MMA23506T	LINEAR ALGEBRA	L	T	P	C
		4	0	0	4

Pre-requisite: Knowledge of Groups and Rings

Course Objectives:

1. To provide a detailed study of linear transformation and related topics.
2. To give an idea about inner product spaces, orthogonality and canonical forms.

Course Outcome:

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

CO1: understand thoroughly the concept of Linear Transformation.

CO2: define Inner Product Spaces, Orthogonality.

CO 3: understand the concept of canonical form.

CO4: describe bilinear forms, Jordan forms, positive and quadratic forms.

Module1:Linear Transformation — **18Hours**

Linear Transformation, Kernel and Image of Linear Transformation, Algebra of Linear transformation, Singular and Non-Singular linear transformation, Isomorphism, Representation of Linear Transformation as matrices, Linear Operators, Change of Basis, Similarity of Matrices.

Module2:Inner Product Space — **15Hours**

Inner product, Inner product spaces, Cauchy – Schwarz inequality, Orthogonality, Orthogonal Sets and Bases, Gram – Schimdt orthogonalization process, Orthogonal and positive definite matrices, Complex Inner product Spaces.

Module3: Canonical forms — **15Hours**

Elementary canonical forms, Rational and Jordan form, Primary decomposition theorem,

Module4:Bilinear Forms — **12Hours**

Bilinear forms, Matrices of bilinear forms, Symmetric bilinear forms, Diagonalization of symmetric matrices, positive and quadratic forms.

TotalLecturehours — **60hours**

TextBook(s)

1. Hoffman, K.and Kunze, R. Linear Algebra, 2nd Edition. New Delhi, India: PHI Learning Private Limited, (2011).
2. Lipschutz, S. and Lipson, M. Schaum's outline of Linear Algebra, 6th Edition. McGraw Hill LLC (2018)

ReferenceBooks

1. Kumaresan. S, Linear Algebra, A Geometric Approach, Prentice – Hall of India, (2000)

MMA23507T	COMPLEX ANALYSIS	L	T	P	C
		4	0	0	4

Pre-requisite: Knowledge of Complex Functions and derivatives

Course Objectives:

1. To give students idea of integration over a complex plane, power series expansion and convergence of infinite sequences and series.
2. To provide a detailed study of residues, its uses in evaluating integrals.
3. To give students idea about conformal mapping, different types of transformations.

Course Outcome:

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

CO1: understand the behaviour of a function at much larger scale by just knowing how the function behaves at an open disc in the complex plane.

CO2: recognize the difference between pointwise and uniform convergence of sequence and series of functions.

CO 3: understand the concepts of residues and its application in evaluation of complex integral.

CO4: understand the concept of bilinear transformation, fixed points and cross ratio.

Module1:Complex Integration — **15Hours**

Cauchy-Goursat Theorem. Cauchy's integral formula, Higher order derivatives. Morera's theorem, Cauchy's inequality and Liouville's Theorem. The fundamental theorem of Algebra, Gauss's Mean Value Theorem Maximum Modulus principle, Schwarz lemma, Open mapping theorem.

Module2:Infinite Series — **15Hours**

Sequences and series of functions, Uniform and Absolute convergence, Power Series, Taylor's and Laurent's Series, Zero and Singularity of an analytic function, Entire function, Meromorphic function. The Argument Principle, Rouche's theorem.

Module3: Theory of Residues — **15Hours**

Residue, Calculation of Residues, Cauchy's residue theorem, Evaluation of definite integrals. Special theorems used in evaluating integrals, Mittag-Leffer's theorem.

Module4:Conformal Mapping — **15Hours**

Conformal Transformation, Necessary and sufficient condition of conformal transformation, Bilinear transformations, Geometrical inversion, Invariance of cross ratio, Fixed points of a bilinear transformation, some special bilinear transformation e.g. real axis on itself, unit circle on itself, real axis on unit circle etc. Branch point and Branch line, Concept of the Riemann surface.

Total Lecture hours — **60hours**

TextBook(s)

1. Spiegel. M. R. Complex variables. Schaum's series, McGraw Hill (2009)
2. Philips. E.G. Functions of complex variables with applications. Oliver and Boyd (Ebook) (1961)

Reference Books

1. Rudin, W. Real and Complex Analysis, Hill Book (1987)
2. Ahlfors, L.V. Complex Analysis, McGraw Hill (1979)
3. Priestly, H.A. Introduction to complex Analysis, Clarendon Press Oxford, (1990)
4. Ablowitz, M.J. and Fokas, A.S. Complex Variables, Introduction and Application, CUP, (1998)

MMA23508T	MATHEMATICAL METHODS	L	T	P	C
		4	0	0	4

Pre-requisite: Differentiation and Integration

Course Objectives:

- To evaluate the solutions of Fredholm and Volterra integral equations
- To understand the concept of Laplace Transform and its properties
- To learn the basic idea of Fourier Transform
- To explain the basic ideas of calculus of variations

Course Outcome:

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

CO 1: solve various kinds of Fredholm and Volterra integral equations

CO 2: find the complete solution of a differential equation by using Laplace Transform method

CO 3: classify and explain Fourier sine and cosine transforms

CO 4: understand the variational problems with functional having higher order derivatives of the only dependent variable

Module 1: Integral Equations — **15 Hours**

Definition of Integral Equation, Reduction of ordinary differential equations into integral equations, Fredholm integral equations with separable kernels, Eigen values and Eigen functions, Volterra Integral Equations of second kind, Resovant Kernal of Volterra equation and its results, Application of iterative scheme to Volterra equation of the second kind. Convolution type kernals.

Module 2: Laplace Transform — **15 Hours**

Basic properties of Laplace Transform, Convolution theorem and properties of convolution, Inverse Laplace Transform, Application of Laplace Transform to solution of ordinary and partial differential equations of initial and boundary value problems.

Module 3: Fourier Transform — **15 Hours**

Fourier Integral Transform. Properties of Fourier Transform, Fourier sine and cosine transforms, Application of Fourier transform to ordinary and partial differential equations of initial and boundary value problems. Evaluation of definite integrals.

Module 4: Calculus of variation — **15 Hours**

Basic ideas of calculus of variations, Euler's equation with fixed boundary of the functional containing only the first order derivative of the only dependent variable with respect to one independent variable, Variational problems with functional having higher order derivatives of the only dependent variable, general case of Euler's equation, applications.

Total Lecture hours — **60 Hours**

Text Book(s)

1. Kanwal R.P., Linear Integral Equations, Theory and Techniques, Academic Press, New York, (1971)
2. Spiegel M.R., Theory and problems of Laplace Transform, Schaum's Outline Series (1965) (Ebook)
3. A.S. Gupta: Calculus of variation with Applications : Prentice Hall of India (1999)

Reference Books

1. Mikhlin S. G., Linear Integral Equations (Translated from Russia), Hindustan Book Agency (1960)
2. Hilderbrand F. B.. Methods of Applied Mathematics, Dover Publication (1962)
3. Raisinghania M. D., Integral Transforms, S. Chand and Co. (2013)
4. Courant R. and Hilbert D., Methods of Mathematical Physics- Vol- I, Wiley Interscience, Newyork (1953)

MMA23509T	PARTIAL DIFFERENTIAL EQUATIONS	L	T	P	C
		4	0	0	4

Pre-requisite: Partial Derivatives and Integration

Course Objectives:

- To give an introduction to Mathematical techniques in analysis of P.D.E.
- To express and explain the physical interpretations of common forms of PDEs
- To introduce various applications of partial differential equations in many fields of science and engineering

Course Outcome:

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

CO 1: solve simplest first order PDEs

CO 2: obtain the general solution of second-order differential equation

CO 3: solve initial and boundary value problems on heat flow and vibration

Module 1: First Order P.D.E. — **20 Hours**

Formulation of P.D.E, First-Order Partial Differential Equations, Quasi-Linear Equations of First Order, Nonlinear First-Order Partial Differential Equations, Charpit's and Jacobi's Methods of Solving First-Order Partial Differential Equations, First order PDE: Characteristics of a linear first order PDE. Cauchy's problem

Module 2: Second Order P.D.E. — **20 Hours**

Origin of Second Order P.D.E - Linear P.D.E , Solution of Reducible Equations, Solution of Irreducible Equations with Constant Coefficients, Rules for Finding C.F and P.I, Classification of Second Order P.D.E - Riemann's Method, Solution of equation by method of separation of variables

Module 3: Applications of Partial Differential Equations — **20 Hours**

Curvilinear Coordinates, Derivation of Heat equation, Wave equation and Laplace equation. Classification of second order linear equations as hyperbolic, parabolic or elliptic. Reduction of second order Linear Equations to canonical forms. Solving the Vibrating String Problem, Solving the Heat Conduction problem.

Total Lecture hours — **60 hours**

Text Book(s)

1. Snedden, I, Elements of partial differential equations, McGraw Hill, (2006)
2. Rao K.S., Introduction to partial differential equations, Prentice Hall, New Delhi, (1997)
3. Raisinghannia M. D., Advanced Differential Equations: S. Chand and Company Ltd.,(Ebook) (2020)

Reference Books

1. Evans L. C. Partial Differential Equations, American Mathematical Society, Vol. 19, (1998)
2. Zachmanoglou E. C. & Thoe D. W., Introduction to Partial Differential Equations with Applications, Dover Publications, Inc., New York (1975)

MMA23510P	LAB-Partial Differential Equation-I	L	T	P	C
		0	0	6	3

Pre-requisite: Fundamental knowledge of programming

Course Objectives:

- To impart the knowledge to the students with MATHEMATICA/MATLAB software.
- To enhance programming knowledge in Research and Development.

Course Outcome:

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

CO1: Demonstrate functions of two or more variables graphically and numerically.

CO 2: Compute multiple integrals using MATHEMATICA/MATLAB

CO 3: Compute analytical, numerical and graphical solutions of partial differential equations with initial or boundary conditions.

Module1:Function of several variables	**20Hours**

Real-Valued Functions of Two or More Variables, Plotting Functions of Two Variables, Partial derivatives, gradient/general derivatives, Jacobian, Hessian matrix.

Module2:Partial Differentiation	**30Hours**

Limits of Functions of Two Variables, Optimization, Double and Triple Integrals, Line and Surface Integrals.

Module3: Numerical Solution to Partial Differential Equations	**40Hours**

Solving Partial Differential Equations, Initial Value Problem for the Heat Equation, Initial Value Problem for the Wave Equation, Initial-Boundary Value Problem for a First-Order PDE.

Total Lecture+ Practical Hours	**90 Hours**

Text Book(s)

1. Feras Awad, A Glimpse To Mathematica, Wolfram Language, June 7, 2019
2. https://reference.wolfram.com/language/guide/PDEModelingAndAnalysis.html
3. https://reference.wolfram.com/language/tutorial/NDSolvePDE.html

MMA23511T	INTRODUCTION TO COMPUTER PROGRAMMING	L	T	P	C
		2	0	4	4

Pre-requisite: Basic knowledge of programming

Course Objectives:

- To familiarize students with the usage of Computer Algebra Systems, e.g., Mathematica/MATLAB/Maxima/Maple etc.
- The basic emphasis is on plotting andworking with matrices using CAS.

Course Outcome:

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

CO1: use CAS such as Mathematica/MATLAB/Maxima/Mapleetc. as calculator, plotting functions.

CO2: demonstrate skills to solve complex mathematical problems graphically, numerically and analytically using CAS.

CO 3: compare and draw conclusions from the solutions obtained by using CAS.

Module1: Linear Algebra	12Hours

Writing Matrices, Check dimensions of a given matrix, Matrix addition and multiplication, Transpose, Determinent, Inverse of a matrix, Minors and cofactors, Working with large matrices, Performing Gauss elimination, Solving system of linear equations,Eigenvalue and Eigenvectors of a matrix, Rank and nullity of a matrix.

Module2: Functions and Their Graphs	12Hours

Defining a Function, Plotting a Function, Factoring and Expanding Polynomials, Finding Rootsof Polynomials analytically and numerically, Solving Equations and Inequalities with Reduce, Solving Systems of Equations.

Module3: Multivariable Calculus	18Hours

Real-Valued Functions of Two or More Variables, Plotting Functions of Two Variables with Plot3D, Plotting Functions of Two Variables with ContourPlot, Vector Fields: Defining a Vector Field, Plotting a Two-Dimensional Vector Field.

Module4: Calculus	18Hours

The Derivative, Visualizing Derivatives, Higher Order Derivatives, Implicit Differentiation, Differential Equations, Integration, Definite and Improper Integrals, Numerical Integration, Surfaces of Revolution, Analytic Solutions of an ODE. Equations with Initial or Boundary Conditions. Numerical Solutions of ODEs, Laplace Transform

Total Lecture hours	**60hours**

Text Book(s)

1. Bruce F. Torrence, Eve A. Torrence,*The Student's Introduction to Mathematica ® A Handbook for Precalculus, Calculus, and Linear Algebra*, CUP
2. FerasAwad (2018) A Glimpse to Mathematica [Wolfram Language] (3 rded.). Instructor Lectures and Notes.

ReferenceBooks

1. Bindner, Donald & Erickson, Martin. (2011): *A Student's Guide to the Study, Practice, and Tools of Modern Mathematics*. CRC Press, Taylor & Francis Group, LLC.