BHARATHIAR UNIVERSITY

Coimbatore 641 046

M.Sc. Mathematics

Eligibility for admission:

A pass in B.Sc. Mathematics or
B.Sc. Mathematics with Computer Applications or
equivalent thereof.

Programme objectives:

PO1 To equip students with advanced knowledge and insight in mathematics
PO2 To equip students with different types of problem solving methods
PO2 To enhance professional skills in mathematics and some specialized areas of applied mathematics
PO4 To equip students with mathematical and computational skills so that they can later get involved in independent research
PO5 To produce professionals who can work on real life and challenging problems

BHARATHIAR UNIVERSITY, COIMBATORE.
M.Sc. BRANCH I (a) - MATHEMATICS
(The Curriculum is offered by the University Department under CBCS from 2018-19 onwards)

SCHEME OF EXAMINATION

SEMESTER I

Subject Code	Title of the Papers	L/T	P	C	IA	EA	T
18MATA13A	Algebra-I	4	-	4	25	75	100
18MATA13B	Real Analysis	4	-	4	25	75	100
18MATA13C	Ordinary Differential Equations	4	-	4	25	75	100
18MATA13D	Optimization Techniques	4	-	4	25	75	100
18MATA1EA	Elective I: Numerical Methods	4	-	4	25	75	100
181GS--	Supportive-I	2	-	2	12	38	50

SEMESTER II

Subject Code	Title of the Papers	L/T	P	C	IA	EA	T
18MATA23A	Algebra-II	4	-	4	25	75	100
18MATA23B	Complex Analysis	4	-	4	25	75	100
18MATA23C	Partial Differential Equations	4	-	4	25	75	100
18MATA23D	Mechanics	4	-	4	25	75	100
18MATA2EB	Elective II: Matlab Theory &Practical	2	2	4	25	75	100
182GS--	Supportive-II	2	-	2	12	38	50

SEMESTER III

Subject Code	Title of the Papers	L/T	P	C	IA	EA	T
18MATA33A	Topology	4	-	4	25	75	100
18MATA33B	Fluid Dynamics	4	-	4	25	75	100
18MATA33C	Mathematical Methods	4	-	4	25	75	100
18MATA33D	Functional Analysis	4	-	4	25	75	100
18MATA3EC	Elective III: Computer Programming C++ Theory &Practical	2	2	4	25	75	100
183GS--	Supportive-III	2	-	2	12	38	50

SEMESTER IV

Subject Code	Title of the Papers	L/T	P	C	IA	EA	T
18MATA43A	Nonlinear Differential Equations	4	-	4	25	75	100
18MATA43B	Control Theory	4	-	4	25	75	100
18MATA43C	Distribution Theory	4	-	4	25	75	100
18MATA4ED	Elective IV: Probability Theory	4	-	4	25	75	100
18MATA4LP	Project	-	-	8	-	-	200

Total Marks for the Course : 2250; **Total Credits for the Course : 90**

L/T - Lecture/Theory P - Practical
C – Credit IA - Internal Assessment
EA – End Semester Assessment T - Total Marks

<u>Supportive Courses for Other Department Students:</u>

1. Applied Mathematics I (Odd Semester)
2. Applied Mathematics II (Even Semester)

Title of the Subject: ALGEBRA-I **No. of credits: 4**

Code No. :18MATA13A **No of Teaching hours:5**

Course objectives:

- Learn the elementary concepts and basic ideas involved in homomorphism and isomorphism.
- Develop the ability to form and evaluate group theory and its actions.

Understand the fundamental concepts of abstract algebra which include sylow theorems and relative this concept to the direct products and abelian groups.

Unit-I:
Introduction to groups:Dihedral groups - Symmetric groups - Matrix groups - Homomorphisms and Isomorphisms - Group actions. Subgroups: Definition and Examples - Centralizers and Normalizer, Stabilizers and Kernels.

Unit-II:
Cyclic groups and Cyclic subgroups of a group:Quotient Groups and Homomorphisms: Definitions and Examples - More on cosets and Lagrange's Theorem - The isomorphism theorems - Transpositions and the Alternating group.

Unit-III:
Group Actions: Group actions and permutation representations - Groups acting on themselves by left multiplication - Cayley's theorem - Groups acting on themselves by conjugation - The class equation - Automorphisms.

Unit-IV:
TheSylow theorems - The simplicity of A_n.Further topics in group theory: p-groups, Nilpotent groups and Solvable groups.

Unit-V:
Direct and semi-direct products and abelian groups: Direct Products - The fundamental theorem of finitely generated abelian groups - Table of groups of small order - semi direct products.

Text Book:
"*Abstract Algebra*" (Third Edition) by **David S. Dummit**and **Richard M. Foote**, Wiley Student Edition (1999),
Unit I : Chapter 1: (Sections 1.2, 1.3. 1.4, 1.6, 1.7)
Chapter 2: (Sections 2.1, 2.2)
Unit II : Chapter 2: (Sections 2.3)
Chapter 3: (Sections 3.1, 3.2, 3.3, 3.5)
Unit III :Chapter 4: (Sections 4.1, 4.2, 4.3, 4.4)
Unit IV: Chapter 4: (Sections 4.5, 4.6)
Chapter 6: (Sections 6.1, 6.2)
Unit V: Chapter 5: (Sections 5.1, 5.2, 5.3, 5.5)

Reference Books:

1. "*Topics in Algebra*" by **I.N. Herstein,** John Wiley & Sons (Second Edition), New Delhi, 1975.
2. "*Lectures in Abstract Algebra*" Vol. I by**N. Jacobson, D. Van Nostrand Co**., New York, 1976.

Course Outcomes:

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

CO 1 – Demonstrate ability to think group actions critically by Cayley's theorem.
CO 2 – Use the logical connectives on abstract algebra to decide whether an argument is a tautology or contradiction.
CO 3 - Effectively write abstract mathematical proofs in a clear and logical manner.
CO 4 – Apply the sylow theorems to describe the structure of certain finite groups.

Course prepared by: Dr P Jayaraman

Course Verified by: HOD

Title of the Subject: REAL ANALYSIS **No. of credits: 4**
Code No. :18MATA13B **No of Teaching hours:5**

Course objectives:

- This course will focus on the proofs of basic theorems of analysis.
- The way to establish the proofs, many new concepts will be introduced.
- Understanding the basic concepts and their properties are important for the development of the present and further courses.

Unit-I:
RiemannStieltjes Integral:Definition and existence of the integral – Properties of the integral – Integration and differentiation – Integration of vector-valued functions – Rectifiable curves.

Unit-II:
Sequences and series of functions:Uniform convergence-Uniform convergence and continuity – Uniform convergence and integration – Uniform convergence and differentiation – Equicontinuous families of functions – The Stone-Weierstrass theorem.

Unit-III:
Functionsof several variables:Linear transformations –Differentiation - The contraction principle – The inverse function theorem – The implicit function theorem – Determinants – Derivatives of higher order – Differentiation of integrals.

Unit-IV:
Lebesguemeasure: Outer measure – Measurable sets and Lebesgue measure – Nonmeasurable set-

Measurable functions – Littlewood's three principles.

Unit-V:
TheLebesgue Integral: The Lebesgue integral of a bounded function over a set of finite measure – The integral of a nonnegative function – The general Lebesgue integral – Convergence in measure.

Text Book:
"*Principles of Mathematical Analysis*" by **W. Rudin,** McGraw-Hill, New York, 1976
Unit-I : Chapter 6.
Unit-II : Chapter 7.
Unit-III : Chapter 9 (Except Rank Theorem).
"*Real Analysis*" by **H.L. Royden,** Third Edition, Macmillan, New York, 1988
Unit-IV : Chapter 3.
Unit-V : Chapter 4.

Course Outcomes:
On successful completion of the course, the students will be able to
CO 1 – Determine the Riemann integrability and the Riemann-Stieltjesintegrability of a bounded function and proved a selection of theorems concerning integration.
CO 2 – Recognize the difference between pointwise and uniform convergence of a sequence of functions.
CO 3 - Determine the continuity, differentiability, and integrability of functions defined on subsets of the real line. Illustrate the derivatives of higher order and differentiation of integral.
CO 4 – Able to learn advanced the Lebesgue measure and Lebesgue integral with related problems.

Course prepared by: Dr N Nithyadevi
Course Verified by: HOD

Title of the Subject: ORDINARY DIFFERENTIAL EQUATIONS **No. of credits: 4**
Code No. :18MATA13C **No of Teaching hours:5**

Course 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.
- This course is designed to prepare students to solve problems arising from many applications such as mathematical models of physical or engineering processes.

Unit-I:
Linear equations with constant coefficients: The second order homogeneous equations – Initial value problems – Linear dependence and independence - A formula for the Wronskian – The non-homogeneous equation of order two.

Unit-II:
Homogeneous and non–homogeneous equations of order n – Initial value problems –Annihilator method to solve a non–homogeneous equation – Algebra of constant coefficient operators.

Unit-III:
Linear equations with variable coefficients: initial value problems for the homogeneous equation-Solutions of the homogeneous equation – The Wronskian and linear independence –Reduction of the order of a homogeneous equation - Homogeneous equation with analytic coefficients – The Legendre equation.

Unit-IV:
Linear equation with regular singular points: Euler equation - Second order equations with regular singular points – Exceptional cases – Bessel equation.

Unit-V:
Existence and uniqueness of solutions to first order equations: Equation with variables separated–Exact equations – The method of successive approximations – The Lipschitz condition – Convergence of the successive approximations.

Text Book:
"*An Introduction to Ordinary Differential Equations*" by **E.A. Coddington,** Prentice Hall of India Ltd., New Delhi, 1957
Unit I : Chapter 2: Sections: 1 - 6.
Unit II : Chapter 2: Sections: 7, 8, 10, 11, 12.
Unit III : Chapter 3: Sections: 1 – 5, 7, 8.
Unit IV : Chapter 4: Sections: 1 - 4, 6 - 8.
Unit V : Chapter 5: Sections: 1 - 6.

Course Outcomes:

On successful completion of the course, the students will be able to
CO 1 – 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.
CO 2 – 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.
CO 3 – 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.
CO 4 – 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.

Course prepared by: Dr R Rakkiyappan

Course Verified by: HOD

Title of the Subject: OPTIMIZATION TECHNIQUES **No. of credits: 4**

Code No. :18MATA13D **No of Teaching hours:5**

Course objectives:

- The student is expected to be able to understand basic theoretical principles in optimization.
- Define and use optimization terminology and concepts, and understand how to classify an optimization problem.
- Be able to implement basic optimization algorithms in a computational setting and apply existing optimization software packages to solve engineering problems.

Unit I: One dimensional minimization methods: Unrestricted search –Exhaustive search Dichotomous search – Fibonacci method – Golden section method – Quadratic interpolation method.

Unit II: Unconstrained Optimization: Random search method – Univariate method – Pattern Directions – Rosenbrock's method of Rotating coordinates – The simplex method-Gradient of a function-Steepest descent method-Conjugate gradient method-Newton's method-Marquardt's Method.

Unit III: Constrained Optimization techniques: The Complex method – Sequential linear programming– Basic approach in the method of feasible directions. Transformation techniques – Interior penalty function method.

Unit IV: Geometric Programming: Unconstrained Minimization problem-Solution of an unconstrained geometric programming-Solution of an unconstrained geometric programming-Primal dual relationship and sufficient conditions in the unconstrained case-Constrained Minimization-Solution of a constrained geometric programming problem-Primal and dual programs in the case of less than inequalities-Geometric programming with mixed inequality constraints

Unit V: Computational procedure in Dynamic Programming-Example illustrating the Calculus method of solution – Example illustrating the Tabular method of solution – Conversion of a final value problem into initial value problem-Linear programming as a case of Dynamic programming-Continuous dynamic programming.

Text Book:

Engineering Optimization Theory and Practice by **SingiresuS. Rao**Third Edition

Unit I: Chapter 5: Sections: 5.3-5.5,5.7,5.8,5.10

Unit II: Chapter 6: Sections: 6.2,6.4-6.7, 6.8-6.12

Unit III: Chapter 7: Sections:7.4-7.6,7.11,7.13

Unit IV: Chapter 8: Sections:8.3-8.10

Unit V: Chapter 9: Sections:9.4-9.9

Course Outcomes:

On successful completion of the course, the students will be able to
CO 1 – Understand and apply constrained and unconstrained optimization theory including the necessary and sufficient optimality conditions and algorithms.
CO 2 – Explain the fundamental knowledge of Geometric programming and Dynamic programming problems including different methods in order to solve various optimization problems arising from engineering areas.
CO 3 - The ability to apply optimization methods to engineering problems, including developing a model, defining an optimization problem, applying optimization methods, exploring the solution, and interpreting results.
CO 4 – Apply optimization techniques to determine a robust design subject to many practical applications.

Course prepared by: Dr R Rakkiyappan

Course Verified by: HOD

Title of the Subject: NUMERICAL METHODS **No. of credits: 4**

Code No. :18MATA1EA **No of Teaching hours:5**

Course objectives:

- To understand appropriate numerical methods to solve algebraic and transcendental equations (Newton's method and Bairstow's method).
- To perform an error analysis for various numerical methods and derive appropriate numerical methods to solve definite integrals.
- To develop appropriate numerical methods to solve a system of linear equations and special kinds of differential equations such as elliptic, parabolic and hyperbolic differential equations.

Unit-I:
Solving 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 – The trapezoidal rule-A composite formula – Romberg integration – Simpson's rules.

Unit-II:
Solving set 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:
Solutionof Ordinary Differential Equations:Taylor series method – Euler and modified Euler methods – Runge-Kutta methods – Multistep methods – Milne's method – Adams-Moulton method.

Unit-IV:
Boundaryvalue problems and Characteristicvalue 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:
Numericalsolution 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,** Sixth Edition, Addison-Wesley, Reading, 1998.
Unit I : Chapter 1: Sections: 1.4, 1.8, 1.11,
Chapter 5: Sections: 5.2, 5.3, 5.6, 5.7.
Unit II : Chapter 2: Sections: 2.3 - 2.5, 2.7, 2.10 - 2.12.

Unit III: Chapter 6: Sections: 6.2 - 6.7.
Unit IV : Chapter 7: Sections: 7.2 – 7.5.
Unit V : Chapter 7: Sections: 7.6,7.7,
Chapter 8: Sections: 8.1 - 8.4.

Course Outcomes:

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

CO 1 – Solve algebraic and transcendental equations using appropriate numerical methods and approximate a function using appropriate numerical methods.

CO 2 – Derive numerical methods for various mathematical operations and tasks such as interpolation, differentiation, integration, the solution of linear and non linear equations and the solution of differential equations.

CO 3 - Analyze and evaluate the accuracy of common numerical methods and apply numerical methods to obtain approximate solution to mathematical problems.

CO 4 – Solve a linear system of equations using an appropriate numerical methods and demonstrate an error analysis for a given numerical methods.

Course prepared by: Dr P Jayaraman

Course Verified by: HOD

Title of the Subject: ALGEBRA-II **No. of credits: 4**

Code No. :18MATA23A **No. of Teaching hours:5**

Course objectives:

- To learn the basic ideas and notions of abstract algebra which includes ring and field theory.
- To develop student's mathematical maturity and enables to build mathematical thinking and use results from ring and field theory to solve contemporary problems.
- Discuss the separable and inseparable extensions over the splitting fields.

Unit I:
Introduction to Rings: Examples: Polynomial rings - Matrix rings and group rings - Ring Homomorphisms and quotient rings - Properties of Ideals - Rings of fractions - The Chinese remainder theorem.

Unit II:
Euclidean domains, principal ideal domains and unique factorization domains: Euclidean domain - Principal ideal domains. Unique factorization domains - Polynomial rings: Definitions and basic properties – Polynomial rings over fields.

Unit III:
Polynomial rings that are unique factorization domains – Irreducibility criteria – Polynomial ring over fields. Introduction to Module Theory: Basics definitions and examples – Quotient modules and Module homomorphism.

Unit IV:
Field theory: Basic Theory of field extensions - Algebraic Extensions

Unit V:
Splitting fields and Algebraic closures - Separable and inseparable extensions - Cyclotomic polynomials and extensions.

Text Book:
"*Abstract Algebra*" (Second Edition) by **David S. Dummit**and **Richard M. Foote**, Wiley Student Edition (1999),
Unit I : Chapter 7: (Sections 7.2,7.3,7.4,7.5,7.6)
Unit II: Chapter 8: (Sections 8.1,8.2,8.3)
Chapter 9: (Sections 9.1,9.2)
Unit III: Chapter 9: (Sections 9.3,9.4,9.5)
Chapter 10: (Sections 10.1,10.2,10.3)
Unit IV: Chapter 13: (Sections 13.1,13.2)
Unit V: Chapter 13: (Sections 13.4,13.5,13.6)

Reference Books:
1) "*Topics in Algebra*" by **I.N. Herstein,** John Wiley & Sons (Second Edition), New Delhi, 1975.
2) "*Lectures in Abstract Algebra*" Vol. I by**N. Jacobson, D. Van Nostrand Co**., New York, 1976.

Course Outcomes:

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

CO 1 – Explain the notion and use the notion of ring theory.

CO 2 – Demonstrate the relationship between ring, field and module theory.

CO 3 - Locate and use Chinese remainder theorem to solve problems in number theory for various real life applications.

CO 4 – Demonstrate understanding of algebraic extensions and algebraic closures.

Course prepared by: Dr P Jayaraman

Course Verified by: HOD

Title of the Subject: COMPLEX ANALYSIS **No. of credits: 4**

Code No. :18MATA23B **No. of Teaching hours:5**

Course 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.

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 conformal mappings: Elementary Riemann surfaces.

Unit-II:
Fundamental theorems: 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 -Local properties of analytical functions: Removable singularities, Taylor's theorem – Zeros and poles – The local mapping – The maximum principle –The general form of Cauchy's theorem: Chains and cycles.

Unit-III:
The calculus of residues: The residue theorem – The argument principle – Evaluation of definite integrals-Harmonic functions: Definition and basic properties – The mean-value property – Poisson's formula.

Unit-IV:
Power series Expansions :Weierstrass theorem – The Taylor series – The Laurent series- Partial fractions and factorization: Partial fractions – Infinite products – Canonical products.

Unit-V:
The Riemann mapping theorem: Statement and proof – Boundary behavior – Use of the reflection principle – Analytic arcs – Conformal mapping of polygons: The behavior at an angle– The Schwarz – Christoffel formula – Mapping on a rectangle.

Text Book:
"*Complex Analysis*" by **L.V. Ahlfors,** Third Edition, McGraw-Hill, New York, 1979.
Unit I : Chapter 2: Section 1,
Chapter 3: Sections: 2.1 - 2.4, 3.1, 3.2, 4.3.
Unit II : Chapter 4: Sections: 1.1 – 1.5, 2.1 - 2.3, 3.1 - 3.4, 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 6: Sections: 1.1 - 1.4, 2.1 – 2.3.

Course Outcomes:

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

CO 1 – Analyze limits and continuity for complex functions as well as consequences of continuity.

CO 2 – 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.

CO 3 - Evaluate integrals along a path in the complex plane and understand the statement of Cauchy's Theorem

CO 4 – Represent functions as Taylor, power and Laurent series, classify singularities and poles, find residues and evaluate complex integrals using the residue theorem.

Course prepared by: Dr Nithyadevi

Course Verified by: HOD

Title of the Subject: PARTIAL DIFFERENTIAL EQUATIONS **No. of credits: 4**

Code No. :18MATA23C **No. of Teaching hours:5**

Course 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.

Unit I:
Nonlinear partial differential equations of the first order: Cauchy's method of characteristics- Compatible systems of first order equations – Charpit's method- Special types of first order equations – Jacobi's method.

Unit II:
Partial differential equations of second order: The origin of second-order equations – Linear partial differential equations with constant coefficients – Equations with variable coefficients – Characteristic curves of second–order equations- Characteristics of equations in three variables.

Unit III:
The solution of linear hyperbolic equations – Separation of variables – The method of integral transforms – Nonlinear equations of the second order.

Unit IV:
Laplace's equation : The occurrence of Laplace's equation in physics- elementary solution of Laplace's equation – Families of equipotential surfaces - boundary value problems- Separation of variables- Problems with axial symmetry.

Unit V:
The wave equation: The occurrence of wave equation in physics – Elementary solutions of the one-dimensional wave equation – vibrating membranes: Applications of the calculus of variations – Three dimensional problems. The diffusion equations: Elementary solutions of the diffusion equation – Separation variables- The use of integral transforms.

Text Book:
"*Elements of Partial Differential Equations*" by **I. N. Sneddon,** McGraw-Hill Book Company, Singapore, 1957.
Unit-I : Chapter 2: Sections: 7, 8, 9, 10, 11, 13.
Unit-II : Chapter 3: Sections: 1, 4, 5, 6, 7.
Unit-III: Chapter 3: Sections: 8, 9, 10, 11.
Unit-IV: Chapter 4: Sections: 1, 2, 3, 4, 5, 6.
Unit-V : Chapter 5: Sections: 1, 2, 4, 5,
Chapter 6: Sections: 3, 4, 5.

Course Outcomes:

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

CO 1 – Extract information from partial differential equations to interpret the reality.
CO 2 – Know the various types of methods and their limitations to solve the partial differential equations.
CO 3 - Identify the physical situations and real world problems to formulate mathematical models using partial differential equations.
CO 4 – Apply the acquired knowledge to select the most appropriate method to solve the particular partial differential equations.

Course prepared by: Dr M Suvinthra

Course Verified by: HOD

Title of the Subject: MECHANICS **No. of credits: 4**

Code No. :18MATA23D **No. of Teaching hours:5**

Course objectives:

- To create a solid foundation for understanding basic principles of mechanics and some classical problems
- To learn Lagrangian and Hamiltonian formulations of classical mechanics
- To learn the importance and consequences of canonical transformations

Unit-I:
Introductory Concepts: The mechanical system – Generalized coordinates – Constraints – Virtual work – Energy and momentum.

Unit-II:
Lagrange's Equations:Derivations of Lagrange's equations- Examples –Integrals of the motion.

Unit-III:
Hamilton's Equations:Hamilton's principle – Hamilton's equations.

Unit-IV:
Hamilton – Jacobi Theory:Hamilton's principal function –The Hamilton – Jacobi equation – Separability.

Unit-V:
Canonical Transformations:Differential forms and generating functions – Lagrange and Poisson brackets**.**

Text Book:
"*Classical Dynamics*" by **D.T. Greenwood,** Prentice Hall of India Pvt. Ltd, New Delhi, 1979.
Unit-I : Chapter 1.
Unit-II : Chapter 2: Sections: 2.1 - 2.3
Unit-III: Chapter 4: Sections: 4.1 - 4.2
Unit-IV: Chapter 5
Unit-V : Chapter 6: Sections: 6.1 - 6.3

Reference Books:

"*Classical Mechanics*" by **H. Goldstein, C. Poole & J. Safko,** Pearson Education, Inc., New Delhi, 2002.

Course Outcomes:

On successful completion of the course, the students will understand the following:

CO 1 – Derivation of Lagrange's equation using elementary calculus as an alternative to the more advanced variational calculus derivation.
CO 2 – The use of Hamilton-Jacobi in identifying conserved quantities for a mechanical system, even when the mechanical problem itself cannot be solved completely.
CO 3 – Defining different sets of generalized coordinates for a given mechanical system and the use of canonical transformations.
CO 4 – The use of analytical treatments in checking the numerical models.

Course prepared by: Dr S Saravanan

Course Verified by: HOD

Title of the Subject: MATLAB THEORY &PRACTICALS **No. of credits: 4**
Code No. :18MATA2EB **No of Teaching hours:5**

Course objectives:

- This course provides basic fundamentals on MATLAB, primarily for numerical computing.
- To learn the characteristics of script files, functions and function files, two-dimensional plots and three-dimensional plots.
- To enhance the programming skills with the help of MATLAB and its features which allow to learn and apply specialized technologies.

Unit – I:
Starting with Matlab - Creating arrays - Mathematical operations with arrays.

Unit – II:
Script files - Functions and function files.

Unit – III:
Two-dimensional plots - Three-dimensional plots.

Unit – IV:
Programming in MATLAB.

Unit – V:
Polynomials, Curve fitting and interpolation - Applications in numerical analysis.

Text Book:
"*MATLAB An Introduction with Application*" by **A. Gilat,** John Wiley & Sons, Singapore, 2004.

Unit – I :Chapter 1, Chapter 2, Chapter 3.
Unit -II :Chapter 4, Chapter 6.
Unit -III :Chapter 5, Chapter 9.
Unit – IV: Chapter 7.
Unit - V :Chapter 8, Chapter 10.

List of practical programs will be issued by course teacher

Reference Books :

1. "*Getting Started with MATLAB – A Quick Introduction for Scientistsand Engineers*" by **R. Pratap,** Oxford University Press, New Delhi, 2006.
2. "*Introduction to Matlab 7 for Engineers*" by **W.J. Palm,** McGraw-Hill Education, New York, 2005.
3. "*Introduction to MATLAB 7*" by **D. M. Etter, D. C. Kuncicky and H.Moore,** Prentice Hall, New Jersy, 2004.

Course Outcomes:

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

CO 1 – It lays foundation for doing matrix manipulations, plotting of functions and data, implementation of algorithms, and creation of user interfaces.

CO 2 – It helps in integrating computation, visualization and programming in an easy to use environment where problems and solutions are expressed in familiar mathematical notations.

CO 3 - This software is a more flexible programming tool for users in order to create large and complex application programs.

CO 4 – It consists of set of tools that facilitates for developing, managing, debugging and profiling M-files, and MATLAB's applications.

Course prepared by: Dr K Mathiyalagan
Course Verified by: HOD

Title of the Subject: TOPOLOGY **No. of credits: 4**

Code No. :18MATA33A **No. of Teaching hours:5**

Course objectives:

- To introduce the concepts of open sets and closed sets in the generalized sense and then to signify the indispensability of general topological spaces.
- To give an insight about different topological spaces and their properties.
- To inculcate the concepts of homeomorphisms, homotopy and isotopy of topological spaces and interpret them with geometrical shapes and structures.

Unit-I:

Spaces and maps: Topological spaces-Sets in a space-Maps-Subspaces-Sum and product of spaces.

Unit-II:

Identification and quotient spaces-Homotopy and isotopy.

Unit-III:

Properties of spaces and maps: Separation axioms and compactness

Unit-IV:

Connectedness – Pathwise connectedness – Imbedding theorems

Unit-V:
Extension theorems-Compactification-Hereditary properties.

Text Book:
"*Introduction to Topology*" by **S.T. Hu,** Tata – McGraw-Hill, New Delhi, 1979.
Unit-I : Chapter 2: Sections: 1 - 5.
Unit-II : Chapter 2: Sections: 6 and 7.
Unit-III: Chapter 3: Sections: 1 and 2.
Unit-IV: Chapter 3: Sections:4-6.
Unit-V : Chapter 3: Sections:7-9.

References Books:

1. "*Topology*" by **J. Dugunji,**Allyn and Bagon, Boston, 1966.
2. "*Topology*" by **K. Kuratowski,** Academic Press, New york, 1966.
3. "*Topology , A First Course* " by **J.R. Munkres,** Prentice Hall , Englewood Cliffs, 1975.
4. "*General Topology*" by **S. Willard,** Addison-Wesley, Reading, 1970 .

Course Outcomes:

On successful completion of the course, the students will be able to
CO 1 – Understand the generalized notions lying behind real and complex spaces and understand the way these spaces are generalized to topological spaces.
CO 2 – Have a thorough knowledge about different topological spaces, their properties and get an insight about the significance of topological spaces in mathematical analysis
CO 3 - Know and analyse the topological properties of function spaces and distinguish between the properties of spaces with strong and weak topologies
CO 4 – Expertise on standard results like the Urysohn lemma, imbeddings and extensions of spaces and their applications.

Course prepared by: Dr M Suvinthra

Course Verified by: HOD

Title of the Subject: FLUID DYNAMICS **No. of credits: 4**

Code No. :18MATA33B **No. of Teaching hours:5**

Course objectives:

- To establish an understanding of the fundamental concepts of fluid dynamics
- To make students understand the importance of fluid dynamics in diverse real life applications
- To build the necessary theoretical background for solving a variety of problems

Unit – I:

Inviscid Theory:Introductory Notions, velocity:Streamlines and paths of the particles-stream tubes and filaments-fluid body- Density- Pressure- Bernoulli's theorem. Differentiation with respect to time- Equation of continuity- Boundary conditions: kinematical and physical- Rate of change of linear momentum-The equation of motion of an inviscid fluid.

Unit – II:

Euler's momentum theorem- conservative forces- Lagrangian form of the equation of motion- Steady motion- The energy equation- Rate of change of circulation- Vortex motion- Permanence of vorticity.

Unit - III:

TwoDimentionsal Motion:Two dimensional functions : Stream function-Velocity potential- Complex potential- Indirect Approach- Inverse function. Basic singularities : Source- Doublet- Vortex- Mixed flow- Method of images: Circle theorem-Flow past circular cylinder with circulation. The aerofoil: Blasius's theorem-Lift force.

Unit - IV:

Viscous Theory:The equations of motion for viscous flow: The stress tensor- The Navier-Stokes equations- Vorticity and circulation in a viscous fluid. Flow between parallel flat plates: Couette flow, Plane Poiseuille flow. Steady flow in pipes: Hagen-Poiseuille flow.

Unit - V:

Boundary Layer Theory:Boundary layer concept- Boundary layer equations in two dimensional flow- Boundary layer along a flat plate: Blasius solution-Shearing stress and boundary layer thickness-Momentum integral theorem for the boundary layer:The von Karman integral relation- von Karman integral relation by momentum law.

Text Books:

"*Theoretical Hydrodynamics*" by **L.M. Milne Thomson**, Dover, 1996.
Unit I :Chapter 1 :Sections: 1.0-1.4
Chapter 3: Sections: 3.10-3.31, 3.40, 3.41.
Unit II: Chapter 3 :Sections: 3.42-3.45, 3.50-3.53.
"*Modern Fluid Dynamics Vol-I*" by **N. Curle and H.J. Davies,** D Van Nostrand Company Ltd.,London, 1968.
Unit III: Chapter 3: Sections: 3.2, 3.3, 3.5 - 3.5.1, 3.5.2, 3.7.4, 3.7.5.

Unit IV: Chapter 5: Sections: 5.2.1- 5.2.3
"*Foundations of Fluid Mechanics*" by **S.W. Yuan** Prentice- Hall of India, New Delhi, 1988.
Unit IV: Chapter 8: Sections: 8.3 - a,b, 8.4 – a.
Unit V : Chapter 9: Sectons: 9.1, 9.2, 9.3 – a,b, 9.5 – a,b.

Course Outcomes:

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

CO1 - analyze fluid flow problems with the application of the momentum and energy equations
CO2 - understand modelling approximations in finding exact solutions
CO3 - apply basic principles of multi-variable calculus, differential equations and complex variables to fluid dynamic problems

Course prepared by: Dr S Saravanan
Course Verified by: HOD

Title of the Subject: MATHEMATICAL METHODS **No. of credits: 4**

Code No. :18MATA33C **No. of Teaching hours:5**

Course objectives:

- Learn the fundamentals of variational calculus, Integral equations and its applications in various fields.
- Understand the relationship between the integral equations and differential equations, and how to convert from one another.
- Familiar with variational problems and use the calculus of variations to characterize the function that extremizes a functional.

Unit-I:
Integral Equations:Introduction: Integral equations with separable kernels - Reduction to a system of algebraic equations, Fredholm alternative, an approximate method, Fredholm integral equations of the first kind, method of successive approximations - Iterative scheme, Volterra integral equation, some results about the resolvent kernel, classical Fredholm theory - Fredholm's method of solution - Fredholm's first, second, third theorems.

Unit-II:
Applicationsof Integral Equations:Application to ordinary differential equation - Initial value problems, boundary value problems - Singular integral equations - Abel integral equation.

Unit-III:
Calculusof Variations: Themethod of variations in problems with fixed boundaries:Variation and its properties - Euler's equation - Functionals of the form ∫ F(x,y1,y2,…, yn,y1',y2',…yn')dx, Functionals dependent on higher order derivatives – Functionals dependent on the functions of several independent variables - Variational problems in parametric form - Some applications.

Unit-IV:
Sufficient Conditionsfor an Extremum:Field of extremals - The function E(x,y,p,y') - Transforming the Euler equations to the canonical form.

Unit-V:
Direct Methodsin variational problems:Direct methods - Euler's finite difference method - The Ritz method - Kantorovich's method.

Text Books:
"*Linear Integral Equations - Theory and Technique*" by **R. P. Kanwal**, Second Edition, Birkhauser, Boston, 1997.
Unit – I :Chapter 1 - Chapter 4.
Unit – II :Chapter 5: Sections: 5.1, 5.2
Chapter 8: Sections: 8.1, 8.2

"*Differential Equations and the Calculus of Variations*" by **L. Elsgolts,** MIR Publishers, Moscow, 1970.
Unit - III: Chapter 6
Unit - IV: Chapter 8
Unit - V :Chapter 10

References Books:

1."*Integral Equations and Applications*" by **C. Corduneanu,** Cambridge University Press, Cambridge, 1991.
2."*Calculus of Variations, with Applications to Physicsand Engineering*" by **R. Weinstock,** McGraw-Hill Book Co., Inc., New York, 1952.

Course Outcomes:

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

CO 1 – Apply the acquired knowledge to identify the different kinds of kernels and techniques for solving them analytically and also numerically.
CO 2 – Solve simple IVP and BVP by using calculus of several variable and integral equations of several types.
CO 3 - Explain the fundamental concepts of calculus of variations and their role in modern mathematics and applied contexts.
CO 4 – Formulate variational problems and analyse them to deduce key properties of system behaviour.

Course prepared by: Dr K Mathiyalagan
Course Verified by: HOD

Title of the Subject: FUNCTIONAL ANALYSIS **No. of credits: 4**
Code No. :18MATA33D **No. of Teaching hours:5**

Course 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.
- To impart analytic knowledge on infinite-dimensional vector spaces, of which the most important cases are Banach spaces and Hilbert spaces.
- 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.

Unit-I:
Banach spaces: Definition and examples – Continuous linear transformations – The Hahn Banach theorem.

Unit-II
The natural imbedding – Open mapping theorem – The conjugate of an operator.

Unit-III
Hilbert spaces: Definition and simple properties – Orthogonal complements – Orthonormal sets– Conjugate space.

Unit-IV
The adjoint of an operator-Self –adjoint operators-Normal and unitary operators-Projections.

Unit-V:
Algebrasof Operators: General Preliminaries on Banach Algebras: The definitions and some examples-Regular and singular elements-Topological divisors of zero-The spectrum-The formula for the spectral radius.

Text Book:
"*Introduction to Topology and Modern Analysis*" by **G.F.Simmons,** McGraw-Hill, New York, 1963

References Books:

1. "*A Course in Functional Analysis*" by **J. B. Conway,** Springer, New York, 1990.
2. "*First Course in Functional Analysis*" by **C. Goffman& G. Pedrick**, Prentice-Hall of India, New Delhi, 2002.
3. "*Elements of Functional Analysis*" by **L. A. Lusternik& V. J. Sobolev,** Hindustan Publishing Co, New Delhi, 1985.
4. "*Introduction to Functional Analysis*" by **A. E. Taylor,** John Wiley, New York, 1958.

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

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

Course prepared by: Dr N Annapoorani
Course Verified by: HOD

Title of the Subject: COMPUTER PROGRAMMING C++ **No. of credits: 4**

Code No. :18MATA3EC **No. of Teaching hours:5**

Course objectives:

- To perform object oriented programming to develop solution to problems demonstrating the usage of objects as instances of classes and data members, to implement various member functions and manage I/O operation.
- To learn the characteristics of the object oriented programming language, data abstraction, dynamic memory allocation, inheritance, and operator overloading and type conversions.
- To enhance problem solving and programming skills in C++ with extensive programming sessions.

Unit I

The Big Picture: Overview of object-oriented programming –Characteristics of object- oriented languages –C++ and C. C++ Programming Basics: Basic program construction- Output using cout –Preprocessor directives –Comments –Integer variables –Character variables –Input with cin –Type float –Manipulators –Variable type summary –Type conversion –Arithmetic operators –Library functions.

Unit II:

Loops and Decisions: Relational operators –Loops –Decisions –Logical operators- Precedence summary –Other control statements. Structures: Enumerated datatypes. Functions: Simple functions –Passing arguments to functions –Returning values from functions –Reference arguments –Overloaded functions –Inline functions –Default arguments- Variables and storage classes –Returning by reference.

Unit III

Objects and Classes: A simple class – C++ objects as physical objects –C++ objects as datatypes –Constructors –Objects as function arguments –Returning objects from functions- A card game example –Structures and classes –Classes, objects, and memory –Static class data. Arrays: Array fundamentals –Arrays as class member data –Arrays of objects –Strings.

Unit IV

Operator Overloading: Overloading unary operators –Overloading binary operators –Data conversion –Pitfalls of operator overloading and conversion. Inheritance: Derived class and base class –Derived class constructors –Overriding member functions –Inheritance in the English distance class –Class hierarchies –Public and private inheritance –Levels of inheritance –Multiple inheritance –Ambiguity in multiple inheritance –Containership: classes within classes –Inheritance and program developing.

Unit V:

Pointers: Address and pointers –Pointers and arrays –Pointers and functions –Pointers and string –Memory management: new and delete –Pointers to objects –A linked list example- Pointers to pointers – Debugging pointers. Virtual Functions and Other Subtleties: Virtual functions –Friend functions –Static functions –Assignment and copy-initialization – The this pointer. Files and Streams: Streams –String I/O –Character I/O –Object I/O – I/O with multiple objects –File pointers –Disk I/O with member functions –Error handling Redirection –Command-line arguments –Printer output –Overloading the extraction and insertion operators.

Text Book:
"*Object – Oriented Programming in Microsoft C++*" by**R. Lafore,**Galgotia Publications Pvt. Limited, New Delhi, 1999.
Unit I :Chapters 1,3
Unit II :Chapters 4,5,6.
Unit III: Chapter 7, 8.
Unit IV: Chapters 9, 10.
Unit V :Chapters 12, 14.

Reference Books:

1. "*The C Programming Language*" by **B.W. Kernighan & D. M. Ritchie,** Second Edition, Prentice Hall of India Pvt. Limited, New Delhi, 2006.

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

CO 1 – Ability to use different data structures and memory allocation method.

CO 2 – Apply the major object oriented concepts to implement object oriented programs in C++, encapsulation and inheritance.

CO 3 - Understand advanced feature of C++ specifically stream I/O templates and operator overloading.

CO 4 – Write programs from the underlying algorithms, and demonstrate the ability to employ good commenting and coding techniques.

Course prepared by: Dr N Nithyadevi
Course Verified by: HOD

PRACTICALS (50 Marks)

SAMPLE LIST OF PRACTICALS

1. DISTANCE CONVERSION PROBLEM

Create two classes DM and DB which store the value of distances. DM stores the value of distances. DM stores distances in meters and centimeters in DB in feet and inches. Write a program that can create the values of the class objects and add one object DM with another object DB. Use a friend function to carry out addition operation. The object that stores the result may be DM object or DB object depending on the units in which results are required. The display should be in the order of meter and centimeter and feet or inches depending on the order of display.

2. OVERLOADING OBJECTS

Create a class FLOAT that contains one float data member overload all the four arithmetic operators so that operate on the objects of FLOAT.

3. OVERLOADING CONVERSIONS

Design a class polar which describes a pant in a plane using polar Co-ordinates radius and angle. A point in polar Co-ordinates is as shown below. Use the overloader + operator to add two objects of polar. Note that we cannot add polar values of two points directly. This requires first the conversion. Points into rectangular co-ordinates and finally converting the result into polar coordinates. You need to use following trigonometric formulas.

X= r * cos (a); Y= r * sin (a); a=tan-1(Y/X) ; r = √(X 2 +Y 2);

4. POLAR CONVERSION

Define two classes polar and rectangular coordinates to represent points in the polar and rectangular systems. Use conversion routines to convert from one system to another.

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 – 2*A*B

6. AREA COMPUTATION USING DERIVED CLASS

Area of rectangle = X*Y

Area of triangle = ½ * X * Y

7. VECTOR PROBLEM

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.

Title of the Subject: NONLINEAR DIFFERENTIAL EQUATIONS **No. of credits: 4**

Code No. :18MATA43A **No. of Teaching hours:5**

Course objectives:

- Nonlinear systems occur widely in the real world and may produce oscillations or wild chaotic fluctuations even when influenced by a constant external force. This course provides a first introduction to the mathematics behind such behaviour.
- To discuss nonlinear differential equations and the solution behaviour without finding the solutions explicitly.
- To develop clear thinking and analyzing capacity for advanced research.

Unit I:
First order systems in two variables and linearization: The general phase plane – Some population models – Linear approximation at equilibrium points – Linear systems in matrix form.

Unit II:
Averaging Methods: An energy balance method for limit cycles – Amplitude and frequency estimates – Slowly varying amplitudes ; Nearly periodic solutions - Periodic solutions: Harmonic balance – Equivalent linear equation by harmonic balance – Accuracy of a period estimate.

Unit III:
Perturbation Methods: Outline of the direct method – Forced oscillations far from resonance Forced oscillations near resonance with weak excitation – Amplitude equation for undamped pendulum – Amplitude perturbation for the pendulum equation – Lindstedt's method- Forced oscillation of a self – excited equation – The Perturbation method and Fourier series.

Unit IV:
Linear systems: Structure of solutions of the general linear system – Constant coefficient system – Periodic coefficients –Floquet theory – Wronskian.

Unit V:
Stability: Poincare stability – Solutions, paths and norms – Liapunov stability- Stability of linearsystems – Comparison theorem for the zero solutions of nearly-linear systems.

Text Book:
"*Nonlinear Ordinary Differential Equations*" by **D.W.Jordan and P.Smith,** Clarendon Press, Oxford, 1977.
Unit-I :Chapter 2.
Unit-II :Chapter 4.
Unit-III: Chapter 5: Sections: 5.1 - 5.4, 5.7 -5.10.
Unit-IV: Chapter 8: Sections: 8.1 - 8.4.
Unit-V :Chapter 9: Sections: 9.1 - 9.4, 9.6.

References Books:

1. "*Differential Equations*" by **G.F. Simmons,** Tata McGraw-Hill, New Delhi, 1979.
2. "*Ordinary Differential Equations and Stability Theory*" by **D.A. Sanchez,** Dover, New York, 1968.
3. "*Notes on Nonlinear Systems*" by **J.K. Aggarwal,** Van Nostrand, 1972.

Course Outcomes:

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

- CO 1 – Understand the correspondence between some population models and mathematical equations via interpretation of population behaviour using equilibrium points.
  CO 2 – Solve the nonlinear differential equations and analyse their solution behaviour using averaging methods, perturbation theory, Lindstedt's method and other different techniques.
  CO 3 - Expertise their problem-solving capabilities.
  CO 4 – Master the concepts of stability in different perspectives by practising many problems.

Course prepared by: Dr N Annapoorani

Course Verified by: HOD

Title of the Subject: CONTROL THEORY **No. of credits: 4**

Code No. :18MATA43B **No. of Teaching hours:5**

Course objectives:

- To learn the basic principles underlying the analysis and designing of control systems often being a continuously operating dynamical system using a control action in an optimum manner.
- Familiar with the control theory concepts and properties including observability, controllability, stability and stabilizability.
- To develop clear thinking and analyzing capacity for advanced research.

Unit-I:
Observability:Linear Systems – ObservabilityGrammian – 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 - Linear time varying systems – Perturbed linear systems – Nonlinear systems.

Unit-IV:
Stabilizability:Stabilization via linear feedback control – Bass method – Controllable subspace – Stabilization with restricted feedback.

Unit-V:
Optimal Control:Linear time varying systems with quadratic performance criteria – Matrix Riccati equation – Linear time invariant systems – Nonlinear Systems.

Text Book:
"*Elements of Control Theory*" by **K. Balachandran and J.P. Dauer,**Narosa Publishing House, New Delhi, 1999.
Unit-I :Chapter 2
Unit-II :Chapter 3: Sections: (3.1-3.3)
Unit-III: Chapter 4.
Unit-IV: Chapter 5.
Unit-V :Chapter 6.

References 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.

Course Outcomes:

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

CO 1 – The concept of controllability and observability are two important properties of state models which are to be studied prior designing a controller since they are dual aspects of the same problem.

CO 2 – The field of control theory consists of linear and nonlinear control systems together with some mathematical techniques for analyzing and designing of appropriate control policies.

CO 3 - To deal with the problem of finding a control law for a given system, the use of optimal control theory provides a mathematical optimization method such that a certain optimality criterion is achieved.

CO 4 – Understanding and learning how control theory underpins modern technologies and provides an insight in mathematical analysis.

Course prepared by: ********

Course Verified by: HOD

Title of the Subject: DISTRIBUTION THEORY **No. of credits: 4**

Code No. :18MATA43C **No. of Teaching hours:5**

Course objectives:

- To introduce the basic concepts of test functions, distributions and tempered distributions which replace the classical theory of calculus and suits the need of a more appropriate calculus to analyse realistic problems.
- To inculcate the notions of weak derivatives, primitives, fundamental solutions and Green's functions via test functions and distributions.
- To familiarise the techniques of integral transforms to find the solutions of ordinary/partial differential equations in the distributional sense.

Unit - I:
Test Functionsand Distributions:Test functions - Distributions - Localization and regularization - Convergence of distributions-Tempered distributions.

Unit - II:
Derivativesand Integrals:Basic Definitions - Examples - Primitives and ordinary differential equations.

Unit - III:
Convolutionsand Fundamentalsolutions:The direct product of distributions - Convolution of distributions – Fundamental solutions.

Unit - IV:
The Fourier Transform:Fourier transforms of test functions - Fourier transforms of tempered distributions- The fundamental solution for the wave equation-Fourier transform of convolutions-Laplace transforms.

Unit - V:
Green's Functions:Boundary-Value problems and their adjoints - Green's functions for boundary-Value problems- Boundary integral methods.

Textbook:
"*An Introduction to Partial Differential Equations*" by **M. Renardy and R.C. Rogers**,
Second Edition, Springer Verlag, New York, 2008.
Unit I :Section: 5.1.
Unit II :Section: 5.2.
Unit III: Section: 5.3.
Unit IV: Section: 5.4.
Unit V :Section: 5.5.

References Books:

1. "*The Analysis of Linear Partial Differential Operators I – Distribution Theory and Fourier Analysis*" by **L. HÖrmander,** Second Edition, Springer Verlag, Berlin, 2003.
2. "*Introduction to the Theory of Distributions*" by **F.G. Friedlander and M. Joshi,** Cambridge University Press,UK, 1998.
3. "*Generalized Functions - Theory and Technique*" by **R.P. Kanwal,** Academic Press, New York, 1983.

Course Outcomes:

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

CO1– Realise the significance of considering distributions in place of the classical functions.

CO2– Get a motivation towards learning and analysing differential equations in terms of weak formulations and get convinced that the concept of distributions is better tool to model physical phenomena.

CO3- Understand the concept of weak solutions, weak derivatives and know that mathematical concepts are far more generalized by means of the learned theory.

CO4– Analyse the behaviour of a realistic system with more addiction to realistic phenomena.

Course prepared by: Dr M Suvinthra

Course Verified by: HOD

Title of the Subject: PROBABILITY THEORY **No. of credits: 4**

Code No. :18MATA4ED **No. of Teaching hours:5**

Course objectives:

- To provide a thorough treatment of probability ideas and techniques necessary for a firm understanding of the subject.
- Understanding of the ideas in their proofs, and ability to make direct application of those results to related problems.

As evidence of that understanding, students should be able to demonstrate mastery of all relevant vocabulary, familiarity with common examples and counterexamples, knowledge of the content of the major theorems.

Unit I:
Random Events and Random Variables:conditional probability - Bayes Theorem-Independent events - Random variables - Distribution Function - Joint Distribution - Marginal Distribution - Conditional Distribution - Independent random variables - Functions of random variables.

Unit II:
Parameters of the Distribution: Expectation – Moments - The Chebyshev Inequality-Absolute moments.Characteristic functions: Properties of characteristic functions - Characteristic functions and moments-semi invariants - characteristic function of the sum of the independent random variables - Determination of distribution function by the Characteristic function - Characteristic function of multidimensitional random vectors - Probability generating functions.

Unit III:
Some Probability distributions: One point, two point, Binomial - Polya -Hypergeometric - Poisson (discrete) distributions-Uniform-normal gamma-Beta-Cauchy and Laplace (continuous) distributions.

Unit IV:
Limit Theorems:Stochastic convergence - Bernaulli law of large numbers -Convergence of sequence of distribution functions – Levy - Cramer Theorems - de Moivre - Laplace Theorem - Poisson, Chebyshev, Khintchine Weak law of large numbers - Lindberg Theorem - Lapunov Theorem – Borel - Cantelli Lemma -Kolmogorov Inequality and Kolmogorov Strong Law of Large numbers.

Unit V:
Markov Chains:Preliminaries-Homogeneous Markov chains-The Transition matrix-The ergodic theorem- Random variables forming a homogeneous Markov chain.

Text Book:
"*Probability theory and Mathematical statistics*", **MarekFisz,** John Wiley and Sons, Third Edition, New York, 1963.
Unit I: Chapter 1 & 2, 1.5-1.7, 2.1-2.9
Unit II: Chapter 3 & 4, 3.1-3.5, 4.1-4.7
Unit III: Chapter 5, 5.1-5.10
Unit IV: Chapter 6, 6.2-6.4,6.6-6.9,6.11,6.12
Unit V: Chapter 7, 7.1-7.5

Course Outcomes:

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

CO1– The ability to use and simulate random variables, distribution functions, probability mass functions, and probability density functions, through calculus and functional transformations, to answer quantitative questions about the outcomes of probabilistic systems.

CO2- The ability to use and simulate multivariate distributions, independence, conditioning, and functions of random variables, including the ability to compute expectations, moments, and correlation functions, to describe relationships between different experimental conditions.

CO3- 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 Kolmogorov's axioms.

CO4- The ability to use Markov chain from measurements and transition matrices to make reasonable quantitative inferences about engineering systems.

Course prepared by: Dr Rakkiyappan

Course Verified by: HOD

ELECTIVES:

Title of the Subject: Elective: LINEAR ALGEBRA **No. of credits: 4**

Code No. :18MATA1EE **No. of Teaching hours:5**

Course objectives:

- Compose clear and accurate proofs using the concepts of this course.
- Provide a setting that prepares students to read and learn algebraic mathematics on their own thus engaging students to sound mathematical thinking and reasoning.
- To train solving problems and exercises concerning vectors, matrices, complex numbers, and linear spaces.

UNIT I:
Polynomials and Determinants: Algebras - The algebra of polynomials – Lagrange interpolation – Polynomial ideals, The prime factorization of a polynomial - Determinant functions - Permutations and the uniqueness of determinants – Additional properties of determinants.

UNIT II:
Canonical Forms:Characteristic values – Annihilating polynomials – Invariant subspaces – Simultaneous triangulations – Simultaneous diagonalization – Direct-sum decompositions – Invariant direct sums – The primary decomposition theorem.

UNIT III:
The Rational and Jordan Forms, Inner Product Spaces:Cyclic subspaces and annihilators – Cyclic decompositions and the rational form – The Jordan form, Computation of invariant factors - Inner product – Inner product spaces.

UNIT IV:
Inner Product Spaces & Operators on Inner product spaces:Linear functional and adjoints, Unitary operators, Normal operators – Forms on inner product spaces – Positive forms – More results on forms.

UNIT V:
Bilinear forms:Spectral theory, further properties of normal operators – bilinear forms, symmetric bilinear forms, skew-symmetric bilinear forms, groups preserving bilinear 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 4 & 5 : Sections: 4.1- 4.5, 5.1-5.4.
Unit-II :Chapter 6 : Sections: 6.1 - 6.8.
Unit-III :Chapter 7 & 8 : Sections: 7.1-7.4, 8.1-8.2.
Unit-IV :Chapter 8 & 9 : Sections: 8.3 – 8.5, 9.2 – 9.4.
Unit-V :Chapter 9 & 10 : Sections: 9.5 – 9.6, 10.1 – 10.4.

Course Outcomes:

CO1- Students are introduced to modern concepts and methodologies in numerical linear algebra, with particular emphasis on the methods that can be used to solve very large-scale problems.

CO2- Students are made familiar with the basic ideas of linear algebra including concepts of linear systems, independence, theory of matrices, linear transformations, bases and dimension, eigenvalues, eigenvectors and diagonalization.

CO3- Ability to apply appropriate linear algebraic concepts, thinking processes, tools, and technologies in the solution to various conceptual or real-world problems.

CO4- Enhancing their knowledge and prepare them for other courses to be encountered at higher levels.

Course prepared by: Dr R Rakkiyappan

Course Verified by: HOD

Title of the Subject: Elective: DIFFERENTIAL GEOMETRY **No. of credits: 4**

Code No. :18MATA2EF **No of Teaching hours:5**

Course objectives:

- To make students understand the basic terms and tools of differential geometry, which will be used in formulating and solving problems.
- To interpret smooth analytical statements geometrically and vice versa.
- To formulate and prove fundamental theorems of differential geometry.

Unit I:
Space curves:Definition of a space cure – Arc length – tangent – normal and binormal – curvature and torsion – contact between curves and surfaces – tangent surface – involutes and evolutes – Intrinsic equations – Fundamental Existence Theorem for space curves – Helics.

Unit II:
Intrinsic properties of a surface:Definition of a surface – curves on a surface – Surface of revolution – Helicoids – Metric – Direction coefficients – families of curves – Isometric correspondence – Intrinsic properties.

Unit III:
Geodesics:Geodesics – Canonical geodesic equations – Normal property of geodesics – Existence Theorem – Geodesic parallels – Geodesics curvature – Gauss – Bonnet Theorem – Gaussian curvature – surface of constant curvature.

Unit IV:
Non Intrinsic Properties of a surface:The second fundamental form – Principle curvature – Lines of curvature – Developable – Developable associated with space curves and with curves on surface – Minimal surfaces – Ruled surfaces.

Unit V:
Differential Geometry of Surfaces: Compact surface whose points are umblics – Hilbert's lemma – Compact surface of constant curvature – Complete surface and their characterization – Hilbert's Theorem – Conjugate points on geodesics.

Text Book:
T. J Willmore, "*An Introduction to Differential Geometry*", Oxford University Press, (17^{th} impression) New Delhi 2002. (Indian Print)
Unit-I :Chapter 1 : Sections: 1-9.
Unit-II :Chapter 2 : Sections: 1-9.
Unit-III :Chapter 2 : Sections: 10-18.
Unit-IV :Chapter 3 : Sections: 1-8.
Unit-V :Chapter 4 : Sections: 1-8.

Course Outcomes:

CO1- Initially the student will be able to compute quantities of geometric interest such as curvature, as well as develop a facility to compute in various specialized systems, such as semigeodesic coordinates or ones representing asymptotic lines or principal curvatures.
CO2- Students will start being able to develop knowledge in the geometric description of curves and surfaces in order to establish basic properties of geodesics, involutes and evolutes, minimal surfaces, and intrinsic and non-intrinsic properties of curves on a surface.
CO3- Able to apply tools of differential geometry to related fields, such as smooth dynamics and Lie group actions, hyperbolic geometry.
CO4- Select a reasoned argument to the solution of familiar and unfamiliar problems relevant to differential Geometry.

Course prepared by: Dr S Saravanan

Course Verified by: HOD

Title of the Subject: Supportive I-APPLIED MATHEMATICS-I **No. of credits: 2**

Code No. :181GS **No. of Teaching hours:2**

Course objectives:

- Understand the use of mathematical tools and concepts in other fields.
- Emphasis on the development of new methods to meet the challenges of new problems, and the real world.
- Critically analyse information and concepts to adapt to advances in knowledge and technology in the workplace.

Unit I:
Ordinary Differential Equations:Second and higher order linear ODE – Homogeneous linear equations with constant and variable coefficients – Non-homogeneous equations – Solutions by variation of parameters.

Unit II:
Functionsofseveral variables:Partial derivatives – Total differential – Taylor's expansions – Maxima and minima of functions– Differentiation under integral sign**.**

Unit III:
Partial Differential Equations:Formation of PDE by elimination of arbitrary constants and functions – Solutions –General and singular solution- Lagrange's linear equation – Linear PDE of second and higher order with constant coefficients.

Unit IV:
FourierSeries:Dirichlet conditions – General fourier series – Half range sine and cosine series – Parseval's identity – Harmonic analysis.

Unit V:
Boundary Value Problems:Classification of PDEs – Solutions by separation of variables - One dimensional heat and wave equation.

Reference books:
1. "*Advanced Engineering Mathematics*" by **E. Kreyszig,** Eighth Edition, John Wiley and Sons (Asia) Pvt. Ltd., Singapore, 2000.
2. "*Higher Engineering Mathematics*" by **B.S. Grewal,** Thirty Eighth Edition, Khanna Publishers, New Delhi, 2004.

Course Outcome:

CO1-Have the ability to make inferences and generalizations regarding the real life situations that the applied mathematics algorithms are used for.

CO2- Use appropriate technology successfully and solve large scale mathematical models that involve systems of matrices, differential equations or integral equations and solve large scale problems through optimization techniques.

CO3-Knowledge and understanding of the role of logical mathematical argument and deductive reasoning, together with formal processes of mathematical proof and development of mathematical theories.

CO4-The problems come from various applications, such as physical and biological sciences, engineering, and social sciences. Their solutions require knowledge of various branches of mathematics, such as analysis, differential equations, and stochastics, utilizing analytical and numerical methods.

Course prepared by: Dr P Jayaraman

Course Verified by: HOD

Title of the Subject: Supportive II-APPLIED MATHEMATICS-II **No. of credits: 2**

Code No. :181GS **No. of Teaching hours:2**

Course objectives:

- Learn the basic concepts of system dynamics and applications in various disciplines.
- Understand the methods to analyse the system behavior for linear and nonlinear, homogeneous and nonhomogeneous cases.
- Solve the simple problems using Fourier transform and Complex Integration.

Unit – I :
Systems of differential equations, Phase Plane, Stability: Introduction: Vectors, Matrices - Introductory examples - Basic concepts and theory – Homogeneous linear systems with constant coefficients.

Unit – II :
Phase Plane, Critical Points, Stability - Phase Plane methods for nonlinear systems – Non homogeneous linear systems.

Unit - III:
Fourier integral theorem - Fourier transform pairs - Fourier sine and cosine transforms - Properties - Transforms of simple functions - Convolution theorem, Parseval's identity, ZTransforms.

Unit - IV:
Complexintegration:Line integral in the complex plane - Two integration methods - Cauchy's integral theorem - Existence of indefinite integral - Cauchy's integral formula - Derivatives of analytic functions.

Unit - V:
Residue Integrationmethod:Residues - Residue theorem - Evaluation of real integrals - Further types of real integrals.

Reference Books:

1. "*Advanced Engineering Mathematics*" by **E. Kreyszig,** Eighth Edition, John Wiley and Sons, (Asia) Pvt Ltd., Singapore, 2000.
2. "*Higher Engineering Mathematics*" by **B.S. Grewal,** Thirty Eighth Edition, Khanna Publishers, New Delhi, 2004.

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

CO 1 - Formulate simple physical processes as mathematical models.

CO 2 - Select the appropriate methods to solve the mathematical problems.

CO 3 - Apply the acquired knowledge to identify the different kinds of system behavior.

CO 4 - Find the Fourier transform, inverse Fourier transform and Residue of a function.

Course prepared by: Dr K Mathiyalagan
Course Verified by: HOD