Thiruvalluvar University, Vellore

(A State University)

Tamil Nadu- 632115, India.

Department of Mathematics

Percentage of Revised Syllabus during the Academic Year 2014-2015

S.No	Course code	Course Name	Percentage Revised
1	PDMA 11	Algebra I	100%
2	PDMA 12	Real Analysis I	80%
3	PDMA 13	Ordinary Differential Equations	75%
4	PDMA 14	Number Theory	100%
5	PDMA 15A	Calculus of Variations and Integral Equations	50%
6	PDMA 21	Algebra II	70%
7	PDMA 22	Real Analysis II	70%
8	PDMA 23	Partial Differential Equations	65%
9	PDMA 24	Mechanics	20%
10	PDMA31	Topology	50%
11	PDMA32	Complex Analysis	65%
12	PDMA33	Mathematical Statistics	75%
13	PDMA34	Measure Theory	100%
14	PDMA35A	Graph Theory	75%
15	PDMA41	Functional Analysis	80%
16	PDMA42	Numerical Analysis	100%
17	PDMA44B	Control Theory	100%

Head Department of Mathematics

THIRUVALLUVAR UNIVERSITY, VELLORE – 115
UNIVERSITY DEPARTMENT (CBCS) from 2014 – 2015 Batch)
M.SC MATHEMATICS

PDMA 11 : ALGEBRA-I

Objectives: To enable the students to acquire the basic knowledge in group theory and ring theory.

Course Outcome: At the end of the Course, the Students will able to	
CO1	Identify whether the given abstract structure is group or not.
CO2	Apply the concepts of homomorphism and isomorphism forcomparing the algebraic features of mathematical systems in groups and rings.
CO3	Define an automorphism of a group,Direct,semi direct Products and abelian groupssymmetric group, ring and some special classes of rings like commutative ring, fields.
CO4	Analyze Principal ideal domains,Polynomial rings – Definitions and basic properties.
CO5	Discussed about Euclidean domains, principal ideal domains and unique factorization

Employability: *Laying strong foundation on the mathematical concepts train the students to choose the career in Mathematics Research and Education.*

UNIT-I: Introduction to Groups

Dihedral groups – Homomorphisms and Isomorphisms - Group actions – Subgroups -Definition and Examples – Centralizers and Normalizer, Stabilizers and Kernels - Cyclic groupsand Cyclic subgroups of a group – Subgroups generated by subsets of a group.

Chapter 1: 1.2, 1.6 & 1.7 and Chapter 2: 2.1 - 2.4.

UNIT-II: Quotient Groups and Homomorphisms

Definitions and Examples – More on cosets and Lagrange's Theorem – The isomorphismtheorems - Composition series and the Holder program – Transpositions and the Alternatinggroup.

Chapter 3: (Full).

UNIT-III: Group Actions

Group actions and permutation representations – Groups acting on themselves by leftmultiplication - Cayley's theorem – Groups acting on themselves by conjugation – The classequation – Automorphisms – The Sylow theorems – The simplicity of An – Direct and semidirect Products and abelian groups - Direct Products – The fundamental theorem of finitelygenerated abelian groups.

Chapter 4 & Chapter 5: 5.1 - 5.2

UNIT-IV: Introduction to Rings

Basic definitions and examples – Examples - Polynomial rings - Matrix rings and group rings - Ring Homomorphisms and quotient rings – Properties of Ideals - Rings of fractions – The Chinese remainder theorem.

Chapter 7: (Full)

UNIT-V:**Euclidean domains, principal ideal domains and unique factorization**

Domains

Principal ideal domains – Unique factorization domains – Polynomial rings – Definitionsand basic properties – Polynomial rings over fields - Polynomial rings that are uniquefactorization domains – Irreducibility criteria – Polynomial ring over fields.

Chapter 8 & Chapter 9: (Full)

Recommended Text

1. David S. Dummit and Richard M. Foote, Abstract Algebra (Second Edition), Wiley, 2003.

Reference Books

1. Serge Lang, Algebra, Springer, 2002.
2. I.N. Herstein. Topics in Algebra (II Edition) Wiley Eastern Limited, New Delhi, 1975.
3. M. Artin, Algebra, Prentice Hall of India, 1991.
4. N. Jacobson, Basic Algebra, Vol. I & II, published by Hindustan Publishing Company, New Delhi, 1980.
5. W.H. Freeman, published by Hindustan Publishing Company, New Delhi, 1980.
6. I.S. Luther and I.B.S. Passi, Algebra, Vol. I - Groups (1996); Vol. II *Rings*, Narosa Publishing House, New Delhi, 1999.
7. Joseph A. Gallian, Contemporary Abstract Algebra, Brooks/Cole Pub Co.,2012.

PDMA 12 : REAL ANALYSIS – I

Objectives: Develop the ability to reflect on problems that are quite significant in the field of real analysis. Develop the ability to reflect on problems that are quite significant in the field of real analysis. Ability to consider problems that could be solved by implementing concepts from different areas in mathematics. Ability to identify, formulate, and solve problems. Understanding of professional and ethical responsibilitiesS2-Communicate ideas effectively in graphical, oral, and written media

CO1: students will be able to apply limiting properties to describe and prove continuity and differentiability conditions for real and complex functions.

CO2: Have a good understanding of **derivative** securities. Acquire knowledge of how forward contracts, futures contracts, swaps and options work, how they are used and how they are priced. Develop a reasoned argument in handling problemsabout functions, especially those that are of bounded variation

CO3:Be able to describe and explain the fundamental features of a range of key financial **derivative** instruments.

CO4: Learn the theory of Riemann-Stieltjes integrals, to be aquainted with the ideas of the total variation and to be able to deal with functions of bounded variation.

CO5:Knowledge of the implementation of theories in problem solving of Riemann-Stieltjes integrals . create ability to understand the different math concepts and be able to implement them in our everyday problems.

Skilldevelopment: *Laying strong foundation on the mathematical concepts train the students to choose the career in Mathematics Research and Education.*

Unit 1: The algebraic order properties of R- Absolute value and the real line- the completeness property of R- Applications of the supremum of R- intervals.
(18 Hours)
Chapter 2 of R.G Bartle and D.R. Sherbert, Introducation to Real Analysis, 4th Edition, John-Wiley & Sons, Inc, 2011
Unit II: Basic topology, Metric Spaces-Finite and infinite Sets- Countable sets-Cantor's theorem*Mertic spaces-open ans closed sets of metric spaces-Compact sets-Perfect setsconnected sets.
(18 Hours)
Chapter 2 of Wakter Rudin, Principals Mathematical Analysis (Third Edition), Mc Graw Hill, Inc, 1964.
Unit III: Continuity: Limits of function Limit Theorems- Continuous functions- Continuity and compactness - Continuity and connectedness –Discontinuities – Monotonic functionsinfinite limits ad limits at infinity.
Chapter 4 of Walter Rudin, Principal of Mathematics Analysis (Third Edition), Mc Grew Hills, Inc, 1964.
Unit IV: Differentiation: The Derivative of a real function – Mean value Theoreme – The Cotinuity of derivatives – L' Hospital's rule – Derivative of Higher Order- Taylor's theoremDifferentiation of Vector valued functions.
Chapter 5 of Walter Rudin, Principal of Mathematical Analysis (Third Edition), Mc Grew Hills, Inc, 1964.
Unit V: The Riemann – Stielitjes integral: Definition and existence of the integral – Properties of Integral- Integration and Differentiation – Integration of vector functionsRectifiable Curves.
Chapter 6 of Walter Rudin, Principal of Mathematical Analysis (Third Edition), Mc Grew Hills, Inc, 1964.
References :
1. Tom M. Apostal, "**Mathematical Analysis**", Addison - Wesley Publishing Company, 1974.
2. Anthony W. Knapp, "**Basic Real Analysis"**, Birkhauser, 2005.
3. Wilder, R. L., "**The Foundations of Mathematics"**, second Edition, John Wiley & Sons, New York, 1965.
4. Kenneth A. Ross, "**Elementary Analysis: Theory of Calculus"**, Second edition Springer, 2013.

PDMA 13 :Ordinary Differential Equations

Objectives:

- The main purpose of the course is to introduce students to the theory and methods of ordinary differential equations.
- Students should be able to implement the methods taught in the course to work associated problems, including proving results of suitable accessibility.

Course Outcome: On successful completion of the course, the students will be able to	
CO1	Enhancing students to explore some of the basic theory of linear ODEs, gain ability to recognize certain basic types of higher-order linear ODEs for which exact solutions may be obtained, and to apply the corresponding methods of solution.
CO2	Able to solve non-homogeneous linear equations with constant coefficients using the methods of undetermined coefficients and variation of parameters and application problems modelled by linear differential equations
CO3	Recognize ODEs and system of ODEs concepts that are encountered in the real world, understand and be able to communicate the underlying mathematics involved in order to solve the problems using multiple approaches.
CO4	Students are introduced to modern concepts and methodologies in ordinary differential equations, with particular emphasis on the methods that can be used to solve very large-scale problems.
CO5	Introduction of Elementary Critical Points - System of Equations with constant coefficients and - Linear Equation with Constant Coefficients.

***Employability**:Recognize ODEs and system of ODEs concepts that are encountered in the eal world, understand and be able to communicate the underlying mathematics involved in order to solve the problems using multiple approaches.*

UNIT-I: Linear Differential Equations of Higher Order

Introduction - Higher Order Equations - A Modeling Problem - Linear Independence - Equations with Constant Coefficients - Equations with Variable Coefficients – Wronskian - Variation of Parameters - Some Standard Methods - Method of Laplace Transforms.

Chapter 2: 2.1 - 2.10

UNIT-II: Systems of Linear Differential Equations

Introduction - Systems of First Order Equations - Model for arms Competition between two Nations - Existence and Uniqueness Theorem - Fundamental Matrix - Non-homogeneous Linear Systems - Linear Systems with Constant Coefficients - Linear Systems with Periodic Coefficients.

Chapter 4: 4.1 - 4.8

UNIT-III: Existence and Uniqueness of Solutions

Introduction – Preliminaries - Successive Approximations - Picard's Theorem - Some Examples - Continuation and Dependence on Initial Conditions – Fixed point methods.

Chapter 5: 5.1 - 5.6

UNIT-IV: Boundary Value Problems Rings

Introduction - Strum-Liouville Problem - Green's Function - Application of Boundary Value Problems (BVP) - Picard's Theorem.
Chapter 7: 7.1 – 7.5

UNIT-V: Stability of Linear and Nonlinear Systems
Introduction - Elementary Critical Points - System of Equations with Constant Coefficients - Linear Equation with Constant Coefficients - Lyapunov Stability.
Chapter: 9: 9.1 - 9.5

Recommended Text
S.G. Deo, V. Lakshmikantham and V. Raghavendra, "Ordinary Differential Equations", Second Edition, Tata Mc Graw-Hill publishing company Ltd, New Delhi, 2004.

Reference Books
1. Earl. A. Coddington, "An Introduction to Ordinary Differential Equations", Prentice Hall of India, New Delhi.
2. G.F. Simmons, S.G. Krantz, "Differential Equations: Theory, Technique and Practice" Tata Mc - Graw Hill Book Company, New Delhi, India, 2007.

PDMA 14 : Number Theory

Objective:
Find quotients and remainders from integer division. Apply Euclid's algorithm and backwards substitution, understand the definitions of congruences, residue classes and least residues. Add and subtract integers, modulo n, multiply integers and calculate powers, modulo n . Determine multiplicative inverses, modulo n and use to solve linear congruences.

CO1: learn to apply mathematical concepts and principles to perform numerical and symboliccomputations.use technology appropriately to investigate and solve mathematical and statistical problems.

CO2: lean write clear and precise proofs.iv. communicate effectively in both written and oral form. Understand the concept of a congruence and use various results related to con-gruences including the Chinese Remainder Theorem.

CO3: Demonstrate the ability to read and learn mathematics and/or statistics inde-pendently. Identify certain number theoretic functions and their properties

CO4: To dentify and apply various properties of and relating to the integers includingthe Well-Ordering Principle, primes, unique factorization, the division algorithm,and greatest common divisors.

CO5: Solve certain types of Diophantine equations. Identify how number theory is related to and used in cryptography.

Skilldevelopment: *Laying strong foundation on the mathematical concepts train the students to choose the career in Mathematics Research and Education.*

Unit I: Divisibility - Primes- The Binomial Theorem – Congruences – solutions of congruence the Chinese Remainder Theorems.

Chapter1 : 1.1-1.4 & Chapter 2: 2.1-2.3 (18 Hours)

Unit II : Prime power Moduli – Prime Modulus – Primitive Roots and Power Residues- Congruences of degree tow prime modulus – Number Theory form Algebraic View Point- Groud, Ring and Fields.

Chapter 2: 2.6-2.11 (18 Hours)

Unit III : Quadratic residues – quadratic reciprocity- the Jacobi symbol- binary quqdratic froms – Equivalence and reduction of Binary quadratic forms- sum of two squares- positive definite Binary Quadratic forms.

Chapter 3 (18 Hours)

Unit IV: Greatest integer Function – Arthmetic Functions – The Mobious inverse function- Recurrence Functions- Combinatorial Number Theory.

Chapter4: (18 Hours)

Unit V: The Equation ax + by =c- Simultaneous Linear Equations – Pythagorean Triangle – Assorted Examples.

Chapter 5: 5.1 – 5.4 (18 Hours)

Text book : I. Niven, H.S. Zuckerman and H.L. Montagomery, An Introduction to the Theory of Numbers, 5 Edition, John Wiley & sons, inc, 1991.

Reference :

1. Gareth A. Jones and J. Mary Jones, Elementary Number Theory, Springer Verlag, Indian Reprint, 2005.
2. David M. Burton, Elementary Number Theory, 6th edition, McGraw Hill, 2007
3. Geogre Andrews, Theory of Numbers , Saunders, 1971.
4. J. William , Fundamentals of Number Theory, Leveque, Addision Wesley publishing Company , Phillipines, 1977

PDMA 15A : CALCULUS OF VARIATIONS AND INTEGRAL EQUATIONS

OBJECTIVES	• The aim of the course is to introduce to the students the concept of calculus of variation and its applications. • Introduce various types of integral equations and how to solve these equations.
Course Outcome: At the completion of the Course, the Students will able to	
CO1	Students know the concept and properties of variational problems with fixed and moving boundaries, functions of dependent and independent variables and also solve some applications problems in mechanics.
CO2	Able to solve differential equations and integral equation problems. Find the solution of eigen value, eigen functions.
CO3	Implementation of various methods to solve Fredholm Intergral equation.
CO4	Students gain acquire knowledge about Hilbert – Schmidt Theory
CO5	Deriving the complex Hilbert space – Orthogonal system of function and Solutions of Fredholm of Integral equation of first kind

Skilldevelopment:*Problem solving skill utilize the so obtained knowledge to build and enhance important work in sciences and engineering, business, manifacturing and communication.*

Unit I: Variational problems with fixed boundaries:

The concept of variation and its properties – Euler's equation – Variational problems for Functions – Functional dependent on higher order derivatives – Functions of several independent variables - Some applications to problems of Mechanics.

Unit II: Variational problems with moving boundaries:

Movable boundary for a functional dependent on two functions – one –sided variations- Reflection and Refraction of extremals - Diffraction of light rays.

Unit III: Integral Equation:

Introduction – Tyoes of Kernals- Eign value and Egien functions – connection with differential equations – Solution of an integral equation - Initial value problems – Boundary value problems.

Unit IV: Solution of Fredholm Intergral equation:

Second kind with separable kernel – Orthogonality and reality eigen function – Fredholm Integral equation with separable kernel – Solution of Fredholm Integral Equation by successive substitution – successive approximation – Volterra integral equation – Solution by successive substitution.

Unit V: Hilbert – Schmidt Theory :

Complex Hilbert space – Orthogonal system of function – Gram –Schmitorthognalization process – Hilbert – Schmidt theorems – Solutions of Fredholm of Integral equation of first kind.

Text Book:

1. A.S. Gupta, Calculus of Variations with Application, Prentice Hall of India,New Delhi, 2005.

2. Sudir k. Pundir and Rimple Pundir, Integral Equations and Boundary Value Problems, Pragati Prakasam, Meerut, 2005.

PDMA 21 : ALGEBRA –II

Objectives	✓ To facilitate the basic concepts of Vector Spaces andMatrix of a linear transformation. ✓ To enable students to learn Rational Canonical Form and Jordan Canonical Form in detail. ✓ To introduce the concept of Finite Fields
Course Outcome: At the end of the Course, the Students will able to	
CO1	Define the Matrix of a linear transformation and Dual vector spaces.
CO2	Comparison betweenRational Canonical Form and Jordan Canonical Form, Field extensions and Algebraic Extensions.
CO3	Define Splitting fields, Algebraic closures and Cyclotomic polynomials.

CO4	Analyze the fundamental theorem of Galois theory.
CO5	Related definitions and fundamental theorem of Galois theory and Finite Fields.

Employability: Laying strong foundation on the mathematical concepts train the students to choose the career in Mathematics Research and Education.

UNIT-I: Vector Spaces

Definitions and basic theory – The Matrix of a linear transformation – Dual vector spaces – Determinants.

Chapter 11: 11.1 - 11.4

UNIT-II: Module over Principal Ideal Domain

Basic definitions and examples – The Basic Theory –The Rational Canonical Form –The Jordan Canonical Form.

Chapter 10: 10.1 & Chapter 12: 12.1 - 12.3

UNIT-III:Field theory

Basic Theory of field extensions – Algebraic Extensions.

Chapter 13: 13.1 - 13.2

UNIT-IV: Field Theory (Cont…)

Splitting fields and Algebraic closures – Separable and inseparable extensions – Cyclotomic polynomials and extensions.

Chapter 13: 13.4 - 13.6

UNIT-V: Galois Theory

Basic definitions – The fundamental theorem of Galois theory – Finite Fields.

Chapter 14: 14.1 - 14.3

Recommended Text

1. David S. Dummit and Richard M. Foote, Abstract Algebra (Second Edition), Wiley,2003.

Reference Books

1. Serge Lang, Algebra, Springer, 2002.
2. I.N. Herstein. Topics in Algebra (II Edition) Wiley Eastern Limited, New Delhi, 1975.
3. M.Artin, Algebra, Prentice Hall of India, 1991.
4. N.Jacobson, Basic Algebra, Vol. I & II W.H.Freeman; also published by Hindustan Publishing Company, New Delhi, 1980.

5. I.S.Luther and I.B.S.Passi, Algebra, Vol. I - Groups (1996); Vol. II *Rings,* Narosa Publishing House, New Delhi, 1999.
6. Joseph A. Gallian, Contemporary Abstract Algebra, Brooks / Cole Pub Co., 2.

PDMA 22 : Real Analysis II

Objectives: The foundations for this work are commenced in Real Analysis, a course that develops this basic material in a systematic and rigorous manner in the context of real-valued functions of a real variable. Topics covered are: Basic set theory. The real numbers and their basic properties. Sequences: convergence, subsequences, Cauchy sequences. Open, closed, and compact sets of real numbers. Continuous functions and uniform continuity. The Riemann integral. Differentiation and Mean Value theorems. The Fundamental Theorem of Calculus. Series. Power series and Taylor series. Convergence of sequences and series of functions.

CO1: learn fundamental properties of the real numbers that lead to the formal development of real analysis;

CO2. Learn comprehend rigorous arguments developing the theory underpinning real analysis;

CO3. Demonstrate an understanding of limits and how they are used in sequences, series, differentiation and integration;

CO4. Learn to construct rigorous mathematical proofs of basic results in real analysis;

CO5. Appreciate how abstract ideas and rigorous methods in mathematical analysis can be applied to important practical problems.

Employability: *Laying strong foundation on the mathematical concepts train the students to choose the career in Mathematics Research and Education.*

Unit I: Sequences and series of functions: Discussion of Main Problem- Uniform Convergence- Uniform convergence and continuity – Uniform convergence and Integration. (18 Hours)
Chapter 7: 7.1 -7.4
Unit II : Uniform convergence and differentiation- Equi – continuous families of functions – The stone –Weierstrass theorem. (18 Hours)
Chapter 7 : 7.5-7.7
Unit III : Functions of Several Variables: Linear transformations- Differentiation – The contraction Principal- The Inverse function theorem – The Implicit function Theorem. (18 Hours)
Chapter 9 : 9.1 – 9.5
Unit IV: Determinants - Derivatives of higher order- Differentiation of Integrals – Integration of Differential forms: Integration- Primitive Mappings- Partitions of Unity –Change of Variables.
Chapter 9: 9.7-9.9 & Chapter 10: 10.1-10.4 (18 Hours)
Unit V: Differential forms – Simplexes and chains – Stokes'Theorem- Closed forms

and exact forms- Vector Analysis. (18 Hours)

Chapter 10: 10.5- 10.9

Text Book: Walter Rudin, Principals of Mathematical Analysis, Mc Grew Hill Inc. 1964.

Reference:

1. Tom M. Apostal, "**Mathematical Analysis**", Addison - Wesley Publishing Company, 1974.

2. Anthony W. Knapp, "**Basic Real Analysis"**, Birkhauser, 2005.

3. Dieudonne, J. Foundations of Modern Analysis, Academic press, Inc, New York 1960.

4. N.L. Carothers, Real Analysis, Cambridge University

PDMA 23 : PARTIAL DIFFERENTIAL EQUATIONS

OBJECTIVES	✓ Learn the elementary concepts and basic ideas involved in partial differential equations. ✓ Develop the mathematical skills to solve problems involving partial differential equations rather than general theory. ✓ Understand the partial differential equations as models of various physical processes such as mechanical vibrations, transport phenomena including diffusion, heat transfer and electrostatics.
Course Outcome: On successful completion of the course, the students will be able to	
CO1	Extract information from partial differential equations to interpret the reality.
CO2	Know the various types of methods and their limitations to solve the partial differential equations.
CO3	Identify the physical situations and real world problems to formulate mathematical models using partial differential equations.
CO4	Apply the acquired knowledge to select the most appropriate method to solve the particular partial differential equations.
CO5	To understand Formation and solution of one-dimensional & two dimensional wave equation - canonical reduction – IVP and BVP.

Employability: *Apply the acquired knowledge to select the most appropriate method to solve the particular partial differential equations.*

UNIT - I: Nonlinear Partial differential Equations of the first order **-** Cauchy's method of Characteristics system First order equations- Charpit's method – Specials types First order equations – Jacobi's method.

Chapter 2: 2.7 – 2.11 & 2.13

UNIT - II: Partial differential Equations of the second order – The origin of second order equations – Linear partial differential equations with constant co efficient – Equations with variable co efficient- Characteristics curves of second- order equations – Characteristics of equations in three variables.

Chapter 3: 3.4-3.7

UNIT - III: The solution of Linear Hyperbolic Equations of Variables – The method of Intergral Transforms - Nonlinear Equations of the second order.
Chapter 3: 3.8-3.11
UNIT - IV: Laplace equation – The occurrence of laplace's equation in physics –Elementary solution of Laplace' Equations – Families of Equipotential surface Boundary value problem-Separation of variables – problems with axial symmetry.
Chapter 3: 3.1 to 3.7 and 3.9. (omit 3.8)

Recommended Text: K. Sankar Rao, *Introduction to Partial Differential Equations*, 2nd Edition, Prentice Hall of India, New Delhi. 2005
Reference Books:
1. R.C.McOwen, *Partial Differential Equations*, 2nd Edn. Pearson Eduction, New Delhi, 2005.
2. I.N.Sneddon, *Elements of Partial Differential Equations,* McGraw Hill, New Delhi, 1983.
3. R. Dennemeyer, *Introduction to Partial Differential Equations and Boundary Value Problems,* McGraw Hill, New York, 1968.
4. M.D.Raisinghania, *Advanced Differential Equations,* S.Chand & Company Ltd., New Delhi, 2001.

PDMA 24 : Mechanics

Objectives:

- To Provide the classical mechanics approach to solve a mechanical problem.
- To study mechanical systems under generalized coordinate system, virtual work, energy and momentum.

Course Outcomes: After completing this course, the student will be able to

CO1 - Understand D'Alembert's Principle and simple application of Lagrangian formulation.
CO2 - Analyze the Derivation of Lagrange equation from Hamiltons's Principle and modified Hamilton's principle.

CO3 - Dintinguish the Concept of Hamilton equation of motion and Principle of least action.

CO4 - Obtain canonical equations using different combinations of generating functions and subsequently developing Hamilton Jacobi Method to solve equations of motion.
CO5 - Study the application of theory of canonical transformations to dynamical theory.
Employability: *Defining different sets of generalized coordinates for a given mechanical system and the use of canonical transformations. The use of analytical treatments in checking the numerical models*

PDMA 24 - MECHANICS

Unit - I: Mechanical system
The Mechanical system - Generalized coordinates - Holonomic and non-holonomic systems - constraints – Virtual work – D' Alembert's principle – Energy and Momentum.

Unit - II: Lagrange's Equations
Derivation of Lagrange's equations – Examples – integrals of motion - cyclic or ignorable coordinates.

Unit - III: Hamilton's Equations

Hamilton's principle - Hamilton's equations - other variational principle - Principle of Least action.

Unit - IV: Hamilton – Jacobi Theory
Hamilton principle function - Hamilton–Jacobi equation - Separability.
Unit - V: Canonical Transformation
Differential forms and generating functions – Special Transformations – Lagrange and Poisson brackets.

Text Book:
D. Greenwood, Classical Dynamics, Prentice Hall of India, New Delhi, 1985.
References:
1. H. Goldstein, Classical Mechanics (Second Edition), Narosa Publishing House, India, New Delhi.
2. N.C.Rane and P.S.C. Joag, Classical Mechanics, McGraw Hill, 1991.
3. J.L. Synge and B.A. Griffth, Principles of Mechanics (3rd Edition), McGraw Hill Book Co. New York, 1970.

PDMA 25A : OPERATIONS RESEARCH

Objectives: This Course aims to study the network problems, inventory models, linear programming problems, queuing models and replacement models in the real life situations.

Course Outcome: At the end of the Course, the Students will able to	
CO1	Understand Types of Decision Making Environments – Decision Making under Uncertainty Decision Making under Risk - Posterior Probabilities and Bayesian Analysis.
CO2	Solve the Network problems by using CPM and PERT methods.
CO3	Identify EOQ of inventory models and when to replace an item in the replacement problems.
CO4	Compute the steady state probabilities for various queuing models.
CO5	Describe the Individual replacement and Group replacement.

Employability: *To understand the characteristics of different types of decision-making environments and the appropriate decision making approaches and tools to be used in each type.*

UNIT I: Decision Theory : Steps in Decision theory, approach- Types of Decision Making Environments – Decision Making under Uncertainty Decision Making under Risk – Posterior Probabilities and Bayesian Analysis – Decision Tree Analysis – Decision Making with Utilities.
Chapter 11: 11.1 – 11.8.
UNIT II: PROJECT NETWORK SCHEDULING BY (PERT AND CPM) : Basic differences between PERT and CPM - Steps in PERT / CPM Techniques - PERT / CPM Network components and Precedence Relationships - Critical Path Analysis - Probability in PERT Analysis - Project Time - Cost Trade Off - Updating the Project.
Chapter 13: 13.1 – 13.7.
UNIT III: DETERMINISTIC INVENTORY CONTROL MODELS : Meaning of Inventory Control - Functional classification - Advantage of Carrying Inventory - Features of

Inventory System - Inventory Model building - Deterministic Inventory Models with or without shortage - Probabilistic Inventory models with or without shortage.

Chapter 14: 14.1 – 14.8
UNIT IV: QUEUEING THEORY : Essential features of Queueing System - Operating Characteristic of Queueing System - Probabilistic Distribution in Queueing Systems - Classification of Queueing Models - Solution of Queueing Models - Probability Distribution of Arrivals and Departures.
Chapter 16: 16.1 – 14.8 ; Appendix 16.A (PP774- 781)
UNIT V: REPLACEMENT AND MAINTENANCE MODELS : Failure Mechanism of Item - Replacement models of Items that deteriorate with time – Replacement of item that fail completely – Other Replacement Problem..
Chapter 17: 17.1 – 17.5
Text Books : J.K.Sharma, Operations Research Theory and Applications, 3rd Edition (2007), Macmillan India Ltd.
Reference:
1. F.S. Hiller and J. Lieberman, Introduction to Operations Research (8th Edition, Tata McGrew Hill Publishing Company, New Delhi, 2006.
2. Beightlet. C. D. Philips, B. Wilde, Foundations of Optimization (2nd Edition), Prentice Hall Pvt. Ltd., New York, 1979.
3. Bazaraa, M.S; J.J. Jarvis, H.D. Sharall, Linear Programming and Network Flow, John Wiley and Sons, New York, 1998
4. Gross, D and C.M.Harris, Fundamentals of Queueing Theory, (3rd Edition), John Wiley and Sons, New York, 1998.
5. Hamdy A.Taha, Operations Research (6th Edition), Prentice Hall of India Private Limited, New Delhi.

PDMA 31 : Topology

Course Objectives:

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

Course Outcomes: Upon successful completion of the course, students will be able to:

CO1 : Define and illustrate the concept of topological spaces and continuous functions.
CO2 : Prove a selection of theorems concerning topological space, continuous functions, product topologies, and quotient topologies.
CO3 : Define and illustrate the concept of product of topologies.
CO4 : Define and illustrate the concepts of the separation axioms.
CO5 : Define connectedness and compactness, and prove a selection of related theorems, and describe different examples distinguishing general, geometric, and algebraic topology.Press, 2000.

***Employability**: Laying strong foundation on the mathematical concepts train the students to choose the career in Mathematics Research and Education*.

Unit I: Topological Spaces
Topological Spaces - xamples Basis for a topology – Sub-basis closed sets –interior – closure - boundary – Limitpoints Hausdorff spaces Subspace topology – The product topology on X - Projections.
Chapter 2: Section: 12 - 17 **(18 Hours)**

Unit II: Continuous Functions

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

Chapter 2: Section: 18 - 21 **(18 Hours)**

Unit III: Connected Spaces

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

Chapter 3: Section: 23 - 25 **(18 Hours)**

Unit IV: Compact Spaces

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

Chapter 3: Section: 26 - 29 **(18 Hours)**

Unit V: Countability and Separation Axioms

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

Chapter 4: Section: 30 - 35 **(18 Hours)**

Text Book:

 James R. Munkres, "Topology", 2nd Edition, Prentice Hall of India Pvt.Ltd., (Third Indian Reprint). 35 .

References :

1. J.Dugundji, Topology, Prentice Hall of India, New Delhi, 1975.

2. George F.Simmons, Introduction to Topology and Modern Analysis, McGraw Hill International Edition, New York, 1963.

3. J.L.Kelly, General Topology, Van Nostrand , Reinhold co., New York.

4. K.D.Joshi, Introduction to General Topology, Wiley Eastern Ltd., 1983.

5. C.Wayne Patty, Foundations of Topology, (Student Edition), Jones & Bartlett India Pvt.Ltd., New Delhi.

6. Colin Adams, Robert Franzosa, Introduction to Topology Pure and Applied, Pearson Education, Indian Edition, 2009.

PDMA 32 : COMPLEX ANALYSIS

Objectives:

- To lay the foundation for this subject, to develop clear thinking and analyzing capacity for further study.
- Cauchy's Theorem guaranteeing that certain integrals along closed paths are zero. This striking result leads to useful techniques for evaluating real integrals based on the 'calculus of residues'.
- Important results are the Mean Value Theorem, leading to the representation of some functions as power series (the Taylor series), and the Fundamental Theorem of Calculus which establishes the relationship between differentiation and integration.

Course Outcome: On successful completion of the course, the students will be able to	
CO1	Analyze limits and continuity for complex functions as well as consequences of continuity.
CO2	Apply the concept and consequences of analyticity and the Cauchy-Riemann equations and of results on harmonic and entire functions including the fundamental theorem of algebra.
CO3	Evaluate integrals along a path in the complex plane and understand the statement of Cauchy's Theorem
CO4	Represent functions as Taylor, power and Laurent series, classify singularities and poles, find residues and evaluate complex integrals using the residue theorem.
CO5	Discuss Harmonic Functions, basic properties – and deriving the theorems Schwarz's a Weierstrass's, Taylor's series and Laurent series

Employability: *Laying strong foundation on the mathematical concepts train the students to choose the career in Mathematics Research and Education.*

UNIT-I: Complex Functions

Spherical representation of complex numbers - Analytic functions - Limits and continuity - Analytic Functions - Polynomials - Rational functions – Elementary Theory of Power series - Sequences - Series - Uniform Convergence - Power series - Abel's limit functions - Exponential and Trigonometric functions - Periodicity – The Logarithm.

Chapter 1: 1.2 & 1.4 and **Chapter 2:** 2.1 – 2.3

UNIT-II: Analytical functions as mappings

Conformality - Arcs and closed curves - Analytic functions in Regions – Conformal mapping - Length and area - Linear transformations - Linear group - Cross ratio -symmetry - Oriented Circles - Families of circles - Elementary conformal mappings - Use of level curves - Survey of Elementary mappings - Elementary Riemann surfaces.

Chapter 3: 3.2 – 3.4

UNIT-III: Complex Integration

Fundamental Theorems - Line Integrals – Rectifiable Arcs- Line Integrals as ArcsCauchy's Theorem for a rectangle and in a disk- Cauchy's Integral Formula – Index of point with respect to a closed curve – The Integral formula – Higher order derivatives – Local properties of analytic functions – Taylor's Theorem – Zeros and
Poles–Local mapping – Maximum Principle.

Chapter 4: 4.1 – 4.3

UNIT-IV: Complex Integration (Contd…)

The General form of Cauchy's Theorem - Chains and Cycles – Simple connectivity –Homology – General statement of Cauchy's theorem – Proof of Cauchy's theorem –Locally exact differentials - Multiply connected regions – Calculus of residues –Residue Theorem – Argument Principle – Evaluation of definite Integrals.

Chapter 4: 4.4 – 4.5

UNIT-V: Harmonic functions and Power Series expansions

Harmonic Functions – Definition and basic properties – Mean-value Property –Poisson's formula – Schwarz's Theorem – Reflection Principle – Weierstrass's theorem – Taylor's series- Laurent series.

Chapter 4: 4.6 and **Chapter 5:** 5.1

Recommended Text

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

Reference Books

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

PDMA 33 : MATHEMATICAL STATISTICS

OBJECTIVES	This course introduces sampling theory, significance tests ,estimation, testing of hypotheses, ANOVA and sequential analysis with rigorous mathematical treatment.
Course Outcome: At the completion of the Course, the Students will able to	
CO1	Students know Random events and Random variables, Probability and some Distributions.
CO2	Students learned Properties of characteristic functions, sum of independent random variables, Determination of distribution function of characteristic functions and probability generating function.
CO3	Having the knowledge of basic concepts and derivations of Some Probability Distributions.

CO4	Derived Parametric tests for small samples and large samples test.
CO5	Application of F-test statistics on ANOVA for one-way and two-way classification. Knowledge about MPT,UMPT and unbiasedness.

Enterpreneurship: *The ability to use probabilistic reasoning and the foundations of probability theory to describe probabilistic engineering experiments in terms of sample spaces, event algebras, classical probability and statistics*

Unit I: Random events and Random Variables:

Random events – Probability axioms combinational formulae – conditional probability – bayes theorem – Independent events Random variables – Distribution Functions – Joint Distribution - Marginal Distribution – Marginal Distribution – Conditional Distribution- Independent random variables – Functional of Random Variables.

Unit II: Characteristic Functions:

Properties of characteristic functions-Characteristic functions and moments- Semi invariants-Characteristic function of the sum of independent random variable – Determination of distribution function by the characteristic function – Characteristic function of multi-dimensional random vectors-probability generating function.

Unit III: Some Probability Distribution :

Probability of Distribution - Binomial,poisson Multinomial, Geometric, Normal, Exponential, Beta and Gamma Distribution – Bivariate Normal Distribution * Conditional and Marginal Distribution – Correlations and Regressions.

Unit IV: Some Probability Distribution (Cont...)

The Distribution of the statistics (X,S) – Student's – Distribution – Fisher's Distribution – distribution – Concept of statistical test – Parametric tests for small samples and large samples - test.

Unit V: Analysis of Variance:

One way classification and two –way classification –Hypotheses Testing : Poser Functions – OC Function – Most Powerful test –Uniformly most powerful test- Unbiased test.

Text Book :

Kapoor & Gupta (1995, Sulton Chand, Delhi).

PDMA 34 : MEASURE THEORY

Objective: Measure theory provides a foundation for many branches of mathematics such as harmonic analysis, ergodic theory, theory of partial differential equations and probability theory. It is a central, extremely useful part of modern analysis, and many further interesting generalizations of measure

theory have been developed. It is also subtle, with surprising, sometimes counter-intuitive, results. The aim of this course is to learn the basic elements of Measure Theory, with related discussions on applications in probability theory.

CO1: Knowledge and understanding basic concepts of measure and integration theory. Computation of Lebesgue measures.

CO2: Application to measure theory is a part of the basic curriculum since it is crucial for understanding the theoretical basis of probablity and statistics. Establishing measurability or non-measurability of sets and functions.

CO3: Reflection of understanding of the theory on the basis of examples of application. Approximating measurable functions by simple and step functions.

CO4: Computation of Lebesgue integrals, applications to volume calculations and Fourier analysis.

CO5: Deciding under which conditions the fundamental theorem of calculus is applicable in the context of Lebesgue integration. Connection between differentiation and integration in the context of Lebesgue theory.

Employability: *Demonstrate understanding of the basic concepts underlying the definition of the general Lebesque integral and basic results of measure theory and integration theory*.

Unit I: Measure on the Real Line: Lebesgue Measure, Measurable set, RegularityMeasurable Functions- Boral and Lebesgue Measurability
(18 Hours)
Chapter 2: 2.1 – 2.5
Unit II: Integration of functions of a Real Line- Integration of Non- Negative functions – Lebesgue integral – Fatou's Lemma- Lebesgue's Monotone Convergence theorem – The General Integral – Lebesgue's Dominated Convergence Theorem – Integration of Series- Reimann and Lebesgue Integrals.
(18 Hours) Chapter 3
Unit III: Abstract Measure Spaces- Measure and Outer Measures – Extension of a Measure- Uniqueness of the extension- Completion of a Measure spaces – Integration with respect to a Measure.
Chapter 5. (18 Hours)
Unit IV : Inequalities and the LP spaces – Convex function – Jensen's inequalityInequalities of Holder and Minikowski Completeness of LP spaces.
Chapter 6. (18 Hours)
UnitV: Singed Measure and the Hahn Decomposition – The Jordan Decomposition – The Tadon – Nikodym Theorem- Measurability on a product space – The product Measure and Fubini's Theorem.
Chapter 8 : 8.1- 8.3 & Chapter 10: 10.1 – 10.2 (18 Hours)
Text Book: G. De Barra, Measure Theory and Integration , New International (p) Ltd, 1981.
Reference :
1. H.L. Royden, Real Analysis, Third Edition, Prentice Hall of India, New Delhi,

2001.
2. Rudin W. Real and complex analysis, Mc Graw – Hill, 1970.
3. Anthony W. Knapp, Basic Real Analysis, Birkhauser, 2005.
4. Elisa M. Stein & Rami Shakarchi, Real Analysis, Princedon University Press, 2005
5. I.K. Rana, An Introduction to Measure and Integration, Second Edition, American Mathematical Society, 2002.

PDMA 35A : GRAPH THEORY

Objectives: To enable the students to learn the fundamental concepts of Graphtheory

Course Outcome: At the end of the Course, the Students will able to	
CO1	Recognize the characteristics of graph
CO2	Convert the graph into matrix form and explain operations on graphs
CO3	Analyze special graphs like Eulerian graphs and Hamiltonian graphs with examples
CO4	Describe planar graphs and identify the chromatic number of the graph.
CO5	Discuss the different types of graphs and five color theorem and, four color conjecture - Non Hamiltonian planar graphs.

Employability: *Be able to formulate and prove central theorems about trees, matching, connectivity, colouring and planar graphs. discuss the concept of graph, tree, Euler graph, cut set and Combinatorics.*

UNIT-I:Graphs and Sub-Graphs

Graphs and simple graphs - Graph isomorphism - Incidence and adjacency matrices – Subgraphs- Vertex degrees - Path and Connection cycles – Applications: The shortest path problem– Trees: Trees - Cut edges and bonds - Cut vertices - Cayley's formula.

Chapter 1 (Except 1.9) and Chapter 2 (Except 2.5)

UNIT-II Connectivity

Connectivity – Blocks - Euler tours and Hamilton cycles: Euler tours – Hamilton cycles –Applications: The Chinese postman problem.

Chapter 3 (Except 3.3) and Chapter 4 (Except 4.4)

UNIT-III: **Matchings**

Matchings - Matching and coverings in bipartite graphs - Perfect matchings –. Edge colorings:Edge chromatic number - Vizing's theorem - Applications: The timetabling problem.

Chapter 5: (Except 5.5) and Chapter 6

UNIT-IV:Independent sets and Cliques

Independent sets - Ramsey's theorem - Turan's theorem - Vertex colorings: Chromatic number - Brook's theorem – Hajo's conjecture - Chromatic polynomials - Girth and chromatic number.

Chapter 7: (Except 7.4 - 7.5) and Chapter 8 (Except 8.6)

UNIT-V:**Planar Graphs**

Plane and planar graphs - Dual graphs - Euler's formula - Bridges - Kuratowski's Theorem(statement only) – The Five color theorem and The Four color conjecture - Non Hamiltonian planar graphs.

Chapter 9 (Except 9.8)

Recommended Text

1. J.A.Bondy and U.S.R. Murthy, Graph Theory and Applications, Macmillan, London,1976.

Reference Books

1. R.J. Wilson, Introduction to Graph Theory, Pearson Education, 4th Edition, 2004, IndianPrint.
2. J.Clark and D.A.Holton, A First look at Graph Theory, Allied Publishers, New Delhi,1995.
3. R.J. Wilson, Introduction to Graph Theory, Pearson Education, 4th Edition, 2004, IndianPrint.
4. Gary Chartrand, Introduction to Graph Theory, Tata McGraw-Hill Education, 2006.
5. A.Gibbons, Algorithmic Graph Theory, Cambridge University Press, Cambridge, 1989.
6. Douglas B.West, Introduction to Graph Theory, Pearson, 2000.

PDMA 41 : FUNCTIONAL ANALYSIS

Objectives:

- This course introduces functional analysis and operator theoretic concepts. This area combines ideas from linear algebra and analysis in order to handle infinite-dimensional vector spaces and linear mappings thereof.
- This course provides an introduction to the basic concepts which are crucial in the modern study of partial differential equations, Fourier analysis, quantum mechanics, applied probability and many other fields.

Course Outcome: On successful completion of the course, the students will be able to	
CO1	Appreciate how ideas from different areas of mathematics combine to produce new tools that are more powerful than would otherwise be possible.
CO2	Understand how functional analysis underpins modern analysis.
CO3	Develop their mathematical intuition and problem-solving capabilities, especially in predicting the space in which the solution of a partial differential equation belongs to.
CO4	Learn advanced analysis in terms of Sobolev spaces, Besov spaces, Orlicz spaces and other distributional spaces.
CO5	Definition and examples of Banach Algebras – To understand the Regular and simple elements, radical and semi-simplicity

Enterpreneurship: *Analyze fluid flow problems with the application of the momentum and energy equations. Understand modelling approximations in finding exact solutions. Apply basic principles of multi-variable calculus, differential equations and complex variables to fluid dynamic problems*

PDMA 41 - FUNCTIONAL ANALYSIS

Unit I : Normed Spaces – Examples – Bounded operators - Banach Spaces – Linear Functional and Hahn Banach Theorem Its Consequences.
Chapter 2 & Chapter 3.
Unit II : Finite dimensional Normal spaces- Uniform Boundedness principal: The Theorem and its consequences – Closed Graph Theorem - Boynded inverse Theoram – Open Mapping theorem.
Chapter 4 & Chapter 5.
Unit III: Stone- Weiersttrass Theorem – Contraction Mapping Theorem and its applications- weak topologies and duality.
Chapter 6-8.
Unit IV: Hilbert Spaces – Orthnormal Systems – Bessel's Inequality- parseval's Identities – Riesz - Fischer Theorem.
Unit V : Adjoint operators – Algebra of Bounded Linear Operators.
Chapters : 11 & 12.
Text Book: Bela Bollobas, Linear Analysis an Introductory course, Cambridge Mathematical Text Books, Cambridge University Press, 1990.
Reference :
1. G.F. Simmons, Introduction to Topology and Modern Analysis, MC Graw- Hill, 1963
2. B.V Limaye, Functional Analysis, Wiley Eastern Limited, Bombay, Second Print, 1985.
3. M. Thamban Nair, Functional Analysis: A frist course, Prentice Hall of India, 2002.
4. K. Yoside, Functional Analysis, Springer- Verlag, 1974
5. E. Kreysizig, Introductory Functional Analysis with application John Wiley, 1978.

PDMA 42 : NUMERICAL ANALYSIS

Objectives:

- ✓ To know and apply different numerical techniques to solve algebraic and differential equations.
- ✓ To acquire the knowledge on methods of finding approximate values by using iteration process of definite integrals and differentiation.

Course Outcome: At the end of the Course, the Students will able to	
CO1	Student to get the knowledge solving sets of Equations by different numerical methods.
CO2	Understanding the solving the problem by different techniques and approximation theory.
CO3	Deriving the theoretical and application oriented of numerical differentiation and integration also derivatives form of difference tables by using different methods.

CO4	Solving the ODE by using different numerical methods.
CO5	Introduction of differences quotients, classification of PDE and solving PDE by using iteration process.

Employability: *Solve algebraic and transcendental equations using appropriate numerical methods and approximate a function using appropriate numerical methods.*

UNIT I : Solving sets of Equations: The Elimination Method, The Gaussian Elimination and Gauss-Jordan Method, Iterative Methods, The Relaxation Method.
Text Book 1 : Chapter 2 : 2.3-2.4 & 2.10-2.11 (18 Hours)
Unit 2: Interpolation and curve Fitting: Lagrangian Polynomials Divided Differences, Interpolation with Cubic Spline, Least-Square Approximation, Approximation of Functions: Chebyshev Polnomials.
Text Book 1: Chapter 3:3.2-3.4 & 3.7 & Chapter 4: 4.1 (18 Hours)
Unit 3: Numerical Differentiation and Numerical Integration: Derivatives form Difference tables, Extrapolation Techniques, The Trapezoidal Rule –A Composite formula, Simpson's rules.
Text Book 1: Chapter 5: 5.2, 5.4 & 5.6-5.7 (18 Hours)
Unit 4: Numerical solution of Ordinary Differential Equations: The Taylor – Series method, Euler and Modified Euler methods, Runge- Kutta Methods, Milne's Method, The Adams- Moulton method.
Text Book 1: Chapter 6: 6.2- 6.4 & 6.6 – 6.7 (18 Hours)
Unit5: Numerical Solution of Pratical Differential Equations: Introduction, Difference Quotients, Geometrical representation of partial differential quotients, Classification of partial differential equations, Elliptic equations, Solution to Laplace's Equation by Liebmann's Iteration process, Poission's Equations and its solutions, Parabolic equations- Crank- Nicholson method Hyperbolic equations.
Text Book 1: Chapter 1

Text Books:
1. Curtis .F. Gerald, Patrick O. Wheatley, "Applied Numerical Analysis", 5th Edition Pearson Education, New Delhi, 2005.
2. V.N. Vadamurthy, N. Ch.S.N. Lyengar, Numerical Methods", Vikas Publishing House Pvt. Ltd., 2000.
Reference :
1. R.L. Burden, J. Dougles Faires, "Numerical Analysis", Thompson Books, USA, 2005. 2. S.S Sastry, "Introductory Methods of Numerical Analysis ", Prentice- Hall of India Pvt. Ltd., New Delhi, 2005.
3. M.K.Jain , S.R.K. Lyengar, R.K. Jain "Numerical Methods for scientific and Engineering Computation", 3rd Edition., Wiley Eastern Ltd., New Delhi, 1993.

PDMA 43A : FLUID DYNAMICS

OBJECTIVES	The aim of the course is to discuss kinematics of fluids in motion, Equations of motion of a fluid, three dimensional flows, two dimensional flows and viscous flows.
Course Outcome: At the completion of the Course, the Students will able to	
CO1	Students know what are Real fluids and ideal fluids, flows and solved problems regarding this.

CO2	Solved some problems and derivations about equation of motion of fluid and learn some naming theorems.
CO3	Students got some knowledge about some three dimensional and two dimensional flows.
CO4	To understand the geometrical knowledge of two dimensional flows – use of cylindrical polar coordinates and complex velocity potential for standard two dimensional flows – the Milne-Thomson circle theorem with examples.
CO5	Analyze the Stress components and relation between Cartesian components of stress, translation motion of a fluid element – the rate of strain quadric. Navier –Stokes equations of motion of a viscous fluid.

Enterpreneurship: *Analyze fluid flow problems with the application of the momentum and energy equations. Understand modelling approximations in finding exact solutions. Apply basic principles of multi-variable calculus, differential equations and complex variables to fluid dynamic problems*

Unit I: Kinematics of fluids in motion:

Real fluids and ideal fluids - velocity of a fluid at a point - stream lines and path lines - steady and unsteady flows - the velocity potential - the vorticity vector - local and particle rates of change - the equation of continuity - worked examples.

Chapter 2 : 2.1 – 2.8 (18 Hours)

Unit II: Equation of motion of fluid:

Pressure at a point in fluid at rest - Pressure at a point in a moving fluid - conditions at a boundary of two inviscid immiscible fluids - Euler's equation of motion - Bernoulli's equation – worked examples.

Chapter 3 : 3.1 – 3.6 (18 Hours)

Unit III: Some three dimensional flows:

Introduction – sources – sinks and doublets – Axis symmetric flow – Stokes stream function.

Chapter 4 : 4.1– 4.2 & 4.5 (18 Hours)

Unit IV: Some two dimensional flows:

Meaning of two dimensional flows – use of cylindrical polar coordinates – the stream function – the potential for two dimensional – irrotational – incompressible flows – complex velocity potential for standard two dimensional flows – the Milne-Thomson circle theorem with examples.

Chapter 5 : 5.1 – 5.5 & 5.8 (18 Hours)

Unit V : Viscous Flows : Stress components in real fluids – relation between Cartesian components of stress – translation motion of a fluid element – the rate of strain quadric and

principle stresses – Some further properties of the rate of strain quadric stress analysis in fluid motion – relation between stress and rate of strain – the co-efficient of viscosity and laminar flow – the Navier –Stokes equations of motion of a viscous fluid.
Chapter 8 : 8.1 – 8.9 (18 Hours)

Text Book:

1. F. Chorlton, Text book of Fluid Dynamics, CBS Publication, New Delhi, 1985.
2. M.K.Venkataraman, Advanced Engineering & Sciences, The National Publishing Co.

References:

1. G.K.Batchelor, An Introduction of Fluid Mechanics, Foundation Books, New Delhi,1993.

2. A.R.Paterson, A First Course in Fluid Dynamics, Cambridge University Press, New York, 1987.

3. R.K.Rathy, An Introduction to Fluid Dynamics, IBH Publishing Company, New Delhi,1976.

4. R.Von Mises, O.Friedrichs, Fluid Dynamics, Springer International Student Edition,Narosa Publishing House, New Delhi.

5. S.W.Yuan, Foundation of Fluid Mechanics, Prentice Hall Private Ltd, New Delhi, 1976.

PDMA 44B : CONTROL THEORY

Objective : The ability to understand the characteristics of various types of nonlinearities present inphysical systems.2.The ability to carry out the stability analysis of non-linear control systems. Tolearn the methods for analyzing the behavior of nonlinear control systems and the designing of control systems

CO1 .The ability to carry out the analysis and design of digital control systems.

CO2 The ability to design compensators for digital control system to achieve desiredspecifications. Ability to perform the stability analysis nonlinear systems by Lyapunovmethoddevelop design skills in optimal control problems

CO3.The ability to represent digital control systems using state space models. Ability to derive discrete-time mathematical models in both time domain (difference equations, state equations) and z-domain

CO4.The ability to analyze the effect sampling on stability, controllability and observability. Ability to predict and analyze transient and steady-state responses and stability and sensitivity of both open-loop and closed-loop linear, time-invariant, discrete-time control systems

CO5.The ability to design digital controllers for industrial applications. Ability to acquire knowledge of state space andstate feedback in modern control systems, pole placement, design of state observers and output feedback controller.

***Enterpreneurship**: Understanding and learning how control theory underpins modern technologies and provides an insight in mathematical analysis.*

Unit I: Observability:

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

Chapter 2 (18 Hours)

Unit II: Controllability:

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

Chapter 3: Sections 3.1-3.3 **(18 Hours)**

Unit III: Stability:

Stability – Uniform stability – Asymptotic stability of linear systems - Linear time varying systems – Perturbed linear systems – Nonlinear systems.

Chapter 4 (18 Hours)

Unit IV: Stabilizability:

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

Chapter 5 (18 Hours)

Unit V: Optimal Control:

Linear time varying systems with quadratic performance criteria – Matrix Riccati equation – Linear time invariant systems – Nonlinear Systems.

Chapter 6 (18 Hours)

Text Book: K.Balachandran and **J.P.Dauer**, *Elements of Control Theory*, Narosa, New Delhi, 1999.

Reference:

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.