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

SCHEME OF EXAMINATION

Subject Code	Title of the Papers	L/T	P	C	IA	EA	T
SEMESTER I							
10MATA13A	Algebra	4	-	4	25	75	100
10MATA13B	Real Analysis	4	-	4	25	75	100
10MATA13C	Ordinary Differential Equations	4	-	4	25	75	100
10MATA13D	Latex	4	-	4	25	75	100
10MATA1EA	Elective I: Numerical Methods	4	-	4	25	75	100
101GS - -	Supportive I	2	-	2	12	38	50
SEMESTER II							
10MATA23A	Complex Analysis	4	-	4	25	75	100
10MATA23B	Partial Differential Equations	4	-	4	25	75	100
10MATA23C	Mechanics	4	-	4	25	75	100
10MATA23D	Matlab	4	-	4	25	75	100
10MATA2EB	Elective II: Computer Programming I (Theory and Practical)	2	2	4	25	75	100
102GS - -	Supportive II	2	-	2	12	38	50
SEMESTER III							
10MATA33A	Topology & Functional Analysis	4	-	4	25	75	100
10MATA33B	Fluid Dynamics	4	-	4	25	75	100
10MATA33C	Mathematical Methods	4	-	4	25	75	100
10MATA33D	Mathematica	4	-	4	25	75	100
10MATA3EC	Elective III: Computer Programming II (Theory and Practical)	2	2	4	25	75	100
103GS - -	Supportive III	2	-	2	12	38	50
SEMESTER IV							
10MATA43A	Nonlinear Differential Equations	4	-	4	25	75	100
10MATA43B	Control Theory	4	-	4	25	75	100
10MATA43C	Distribution Theory	4	-	4	25	75	100
10MATA43D	Practicals (Latex and Matlab)	-	4	4	25	75	100
10MATA4LP	Project	-	-	8	-	-	200
	Total			90			2250

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

Supportive Courses for Other Department Students:

1. Applied Mathematics I (Odd Semester)

2. Applied Mathematics II (Even Semester)

CORE I: ALGEBRA

Unit-I:

Group theory: Direct products- Group action on a set: Isotropy subgroups- Orbits- Counting theorems- p-Groups- The Sylow theorems

Unit-II:

Applications of the Sylow theory: Applications to p-groups and the class equation- Further applications.

Ring theory: Ring of polynomials: Polynomials in an indeterminate - The evaluation homomorphism - Factorization of polynomials over a field

Unit-III:

Field theory: Extension fields-algebraic and transcendental elements-irreducible polynomial over F-simple extensions- algebraic extensions: Finite extensions- Structure of a finite fields

Unit - IV:

Automorphisms of fields- Conjugation isomorphisms- Automorphisms and fixed fields- The Frobenius automorphism- splitting fields.

Unit-V:

Separable extensions- Galois theory: Normal extensions- The main theorem-Illustrations of Galois theory: Symmetric functions

Text book:

"A *First Course in Abstract Algebra*" by **J.B.Fraleigh**, Fifth Edition, Addison-Wesly Longman, Inc, Reading Massachusetts, 1999.

Unit-I: Chapter 2: Section: 2.4 (Direct Product only),
Chapter 3 : Sections: 3.6, 3.7,
Chapter 4 : Section 4.2.
Unit-II: Chapter 4 : Section: 4.3,
Chapter 5 : Sections: 5.5, 5.6.
Unit-III: Chapter 8: Sections: 8.1, 8.3 (Finite Extensions Only), 8.5.
Unit-IV: Chapter 9: Sections: 9.1, 9.3.
Unit-V: Chapter 9: Sections: 9.4, 9.6, 9.7 (Symmetric Functions only).

References:

1. *"Topics in Algebra"* by **I.N.Herstein**, Blaisdell, New York, 1964.
2. *"Algebra"* by **M.Artin**, Prentice-Hall of India, New Delhi, 1991.

CORE II: REAL ANALYSIS

RIEMANN STILTJES INTEGRAL

Unit-I:
Definition and existence of the integral – Properties of the integral – Integration and differentiation – Integration of vector-valued function – Rectifiable curves

Unit-II:
Uniform convergence and continuity – Uniform convergence and integration - Uniform convergence and differentiation – Equicontinuous families of functions – The Stone-Weirstrass theorem

FUNCTIONS OF SEVERAL VARIABLES

Unit-III:
Linear transformation – The contraction principle – Inverse function theorem – Implicit function theorem – Determinants – Derivatives of higher order – Differentiation of integrals

LEBESGUE MEASURE

Unit-IV:
Outer measure – Measurable sets and Lebesgue measure – Nonmeasurable set-Measurable functions – Littlewood's theorem

Unit-V:
The Lebesgue integral of bounded functions over a set of finite measure – Integral of a non – negative function – The general Lebesgue integral – Convergence in measure

Text Books:

"*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. Roydon**, Third Edition, Macmillan, New York, 1988

Unit-IV: Chapter 3.
Unit-V: Chapter 4.

CORE III: ORDINARY DIFFERENTIAL EQUATIONS

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 – Method of successive approximations – The Lipschitz condition – convergence of the successive approximations and the existence theorem.

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.

CORE IV: LATEX

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

Unit II:
Commands and environments–Command names and arguments, Environments, Declarations, Lengths, Special Characters, Fragile Commands, Exercises.

Unit III:
Document layout and organization – Document class, Page style, Parts of the document, Table of contents, Fine – tuning text, Word division.
Displayed text - Changing font, Centering and indenting, Lists, Generalized lists, Theorem–like declarations, Tabulator stops, Boxes.

Unit IV:
Tables, Printing literal text, Footnotes and marginal notes. Drawing pictures with LATEX.

Unit V:
Mathematical formulas – Mathematical environments, Main elements of math mode, Mathematical symbols, Additional elements, Fine–tuning mathematics.

Text Book:

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

Unit I : Chapter 1: Sections: 1.1 - 1.3, 1.4.1, 1.5.
Unit II : Chapter 2: Sections: 2.1 - 2.7.
Unit III : Chapter 3: Sections: 3.1 - 3.6, 4.1 - 4.7
Unit IV : Chapter 4: Sections: 4.8 - 4.10, 6.1.
Unit V : Chapter 5: Sections: 5.1 - 5.5.

ELECTIVE I: NUMERICAL METHODS

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: SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS

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

Unit-IV:BOUNDARY VALUE PROBLEMS AND CHARACTERISTIC VALUE PROBLEMS

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

Unit-V: NUMERICAL SOLUTION OF PARTIAL DIFFERENTIAL EQUATIONS

(Solutions of elliptic, parabolic and hyperbolic partial differential equations) representation as a difference equation – Laplace's equation on a rectangular region – Iterative methods for laplace equation – The Poisson equation – Derivative boundary conditions – Solving the equation for time-dependent heat flow (i) The explicit method (ii) The Crank Nicolson method – Solving the wave equation by finite differences.

Text Book:

"*Applied Numerical Analysis"* by **C.F.Gerald and P.O.Wheatley**, Fifth Edition, Addison-Wesley, Reading, 1998.

Unit I : Chapter 1: Sections: 1.4, 1.8, 1.11,
Chapter 4: Sections: 4.2, 4.3, 4.6, 4.7.
Unit II : Chapter 2: Sections: 2.3 - 2.5, 2.7, 2.10 - 2.12.
Unit III : Chapter 5: Sections: 5.2 - 5.7.
Unit IV: Chapter 6: Sections: 6.1 - 6.3, 6.6, 6.7.
Unit V : Chapter 7: Sections: 7.3 - 7.7,
Chapter 8: Sections: 8.1 - 8.3,
Chapter 9: Section: 9.2.

CORE V: COMPLEX ANALYSIS

Unit–I:
Introduction to the concept of analytic function: Limits and continuity – Analytic functions – Polynomials – Rational functions – Conformality: Arcs and closed curves – Analytic functions in regions – Conformal mapping – Length and area – Linear transformations: The linear group – The cross ratio – Elementary Riemann surfaces.

Unit-II:
Complex integration: Line integrals rectifiable arcs – Line integrals as functions of arcs – Cauchy's theorem for a rectangle - Cauchy's theorem in a disk, Cauchy's integral formula: The index of a point with respect to a closed curve – The integral formula – Higher derivatives - Removable singularities, Taylor's theorem – Zeros and poles – The local mapping – The maximum principle – Chains and cycles.

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

Unit-IV:
Series and product developments: Weierstrass theorem – The Taylor series – The Laurent series – Partial fractions and factorization: partial fractions – Infinite products – Canonical products.

Unit-V:
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.

CORE VI: PARTIAL DIFFERENTIAL EQUATIONS

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 – Characteristics 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 of 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.

CORE VII: MECHANICS

Unit-I: INDRODUCTORY CONCEPTS
Mechanical system – Generalized coordinates – Constraints – Virtual work – Energy and momentum.

Unit-II: LAGRANGE'S EQUATIONS
Derivations of Lagrange's equations: Derivations of Lagrange's equations – Examples – Integrals of motion.

Unit-III: HAMILTON'S EQUATIONS
Hamilton's principle – Hamilton's equations.

Unit-IV: HAMILTON – JACOBI THEORY
Hamilton's principal function – 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.

CORE VIII: MATLAB

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.

Reference Books:

1. *Getting Started with MATLAB – A Quick Introduction for Scientists and 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.

ELECTIVE II - COMPUTER PROGRAMMING AND LAB I
THEORY (50 Marks)

Unit-I:
Overview of C - Constants, Variables and data types: Character set – C tokens – Keywords & identifiers – Constants – Variables – Data types – Declaration of variables – Assigning values to variables – Defining symbolic constants.

Unit-II:
Arithmetic of operators – Relational operators – Logical operators – Assignment operator – Increment and decrement operators – conditional operator – Bitwise operators – special operators – Arithmetic expressions – Evaluation of expressions – Precedence of arithmetic operators – Type conversions in expressions – Operator precedence and associativity – Mathematical functions.

Unit-III:
Managing input and output operators: Reading a character – writing a character – formatted input - formatted output – Decision making with IF statement – IF ... ELSE – statement – Nesting of IF ... ELSE statements – The switch statement – The GOTO statement.

Unit-IV:
The WHILE statement - DO statement – FOR statement –Jumps in loops – One-dimensional arrays – Two dimensional arrays – Initializing two dimensional arrays - Multidimensional arrays.

Unit-V:
Need for user defined functions – A multi-function program – the form of C functions – Return values and their types - calling a function – Category of functions – Arguments but no return values - Arguments with return values - File management in C: Defining and opening a file – Closing a file- Input / output operations on files.

Text Book:
"Programming in ANSI C" by **E. Balagurusamy**, Second Edition, Tata McGraw-Hill, New Delhi, 1992.

Unit-I: Chapter 1, Chapter 2.
Unit-II: Chapter 3 (Except section 3.13).
Unit-III: Chapter 4, Chapter 5 (Except section 5.8).
Unit-IV: Chapter 6, Chapter 7.
Unit-V: Chapter 9: Sections: 9.1 – 9.7, 9.9, 9.10,
Chapter 12: Sections: 12.1 – 12.4.

COMPUTER PROGRAMMING AND LAB I
PRACTICALS (50 Marks)

SAMPLE LIST OF PRACTICALS

(Big Questions – marked with * marks & small questions without * marks)

Program for reversing an integer.

Program for generating Fibonocci numbers.

* Solving a quadratic equation for all types of roots.

Obtaining the root of an equation by bisection method.

Obtaining the root of an equation by False – position method.

* Obtaining the root of a transcendental equation by Newton – Raphson method.

Obtaining the Transpose of a matrix.

Finding the determinant of a matrix

Program for multiplication of two matrices of type m x n and n x p.

*Determining the Eigenvalues & Eigenvectors of a symmetric matrix.

Programming for polynomial interpolation.

*Single Integration by Trapezoidal rule.

*Single Integration by Simpson's 1/3 rule.

*Solving ODE using second order Runge-Kutta Method.

*Solving ODE using fourth order Runge-Kutta Method.

*Solving set of simultaneous linear equations by Jacobi Iteration Method.

*Solving set of simultaneous linear equations by Gauss Elimination Method.

One question may be asked from the above list which are marked
with asterisk (*) Marks. (OR)
Two questions can be asked from the above list of questions
without asterisk (*) Marks.

References:

1. "*Computer Programming in C "* by **V.Rajaraman**, Prentice Hall of India Pvt. Limited, New Delhi, 2004.
2. "*Programming in ANSI C "* by **E. Balagurusamy,** Second Edition, Tata McGraw-Hill Publishing Co., Ltd., New Delhi , 1992.
3. "*Applied Numerical Analysis"* by **C.F. Gerald and P.O. Wheatley**, Fifth Edition, Addison-Wesley Publishing Co., Reading, 1994.

CORE IX: TOPOLOGY AND FUNCTIONAL ANALYSIS

TOPOLOGY

Unit-I:
Spaces and maps.

Unit-II:
Separability axioms and compactness.

Unit-III:
Connectedness – Pathwise connectedness – Imbedding and Extension theorems.

FUNCTIONAL ANALYSIS

Unit-IV:
Banach spaces: Definition and examples – Continuous linear transformations – Hahn Banach theorem – Natural imbedding – Open mapping theorem – Conjugate of an operator.

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

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

"*Introduction to Topology and Modern Analysis"* by **G.F.Simmons**, McGraw-Hill, New York, 1963.
Unit-IV: Chapter 9
Unit-V: Chapter 10: Sections: 52 - 55.

CORE X: FLUID DYNAMICS

Unit – I: INVISCID THEORY

Introductory Notions; velocity, streamlines and paths of 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, equation of motion of an inviscid fluid.

Unit – II:

Euler's momentum theorem, conservative forces, Lagrangian form of the equation of motion, steady motion; energy equation; rate of change of circulation; vortex motion, permanence of vorticity.

Unit - III: TWO DIMENTIONSAL 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; aerofoil - Blasius's theorem, lift force.

Unit - IV: VISCOUS THEORY

Equations of motion – Stress tensor, 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 - 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 I :Sections: 1.0-1.4
Chapter III: Sections: 3.10-3.31, 3.40, 3.41.
Unit II : Chapter III :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.

CORE XI: MATHEMATICAL METHODS

Unit-I: FOURIER TRANSFORMS

Fourier Transforms – Defn. inversion theorem – Fourier cosine transforms - Fourier sine transforms – Fourier transforms of derivatives - Fourier transforms of some simple functions - Fourier transforms of rational functions – The convolution integral – convolution theorem – Parseval's relation for cosine and sine transforms – solution of PDE by Fourier transform. Laplace's equation in half plane - Laplace's equation in an infinite strip - The linear diffusion equation on a semi-infinite line - The two-dimensional diffusion equation.

Unit-II: HANKEL TRANSFORMS

Definition – Elementary properties of Hankel Transforms - Hankel Transforms of derivatives of functions - Hankel Transforms of some elementary functions - The Parseval relation for Hankel Transforms – Relation between Fourier and Hankel Transforms – Application to PDE. axisymmetric Dirichlet problem for a half– space. axisymmetric Dirichlet problem for a thick plate.

Unit-III: 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-IV: APPLICATIONS OF INTEGRAL EQUATIONS

Application to ordinary differential equation – Initial value problems, boundary value problems – Singular integral equations – Abel integral equation.

Unit-V: CALCULUS OF VARIATIONS

Introduction - Variation of a functional, A necessary condition for an extremum. The simplest variation problem - Euler's equation, The case of several variables, A simple variable end point problem, The fixed end point problem for n unknown functions, variational problems in parametric form, functionals depending on higher order derivatives.

Text Books:

"The Use of Integral Transforms" by **I.N.Sneddon**, McGraw-Hill Book Company, New York, 1972.

Unit - I: Chapter 2: Sections: 2.3 - 2.10, 2.16.1 - 1 (a), 1(b), 2.16.2 – 2(a), 2(b).
Unit- II: Chapter 5: Sections: 5.1, 5.2, 5.4 – 5.7, 5.10.1, 5.10.2.

" Linear Integral Equations Theory and Technique" by **R.P.Kanwal**, Second Edition, Birkhauser, Boston, 1997.

Unit - III: Chapter 1 - Chapter 4.
Unit- IV: Chapter 5: Sections: 5.1, 5.2,
Chapter 8: Sections: 8.1, 8.2.

"*Calculus of Variations"* by **I. M. Gelfand and S. V. Fomin**, Dover, New York, 2000.

Unit- V: Chapter 1: Sections: 3 - 6,
Chapter 2: Sections: 9 -11.

CORE XII: MATHEMATICA

Unit – I: INTRODUCTION TO *MATHEMATICA*

Running *Mathematica* - Numerical calculations – Building up calculations – Using the Mathematica system – Algebraic calculations - Symbolic mathematics - Numerical mathematics.

Unit – II:

Functions and programs – Lists – Graphics – Input and output in notebooks – The structure of graphics.

Unit – III: ADVANCED MATHEMATICS IN *MATHEMATICA*

Numbers - Mathematical functions – Algebraic manipulation – Manipulating equations - Calculus.

Unit – IV:

Series, limits and residues - Linear algebra.

Unit – V:

Numerical operations on data – Numerical operations on functions.

Text Book:

"The Mathematica Book" by **S. Wolfram**, Fourth Edition, Cambridge University Press, Cambridge, 1999.

Unit-I: Chapter 1: Sections: 1.0 - 1.6.
Unit-II: Chapter 1: Sections: 1.7 - 1.10.
Chapter 2: Section: 2.9.
Unit-III: Chapter 3: Sections: 3.1 - 3.5.
Unit-IV: Chapter 3: Sections: 3.6 - 3.7.
Unit-V: Chapter 3: Sections: 3.8 - 3.9.

ELECTIVE III - COMPUTER PROGRAMMING AND LAB II
THEORY (50 Marks)

Unit I:

Principles of object-oriented programming: Software crisis – Software evolution – A look at procedure-oriented programming – Object-oriented programming paradigm – Basic concepts of Object-Oriented Programming – Benefits of OOP – Object-Oriented languages – Applications of OOP.

Unit II:

Tokens, Expressions and Control structures: Introduction – Tokens – Keywords – Identifiers and constants – Basic data types – User defined data types - Derived data types – Symbolic constants – Type compactability – Declaration of variables – Dynamic insulation of variables – Reference variables – Operators in C++ - Scope resolution operator – Member dereferencing operators – Memory management operators – Manipulators – Type cast operator – Expressions and their types – Special assignment expressions – Implicit conversions – Operator over loading – Operator precedence – Control structures.

Unit III:

Functions in C++: Introduction – The main function – Function prototyping – Call by reference – Return by reference-Inline functions – Default arguments – Constant arguments – Function over loading – Friend and virtual functions – Math library functions managing console I/O operations: Introduction – C++ streams – C++ stream classes – Unformatted I/O operations - Formatted I/O operations – Managing output with manipulators.

Unit IV:

Classes and Objects: Introduction – C Structures revisited – Specifying a class – Defining member functions – A C++ program with class – Making an outside function inline – Nesting of member functions – Private member functions – Arrays within a class – Memory allocation for objects – Static data members – Static member functions – Arrays of objects – Objects as function arguments – Friendly functions – Returning objects – Constant member functions.
Constructors and Destructors: Introduction – Constructors – Parameterized constructors – Multiple constructors in a class – Constructors with default Arguments – Dynamic initializations of objects – Copy constructor – Constructing two dimensional arrays – Constant objects – Destructors.

Unit V:

Operators overloading and Type conversions: Introduction – Defining operator overloading – Overloading unary operators – Overloading binary operators – Overloading binary operators Using friends – Manipulation of strings using operators – Rules of overloading operators.
Inheritance: Extending classes: Introduction – Defining derived classes – Single inheritance – Making a private member inheritable – Multilevel inheritance – Multiple inheritance – Hierarchical inheritance – Hybrid inheritance – Virtual base classes – Abstract classes – Constructors in derived classes – Member classes: Nesting of classes.

Text Book:

"Object – Oriented Programming with C++" by **E. Balaguruswamy**, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2006.

Unit I : Chapter 1: Sections: 1.1 - 1.8.
Unit II : Chapter 3: Section: 3.1 - 3.24.
Unit III: Chapter 4: Section: 4.1 - 4.11,
Chapter 10: Sections: 10.1 - 10.6.
Unit IV: Chapter 5: Sections: 5.1 - 5.17,
Chapter 6: Sections 6.1 - 6.7, 6.9 - 6.11.
Unit V : Chapter 7: Sections: 7.1 - 7.7,
Chapter 8: Sections: 8.1 - 8.12.

COMPUTER PROGRAMMING AND LAB II
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 co-ordinates.

You need to use following trigonometric formulas.

$X = r * \cos(a);$ $Y = r * \sin(a);$ $a = \tan^{-1}(Y/X)$; $r = \sqrt{(X^2 + Y^2)};$

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.

CORE XIII - NONLINEAR DIFFERENTIAL EQUATIONS

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: Time varying systems – Constant coefficient system – Periodic coefficients – Floquet theory – Wronskian.

Unit-V:
Stability: Poincare stability – Solutions, paths and norms – Liapunov stability. Stability of linear systems – 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:

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.

CORE XIV: CONTROL THEORY

Unit-I: OBSERVABILITY
Linear Systems – Observability Grammian – Constant coefficient systems – Reconstruction kernel – Nonlinear Systems.

Unit-II: CONTROLLABILITY
Linear systems – Controllability Grammian – Adjoint systems – Constant coefficient systems – Steering function – Nonlinear systems.

Unit-III: STABILITY
Stability – Uniform stability – Asymptotic stability of linear systems - 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:

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.

CORE XV: DISTRIBUTION THEORY

Unit - I: TEST FUNCTIONS AND DISTRIBUTIONS
Test Functions - Distributions - Localization and Regularization - Convergence of Distributions - Tempered Distributions.

Unit - II: DERIVATIVES AND INTEGRALS
Basic Definitions - Examples - Primitives and Ordinary Differential Equations.

Unit - III: CONVOLUTIONS AND FUNDAMENTAL SOLUTIONS
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.

Reference 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.

CORE XVI: PRACTICALS (Latex and Matlab)

Creating documents using Latex and solving mathematical problems using Matlab.

SUPPORTIVE I: APPLIED MATHEMATICS – I

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: FUNCTIONS OF SEVERAL 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: FOURIER SERIES
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, T**hirty Eighth Edition, Khanna Publishers, New Delhi, 2004.

SUPPORTIVE II: APPLIED MATHEMATICS – II

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, Z-Transforms.

Unit - IV: COMPLEX INTEGRATION
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 INTEGRATION METHOD
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.