Syllabus Version		20-21	

Course Objectives:

The main objectives of this course are to:

1. To give Introduction to Elementary Number Theory.
2. To show how certain number theorems can be applied within Cryptography.

Expected Course Outcomes:

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

1	Find quotients and remainders and greatest common divisors applying Euclidean Algorithm	K3
2	Understand the definitions of congruence, residue classes and least residues	K2
3	Analyze the concept of Prime Power Moduli and Quadratic Residues	K4
4	Determine multiplicative inverses, modulo n and use to solve linear congruence.	K3
5	Acquire knowledge on Linear Diaphantine equation	K4

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

Unit:1	Divisibility	11 hours

Divisibility and Euclidean algorithm.

Unit:2	Congruences	12 hours

Congruences, Euler's theorem, Wilson's Theorem. Solutions of congruences, Congruences of Degree 1. Chinese Remainder Theorem, The functions $\phi(n)$, Congruences of higher degree.

Unit:3	Congruences (contd), Quadratic Reciprocity	11 hours

Prime power moduli, Prime modulus. Quadratic residues - Quadratic reciprocity.

Unit:4	Jacobi Symbol and Some Functions of Number Theory	12 hours

The Jacobi symbol – Greatest integer function - Arithmetic functions – The Moebius Inversion formula.

Unit:5	Arithmetic Functions and Diophantine Equations	12 hours

Multiplication of arithmetic functions, Linear Diophantine equations – The equation $x^2 + y^2 = z^2$ - The equation $x^4 + y^4 = z^2$.

Unit:6	Contemporary Issues	2 hours

Sum of Four Squares – https://www.youtube.com/watch?reload=9&v=ZBJLWHpNpI8

	Total Lecture hours	60 hours

Text Book(s)	
1	Ivan Niven and Herbert Zuckerman, An Introduction to the Theory of Numbers, John Wiley and Sons Inc., 1972. Unit-I: Chapter I: Sections: 1.1 – 1.3 Unit-II: Chapter II: Section: 2.1 – 2.5 Unit-III: Chapter II: Section: 2.6 – 2.7, Chapter III: Section: 3.1 – 3.2 Unit-IV: Chapter III: Section: 3.3, Chapter IV: Section: 4.1 – 4.3 Unit-V: Chapter IV: Section: 4.4, Chapter V: Section: 5.1 – 5.6
Reference Books	
1	T. M. Apostol, Introduction to Analytic Number Theory, Springer Verlag, 1976.
2	Kenneth H. Rosen, Elementary Number Theory and its Applications, Addison Wesley Publishing Company, 1968.
3	George E. Andrews, Number Theory, Hindustan Publishing, New Delhi, 1989.
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	https:// freevideolectures.com/course/3027/cryptography-and-network-security
2	https://www.youtube.com/watch?v=SCvtxjpVQms&t=3321s (NPTEL)
3	https://www.youtube.com/watch?v=Oyw5OmOd9B8&list=PLLtQL9wSL16iRzTi2aKPiHO1f1UjTTkJD (Mathpod)
Course Designed By: Dr. R. Buvaneswari	

Mapping with Programme Outcomes										
COs ~~**Pos**~~	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	**S**	**M**	**M**	**L**	**M**	**M**	**M**	**M**	**M**	**S**
CO2	**M**	**S**	**L**	**M**	**M**	**S**	**M**	**M**	**S**	**S**
CO3	**L**	**M**	**S**	**M**	**S**	**S**	**M**	**M**	**S**	**S**
CO4	**L**	**M**	**M**	**L**	**L**	**M**	**M**	**S**	**S**	**S**
CO5	**S**	**M**	**M**	**L**	**M**	**S**	**M**	**S**	**S**	**S**

*S-Strong; M-Medium; L-Low

Course code		ELECTIVE 2: DIFFERENTIAL GEOMETRY	L	T	P	C
Core/Elective/Supportive		Elective	4	0	0	4
Pre-requisite		Acquire knowledge about the concept of curves, surfaces, and their higher dimensional analogues using the methods of calculus.	Syllabus Version		20-21	

The main objectives of this course are to:

1. Gain knowledge about curves and its characterizations.
2. Get sufficient knowledge on Elementary Theory of surfaces.
3. Make the students to familiarize with space curves and curves on surfaces.

Expected Course Outcomes:

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

1	Define and understand basic definitions of the theory of curves.	K1
2	Interpret the notions of surface of revolution and direction coefficients.	K2
3	Analyze the elements of Analytic representation.	K4
4	Acquire knowledge on first fundamental form and second fundamental form.	K4
5	Explain Meusnier's theorem and Euler's Theorem on elementay theory of surface.	K3

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

Unit:1	**Curves**	**11 hours**

Analytic representation - Arc Length – Osculation plane.

Unit:2	**Curves (Continued)**	**12 hours**

Curvature torsion – Formulas of Frenet - Contact – Natural equations – Helices – General solutions of Natural equations.

Unit:3	**Curves (Continued) and Elementary Theory of Surface**	**12 hours**

Evolutes and Involutes - Elementary theory of surface: Analytic representation.

Unit:4	**Elementary Theory of Surface (Continued)**	**12 hours**

First fundamental form – Normal, Tangent plane – Developable surfaces - Second fundamental form.

Unit:5	**Elementary Theory of Surface (Continued)**	**11 hours**

Meusnier's theorem – Euler's Theorem – Dupin's indicatrix – Some surfaces.

Unit:6	**Contemporary Issues**	**2 hours**

Quadratic Surfaces – https://youtu.be/E1L672Q5gd8

	Total Lecture hours	**60 hours**

Text Book(s)

1	Dirk J. Struik, Lectures on Classical Differential Geometry, Addison Wesley Publishing Company, 1961.

Reference Books	
1	Differential Geometry by T.J. Willmore, Oxford University Press (Seventeenth Impression - 2002).
2	Differential Geometry by A First Course by D. Somasundaram, Narosa Publishing House, Reprint 2008.
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	https://nptel.ac.in/noc/courses/noc16/SEM2/noc16-ma07/
2	https://www.youtube.com/watch?v=tKnBj7B2PSg
3	http://pages.uoregon.edu/koch/math433/Final.pdf
Course Designed By : Prof. M. Indhumathi	

Mapping with Programme Outcomes										
COs / POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	**S**	**M**	**M**	**S**	**S**	**L**	**S**	**S**	**L**	**M**
CO2	**M**	**S**	**M**	**M**	**M**	**M**	**M**	**L**	**M**	**S**
CO3	**S**	**M**	**S**	**M**	**L**	**M**	**S**	**M**	**S**	**L**
CO4	**M**	**S**	**L**	**S**	**S**	**L**	**M**	**S**	**M**	**S**
CO5	**M**	**S**	**M**	**S**	**M**	**M**	**S**	**M**	**S**	**M**

*S-Strong; M-Medium; L-Low

Course code		ELECTIVE 3: NEURAL NETWORKS	L	T	P	C
Core/Elective/Supportive			4	0	0	4
Pre-requisite		Basic Knowledge in Computer Architecture and basics of algorithms	Syllabus Version		20-21	

Course Objectives:

The main objectives of this course are to:

1. To know the main fundamental principles and techniques of neural network systems and investigate the principal neural network models and applications.
2. Acquire in-depth knowledge in Non-linear dynamics
3. Apply neural network to classification and generalization problems.

Expected Course Outcomes:

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

1	Understand and analyze different neutron network models	K2 &K4
2	Understand the basic ideas behind most common learning algorithms for multilayer perceptions, radial-basis function networks.	K2
3	Describe Hebb rule and analyze back propagation algorithm with examples.	K4
4	Study convergence and generalization and implement common learning algorithm,	K6
5	Study directional derivatives and necessary conditions for optimality and to evaluate quadratic functions.	K5

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

Unit:1	Neuron Model and Network Architectures	12 hours

Mathematical Neuron Model- Network Architectures- Perceptron-Hamming Network- Hopfield Network-Learning Rules.

Unit:2	Perceptron Architectures	12 hours

Perceptron Architectures and Learning Rule with Proof of Convergence. Supervised Hebbian Learning -Linear Associator.

Unit:3	Supervised Hebbian Learning	12 hours

The Hebb Rule-Pseudo inverse Rule-Variations of Hebbian Learning-Back Propagation - Multilayer Perceptrons.

Unit:4	Back Propagation	11 hours

Back propagation Algorithm-Convergence and Generalization - Performances Surfaces and Optimum Points-Taylor series.

Unit:5	Performance Surfaces and Performance Optimizations	11 hours

Directional Derivatives - Minima-Necessary Conditions for Optimality-Quadratic Functions-Performance Optimizations-Steepest Descent-Newton's Method-Conjugate Gradient.

Unit:6	Contemporary Issues	2 hours

Widrow-Hoff Rule – https://www.youtube.com/watch?v=niF7XUvfEu4

	Total Lecture hours	60 hours

Text Book(s)	
1	Martin T. Hagan, Howard B. Demuth and Mark Beale, Neural Network Design, Vikas Publishing House, New Delhi,2002.
Reference Books	
1	James A. Freeman, David M. Skapura, Neural Networks Algorithms, Applications and Programming Techniques, Pearson Education, 2003.
2	Robert J. Schalkoff, Artificial Neural Network, McGraw-Hill International Edition, 1997.
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	https://nptel.ac.in/courses/117/105/117105084/
2	https://nptel.ac.in/courses/106/106/106106184/
Course Designed By: Dr. V. Jeyanthi	

Mapping with Programme Outcomes										
COs ~~POs~~	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	**S**	**L**	**M**	**M**	**M**	**L**	**M**	**S**	**S**	**M**
CO2	**S**	**M**	**M**	**L**	**L**	**L**	**L**	**M**	**M**	**M**
CO3	**L**	**M**	**M**	**S**	**L**	**L**	**L**	**M**	**M**	**M**
CO4	**M**	**M**	**L**	**L**	**M**	**L**	**L**	**L**	**M**	**S**
CO5	**M**	**M**	**M**	**L**	**L**	**L**	**L**	**S**	**M**	**M**

*S-Strong; M-Medium; L-Low

Course code		ELECTIVE 4: MAGNETOHYDRODYNAMICS	L	T	P	C
Core/Elective/Supportive		Elective	4	0	0	4
Pre-requisite		To know the basic concepts of Statics and Dynamics at Undergraduate level.	Syllabus Version		20-21	

Course Objectives:

The main objectives of this course are to:

1. Understand the concepts of electromagnetism, electrostatic energy and magnetostatic energy.
2. Gain knowledge about boundary conditions of electric and magnetic fields.
3. Develop flexibility and creativity of the students in applying mathematical ideas and techniques to unfamiliar problems arising in everyday life.

Expected Course Outcomes:

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

1	Understand the basic concepts of Electromagnetism, Fundamental Laws and fluid motion in magnetic field.	K2
2	Solve and analyze the Naiver-Stokes equations and velocity Magneto fluid dynamic equations with examples.	K3
3	Understand the MHD approximation and gain ability to analyze Magnetic Reynolds number.	K4
4	Gain knowledge about the Magneto hydrostatics and Alfven waves in incompressible MHD.	K5
5	Understand and develop the Hartmann Flow in the presence of magnetic field.	K6

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

Unit:1	Title of the Unit (Capitalize each Word)	12 hours

Electromagnetism – Fundamental Laws – Electrostatic Energy – Electrodynamics Ampere's Law – Lorentz force on a moving charge – Magnetostatic Energy – Faraday's Law of Induction – Poynting stresses.

Unit:2	Title of the Unit (Capitalize each Word)	12 hours

Electromagnetic Equations with respect to moving axes – boundary conditions of electric and magnetic fields. Kinematics of fluid motion – equation of continuity – Stress tensor – Navier-stokes equations – boundary condition – Velocity Magneto fluid dynamic equations.

Unit:3	Title of the Unit (Capitalize each Word)	10 hours

MHD approximation – equation of Magnetic diffusion in a moving conducting medium – Magnetic Reynolds number.

Unit:4	Title of the Unit (Capitalize each Word)	12 hours

Alfven's theorem Law of isorotation - Magneto hydrostatics – Force-free field – Alfven waves in incompressible MHD.

Unit:5	Title of the Unit (Capitalize each Word)	12 hours

Incompressible viscous flows in the presence of magnetic field – Hartmann Flow – unsteady Hartmann flow – Magneto fluid dynamic pipe flow.

Unit:6	Contemporary Issues	2 hours
Helmholtz's Theorem for Electric Field – https://youtu.be/LOGy8hBTQEQ		
	Total Lecture hours	**60 hours**

Text Book(s)	
1	Crammer K.R. and Pai S.I, Magneto Fluid Dynamics for Engineers and Applied Physicists, McGraw Hill, 1973.
2	Ferraro, VCA and Plumpton, Introduction to Magneto Fluid Dynamics, Oxford, 1966.
Reference Books	
1	P. A. Davidson, An Introduction to Magnetohydrodynamics, Cambridge University press, 2001.
2	R. V. Polovin, V. P. Demutskii, Fundamentals of Magnetohydrodynamics, Springer US, 1990.
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	https://www.youtube.com/watch?v=mE3uY_yKsCo
2	https://www.youtube.com/watch?v=rFJ1UZSFZno
3	https://www.youtube.com/watch?v=A9pUXEI128U
Course Designed By: Prof. M. Indhumathi.	

Mapping with Programme Outcomes

COs / POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	M	S	L	M	S	L	M	M
CO2	M	S	M	M	M	S	M	S	S	M
CO3	S	M	M	M	S	L	M	M	M	M
CO4	M	M	S	S	L	S	S	M	S	M
CO5	S	M	M	S	M	M	M	S	M	S

*S-Strong; M-Medium; L-Low

Course code		ELECTIVE 5: FUZZY LOGIC AND FUZZY SETS	L	T	P	C
Core/Elective/Supportive		Elective	4	0	0	4
Pre-requisite		Basic knowledge in crisp sets, relations and functions at Undergraduate level.	Syllabus Version		20-21	

Course Objectives:

The main objectives of this course are to:

1. identify fuzzy sets and perform set operations on fuzzy sets.
2. apply fuzzy logic in various real-life situations such as decision making and inventory control.

Expected Course Outcomes:

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

1	Gain knowledge about the basic types of fuzzy sets and the difference between crisp sets and fuzzy sets and the concept of operations on fuzzy sets	K1, K2
2	Analyze and apply the knowledge of fuzzy relations.	K3, K4
3	Develop the basic concepts of fuzzy measures.	K6
4	Explore the concept of uncertainity. .	K6
5	Understand the types of uncertainity measures and principles	K3

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

Unit:1	Crisp Sets and Fuzzy Sets	12 hours

Introduction-Crisp sets: An over view-The Notion of Fuzzy Sets-basic concepts of Fuzzy Sets – Classical Logic: complement-Fuzzy Union-Fuzzy intersection – Combination of operations – General aggregation of operations.

Unit:2	Fuzzy Relations	12 hours

Crisp and Fuzzy relations – Binary relations – Binary relations on a single set – Equivalence and similarity relations – Compatibility on Tolerance Relations-Orderings – Morphism – Fuzzy relations Equations.

Unit:3	Fuzzy Measures	11 hours

General discussion – Belief and plausibility Measures –Probability measures – Possibility and Necessity measures.

Unit:4	Fuzzy Measures, Uncertainty	11 hours

Relationship among classes of fuzzy measures - Types of Uncertainty – Measures of Fuzziness-Classical Measures of Uncertainty.

Unit:5	Uncertainty and Information	12 hours

Measures of Dissonance-Measures of Confusion – Measures of Non-Specificity – Uncertainty and Information – Information and Complexity – Principles of Uncertainty and information.

Unit:6	Contemporary Issues	2 hours

Expert lectures, online seminars - webinars

	Total Lecture hours	60 hours

Text Book(s)	
1	George J. Klir and Tina A. Folger, Fuzzy Sets, Uncertainty and Information, Fourth printing, Prentice Hall of India Private Limited, 1995. Unit-I: 1.1 – 1.5, 2.2 - 2.6 Unit-II: 3.1 – 3.8 Unit-III: 4.1 – 4.4 Unit-IV: 4.5, 5.1 – 5.3 Unit-V: 5.4 – 5.9.
Reference Books	
1	George J. Klir and Bo Yuan, Fuzzy Sets and Fuzzy Logic - Theory and Applications, Prentice-Hall of India Private Limited
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	https://giocher.wordpress.com/chapter-2-par-2-2-fuzzy-relations-and-the-extension-principle/
2	https://nptel.ac.in/courses/108/104/108104157/
Course Designed By: Prof. D. Saravanan	

Mapping with Programme Outcomes										
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	**L**	**M**	**S**	**L**	**M**	**L**	**S**	**M**	**S**	**S**
CO2	**M**	**S**	**M**	**S**	**S**	**S**	**S**	**S**	**S**	**S**
CO3	**S**	**S**	**L**	**M**	**S**	**S**	**L**	**M**	**L**	**S**
CO4	**S**	**S**	**L**	**M**	**S**	**S**	**L**	**M**	**L**	**S**
CO5	**M**	**S**	**M**	**S**	**S**	**S**	**S**	**S**	**M**	**S**

*S-Strong; M-Medium; L-Low

Course code		ELECTIVE 6: CONTROL THEORY	L	T	P	C
Core/Elective/Supportive		Elective	4	0	0	4
Pre-requisite		Basic knowledge in differential equations and optimization at Undergraduate level.	Syllabus Version		20-21	

Course Objectives:

The main objectives of this course are to:

1. Understand the concepts of Observability, Controllability and Stability.
2. Gain knowledge about linear time varying systems.
3. Develop the ability of solving linear feedback control.

Expected Course Outcomes:

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

1	Explain observability and estimate the observability of constant coefficient system, linear, nonlinear system, and discuss reconstruction kernel.	K2
2	Apply controllability criteria to constant coefficient system, linear, nonlinear system, and explain steering function.	K3
3	Analyze the stability of linear system, linear time varying system, perturbed linear system and nonlinear system.	K4
4	Evaluate stabilizabilization via linear feedback control, Bass method.	K5
5	Analyze controllable subspace, and stabilization with restricted feedback.	K4

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

Unit:1	**Observability**	**12 hours**

Linear Systems – Observability Grammian – Constant coefficient systems – Reconstruction kernel – Nonlinear Systems.

Unit:2	**Controllability**	**12 hours**

Linear systems – Controllability Grammian – Adjoint systems – Constant coefficient systems – steering function – Nonlinear systems.

Unit:3	**Stability**	**10 hours**

Stability – Uniform Stability – Asymptotic Stability of Linear Systems.

Unit:4	**Perturbed Linear Systems**	**12 hours**

Linear time varying systems – Perturbed linear systems – Nonlinear systems.

Unit:5	**Stabilizability**	**12 hours**

Stabilization via linear feedback control – Bass method – Controllable subspace – Stabilization with restricted feedback.

Unit:6	**Contemporary Issues**	**2 hours**

Expert lectures, online seminars - webinars

	Total Lecture hours	**60 hours**

Text Book(s)	
1	K. Balachandran and J. P. Dauer, Elements of Control Theory, Narosa, New Delhi, 1999.
Reference Books	
1	R. Conti, Linear Differential Equations and Control, Academic Press, London, 1976.
2	R. F. Curtain and A. J. Pritchard, Functional Analysis and Modern Applied Mathematics, Academic Press, New York, 1977.
3	J. Klamka, Controllability of Dynamical Systems, Kluwer Academic Publisher, Dordrecht, 1991.
4	D. L. Russell, Mathematics of Finite Dimensional Control Systems, Marcel Dekker, New York, 1979.
5	E. B. Lee and L. Markus, Foundations of optimal Control Theory, John Wiley, New York, 1967.
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	https://www.youtube.com/watch?v=39Ggoj2fQ2c
2	https://nptel.ac.in/courses/115/108/115108104/
3	https://nptel.ac.in/courses/107/106/107106081/
Course Designed By: Prof. M. Indhumathi	

Mapping with Programme Outcomes										
COs ~~POs~~	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	**S**	**M**	**M**	**L**	**S**	**S**	**M**	**L**	**M**	**M**
CO2	**M**	**M**	**S**	**M**	**M**	**M**	**M**	**M**	**M**	**S**
CO3	**S**	**S**	**M**	**M**	**M**	**M**	**S**	**S**	**S**	**S**
CO4	**M**	**M**	**S**	**S**	**S**	**S**	**L**	**M**	**S**	**M**
CO5	**S**	**S**	**M**	**S**	**M**	**M**	**L**	**M**	**M**	**M**

*S-Strong; M-Medium; L-Low

Course code		ELECTIVE 7: CRYPTOGRAPHY	L	T	P	C
Core/Elective/Supportive		Elective	4	0	0	4
Pre-requisite		Basic knowledge in Modular arithmetic and finite field.	Syllabus Version		20-21	

Course Objectives:

The main objectives of this course are to:

1. Provide the deeper understanding in cryptography and its application to network security.
2. Able to know the applications of number theory in cryptography.
3. Know the methods of public key cryptography and its usefulness.

Expected Course Outcomes:

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

1	Understand the basic concepts and objective of cryptography and recall the concept of modular arithmetic.	K1 & K2
2	Understand mathematical foundations required for various cryptographic algorithms.	K2
3	Apply the concept and properties of modular arithmetic in various algorithms to find the solution.	K3 & K5
4	Describe and Analyze existing authentication protocols for two party communications.	K4
5	Evaluate security mechanisms in the theory of networks and apply the appropriate algorithms.	K3 & K5

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

Unit:1	Title of the Unit (Capitalize each Word)	12 hours

Introduction – Encryption and Secrecy – The objective of Cryptography - Number Theory – Introduction – Modular Arithmetic.

Unit:2	Title of the Unit (Capitalize each Word)	12 hours

Integer factorization problem – Pollard's rho factoring – Elliptic curve factoring – Discrete logarithm problem.

Unit:3	Title of the Unit (Capitalize each Word)	12 hours

Finite fields – Basic properties – Arithmetic of polynomials –Factoring polynomials over finite fields – Square free factorization.

Unit:4	Title of the Unit (Capitalize each Word)	10 hours

Symmetric key encryption – Stream ciphers – Block Ciphers – DES.

Unit:5	Title of the Unit (Capitalize each Word)	12 hours

Public key cryptography – Concepts of public key cryptography – Modular arithmetic – RSA – Discrete logarithm – Elliptic curve cryptography.

Unit:6	Contemporary Issues	2 hours
Expert lectures, online seminars - webinars		
	Total Lecture hours	60 hours

Text Book(s)

1	Hans Delfs, Helmut Knebl, Introduction to Cryptography, Springer Verlag, 2002.
2	Alfred J. Menezes, Paul C. Van Oorschot, Scott A. Vanstone, Handbook of Applied Cryptography, CRC Press, 2000.
3	William Stallings, Cryptography and Network Security, Prentice Hall of India, 2000.

Reference Books

1	Cryptography and Information Security, Pachghare V.K., PHI Learning Pvt. Ltd., New Delhi, 2009
2	Cryptography and Network Security, Behrouz A. Forouzan and Debdeep Mukhopathyey, 2013, second edition, Mc Graw Hill Education Pvt. Ltd., New Delhi.

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

1	https://nptel.ac.in/courses/106/105/106105162/
2	https://nptel.ac.in/courses/106/105/106105031/

Course Designed By: Dr. V. Jeyanthi

Mapping with Programme Outcomes

COs / POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	M	L	M	M	L	M	M	L	M	S
CO2	L	S	L	L	M	M	M	M	M	M
CO3	M	L	M	L	L	M	L	L	L	M
CO4	M	M	M	L	M	L	L	S	M	S
CO5	L	M	L	M	L	M	L	M	M	S

*S-Strong; M-Medium; L-Low

Course code		ELECTIVE 8: MATLAB	L	T	P	C
Core/Elective/Supportive		Elective	4	0	0	4
Pre-requisite		Be able to understand how to built-in math functions enable to quickly explore multiple approaches to arrive at a solution.	Syllabus Version		20-21	

Course Objectives:

The main objectives of this course are to:

1. Understand the Matlab Desktop, Command window and the Graph Window.
2. Be able to carry out numerical computations and analyses.
3. Understand the mathematical concepts upon which numerical methods rely.

Expected Course Outcomes:

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

1	Understand the basic concepts of starting windows and solve the MATLAB applications.	K2
2	Create arrays and solve them in MATLAB.	K6
3	Solve problems using M files and apply the same for advanced data objects in MATLAB.	K4
4	Understand the importance of MATLAB in differential equations and assess it for plotting graphs using layouts.	K6
5	Diagnose various applications of MATLAB in curve fitting, statistics and integration.	K5

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

Unit:1	Starting with Matlab and Creating Arrays	12 hours

Starting with Matlab: Starting MATLAB, MATLAB Windows - Working in the Command Window - Arithmetic Operations with Scalars - Display Formats - Elementary Math Built-In Functions - Defining Scalar Variables - Useful Commands for Managing Variables - Script Files - Examples of MATLAB Applications.

Creating Arrays: Creating a One-Dimensional Array (Vector) - Creating a Two-Dimensional Array (Matrix) - Notes about Variables n MATLAB - The Transpose Operator - Array Addressing - Using a Colon: In Addressing Arrays - Adding Elements to Existing Variables - Deleting Elements - Built-In Functions for Handling Arrays - Strings and Strings as Variables.

Unit:2	Mathematical Operations with Arrays, Using Script Files and Managing Data	12 hours

Mathematical Operations with Arrays: Addition and Subtraction - Array Multiplication - Array Division - Element-By-Element Operations - Using Arrays in MATLAB Built-in Math Functions - Built-in Functions for Analyzing Arrays - Generation of Random Numbers - Examples of MATLAB Applications.

Using Script Files and Managing Data: The MATLAB Workspace and the Workspace Window - Input to A Script File - Output Commands - The Save And Load Commands - Importing And Exporting Data - Examples of MATLAB Applications.

Unit:3	Two-Dimensional Plots and Three-Dimensional Plots	12 hours

Two-Dimensional Plots: The plot Command - The fplot Command - Plotting Multiple Graphs in the Same Plot - Formatting a Plot - Plots with Logarithmic Axes - Plots with Error Bars - Plots With Special Graphics - Histograms - Polar Plots - Putting Multiple Plots on the Same Page - Multiple Figure Windows - Examples of MATLAB Applications.
Three-Dimensional Plots: Line Plots - Mesh and Surface Plots - Plots with Special Graphics - The View Command - Examples of Matlab Applications.

Unit:4	Programming In Matlab, User-Defined Functions and Function Files	12 hours

Programming In Matlab: Relational and Logical Operators - Conditional Statements - The Switch-Case Statement - Loops - Nested Loops and Nested Conditional Statements - The Break and Continue Commands - Examples of MATLAB Applications.
User-Defined Functions and Function Files: Creating A Function File - Structure of a Function File - Local And Global Variables - Saving A Function File - Using A User-Defined Function - Examples of Simple User-Defined Functions - Comparison Between Script Files and Function Files - Anonymous And Inline Functions - Function Functions - Subfunctions - Nested Functions - Examples Of MATLAB Applications.

Unit:5	Polynomials, Curve Fitting, Interpolation and Applications in Numerical Analysis	10 hours

Polynomials, Curve Fitting, and Interpolation: Polynomials - Curve Fitting - Interpolation - The Basic Fitting Interface - Examples of MATLAB Applications.
Applications in Numerical Analysis: Solving an Equation with One Variable - Finding a Minimum or a Maximum of a Function - Numerical Integration - Ordinary Differential Equations - Examples of MATLAB Applications.

Unit:6	Contemporary Issues	2 hours

Expert lectures, online seminars - webinars

	Total Lecture hours	60 hours

Text Book(s)

1. Amos Gilat, MATLAB An Introduction with Applications, John Wiley & Sons, Inc., 2011.

Reference Books

1. Rudra Pratap, Getting Started with MATLAB– A Quick Introduction for Scientists and Engineers, Oxford University Press.
2. William John Palm, Introduction to MATLAB 7 for Engineers, McGraw-Hill Professional, 2005.
3. Dolores M. Etter and David C. Kuncicky, Introduction to MATLAB 7, Printice Hall, 2004.

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

1. https://nptel.ac.in/courses/103/106/103106118/
2. http://web4.cs.ucl.ac.uk/teaching/3085/archive/2010/matlab_tutorial/matlab_booklet.pdf
3. https://www.youtube.com/watch?v=zJm8VHg4TbQ

Course Designed By: Prof. M. Indhumathi

Mapping with Programme Outcomes										
COs / POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	S	L	S	M	S	S	S	S
CO2	M	S	M	M	M	S	M	M	S	M
CO3	M	M	S	S	S	S	M	S	M	S
CO4	S	M	M	L	M	M	S	M	S	M
CO5	S	M	M	S	M	S	M	S	M	S

*S-Strong; M-Medium; L-Low

Course code		ELECTIVE 9: LaTex	L	T	P	C
Core/Elective/Supportive		Elective	4	0	0	4
Pre-requisite		Basic concepts on mathematical functions.	Syllabus Version		20-21	

Course Objectives:

The main objectives of this course are to:

1. Understand richness of Latex rather than using M.S word for documentation.
2. Proficient in documentation using mathematical symbols, graphs and tables.

Expected Course Outcomes:

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

1	Understand basic concepts of Text formatting and LaTex file	K2
2	Demonstrating command names and arguments, Special characters.	K3
3	Apply the commands to create document layout and displayed output	K3, K6
4	Create Table, Printing Text, Foot notes and marginal notes	K6
5	Apply LaTex commands to mathematical formulae	K3

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

Unit:1	Introduction	11 hours

Text formatting, TEX and its offspring, What's different in LATEX 2ϵ, Distinguishing LaTex 2ϵ, Basics of a LaTex file.

Unit:2	Commands and Environments	11 hours

Command names and arguments, Environments, Declarations, Lengths, Special Characters – Spaces and carriage returns, Quotation marks, Hyphens and dashes, Printing command characters, The date, Exercises.

Unit:3	Document Layout and Organization, Displayed Text	14 hours

Document class, Page style, Parts of the document, Table of contents – Automatic entries, Printing the table of contents, Fine-Tuning text – Line breaking, Page breaking. Displayed Text – Changing font – Emphasis, Choice of font size, Font attributes, Centering and indenting, Lists.

Unit:4	Displayed Text (Continued)	10 hours

Tables, Printing literal text, Footnotes and marginal notes.

Unit:5	Mathematical Formulae	12 hours

Mathematical environments, Main elements of math mode,
Mathematical symbols – Greek letters, function names, Additional elements, Fine–tuning mathematics – Horizontal spacing, Selecting font size in formulas.

Unit:6	Contemporary Issues	2 hours

Expert lectures, online seminars – webinars

	Total Lecture hours	60 hours

Text Book(s)	
1	Helmut Kopka and Patrick W. Daly, A Guide to LATEX, Third Edition, Addison – Wesley, London,1999. Unit I : Chapter 1 : Sections : 1.1-1.3, 1.4.1, 1.5. Unit II : Chapter 2 : Sections : 2.1-2.4, 2.5.1-2.5.4, 2.5.9, 2.7. Unit III : Chapter 3 : Sections : 3.1-3.3, 3.4.1, 3.4.2, 3.5.2, 3.5.5, Chapter 4 : 4.1.1-4.1.3, 4.2, 4.3 Unit IV : Chapter 4 : Sections : 4.8-4.10. Unit V : Chapter 5: Sections : 5.1, 5.2, 5.31, 5.3.8, 5.4, 5.4.1 – 5.4.8, 5.5.1, 5.5.2.
Reference Books	
1	Velusamy Kavitha and Mani Mallikarjunan, Fundamentals of Latex for Mathematicians, Physicists and Engineers, LAP LAMBERT Academy Publishing, Germany, 2013.
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	https://www.youtube.com/watch?v=Q4FozDTRE_4
2	https://www.youtube.com/watch?v=DvDO1mea1w0
Course Designed By: Dr. R Buvaneswari	

Mapping with Programme Outcomes										
COs / POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	**S**	**M**	**L**	**M**	**M**	**M**	**L**	**L**	**M**	**M**
CO2	**M**	**L**	**L**	**M**	**M**	**M**	**L**	**L**	**M**	**M**
CO3	**L**	**M**	**L**	**M**	**M**	**S**	**L**	**S**	**S**	**M**
CO4	**M**	**L**	**L**	**M**	**M**	**M**	**L**	**L**	**M**	**M**
CO5	**L**	**M**	**M**	**M**	**M**	**S**	**L**	**S**	**S**	**M**

*S-Strong; M-Medium; L-Low

Course code		10 - ELEMENTS OF STOCHASTIC PROCESSES	L	T	P	C
Core/Elective/Supportive		Elective	4	0	0	4
Pre-requisite		Know the basic concepts of Statistics and Operation Research at Undergraduate level	Syllabus Version		20-21	

Course Objectives:

The main objectives of this course are to:

1. Acquire knowledge about the concept of Markov Chain and Queueing System.
2. Understand the methods of Birth and Death queues with Finite and Infinite Capacity.
3. Develop the ability of Standard Brownian Motion.

Expected Course Outcomes:

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

1	Acquire adequate knowledge about Continuous Time Markov Chain and Queueing Systems.	K1
2	Gain understanding on the Renewal Process, Cumulative Process and Semi-Markov Process.	K3
3	Apply different methods and solve Birth and Death queues.	K3
4	Examine the computations of M/G/1 and G/M/1 Queues and Network of Queues.	K4
5	Conclude the idea of Brownian Motion and First Passage Times.	K5

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

Unit:1	**Continuous-Time Markov Models**	**12 hours**

Continuous Time Markov Chain, Examples, Transient Analysis, Occupancy Times, Limiting Behavior.

Unit:2	**Generalized Markov Models**	**12 hours**

Renewal Process, Cumulative Process, Semi-Markov Process, Examples and Long term Analysis.

Unit:3	**Queueing Models**	**12 hours**

Queueing Systems, Single-Station Queues, Birth and Death queues with Finite and Infinite Capacity.

Unit:4	**Queueing Models (Contd)**	**10 hours**

M/G/1 and G/M/1 Queues and Network of Queues.

Unit:5	**Brownian Motion**	**12 hours**

Standard Brownian Motion, Brownian Motion and First Passage Times.

Unit:6	**Contemporary Issues**	**2 hours**

Black Scholes – https://www.youtube.com/watch?v=Xy_txjKPNyg

	Total Lecture hours	**60 hours**

Text Book(s)	
1	V. G. Kulkarni, Introduction to Modelling and Analysis of Stochastic Systems, Second Edition, Springer, 2011.
Reference Books	
1	J. Medhi, Stochastic Processes, New Age, 2009.
2	S. M. Ross, Stochastic Processes, Wiley Series in Probability and Statistics, 1996.
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	https://nptel.ac.in/courses/111/102/111102014/#
2	https://nptel.ac.in/courses/111/102/111102014/#
3	https://digitalcommons.usu.edu/cgi/viewcontent.cgi?article=2145&context=gradreports
Course Designed By: Prof. M. Indhumathi	

Mapping with Programme Outcomes										
COs ~~POs~~	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	**M**	**S**	**M**	**S**	**M**	**S**	**S**	**L**	**S**	**S**
CO2	**S**	**M**	**L**	**M**	**L**	**M**	**L**	**M**	**S**	**M**
CO3	**S**	**S**	**M**	**M**	**M**	**M**	**S**	**L**	**M**	**M**
CO4	**M**	**M**	**S**	**S**	**S**	**S**	**M**	**M**	**S**	**S**
CO5	**M**	**M**	**M**	**S**	**M**	**M**	**S**	**M**	**S**	**S**

*S-Strong; M-Medium; L-Low

Annexure

BHARATHIAR UNIVERSITY : : COIMBATORE 641046
DEPARTMENT OF MATHEMATICS

MISSION

1. To create opportunities which will ensure academic excellence in critical thinking, humanistic and scientific inquiry.

2. To organize, connect, create and communicate mathematical ideas effectively, through Dedication, Discipline and Determination.