BHARATHIAR UNIVERSITY, COIMBATORE.
M.Sc. BRANCH I (a) - MATHEMATICS
(The Curriculum is offered by the University Department under CBCS from 2014-15 onwards)

SCHEME OF EXAMINATION

SEMESTER I

Subject Code	Title of the Papers	L/T	P	C	IA	EA	T
14MATA13A	Algebra	4	-	4	25	75	100
14MATA13B	Real Analysis	4	-	4	25	75	100
14MATA13C	Ordinary Differential Equations	4	-	4	25	75	100
14MATA13D	Latex and Mathematica	4	-	4	25	75	100
14MATA1EA	Elective I: Numerical Methods	4	-	4	25	75	100
141GS--	Supportive I	2	-	2	12	38	50

SEMESTER II

Subject Code	Title of the Papers	L/T	P	C	IA	EA	T
14MATA23A	Complex Analysis	4	-	4	25	75	100
14MATA23B	Partial Differential Equations	4	-	4	25	75	100
14MATA23C	Mechanics	4	-	4	25	75	100
14MATA23D	Matlab	4	-	4	25	75	100
14MATA2EB	Elective II: Computer Programming I (Theory and Practical)	2	2	4	25	75	100
142GS--	Supportive II	2	-	2	12	38	50

SEMESTER III

Subject Code	Title of the Papers	L/T	P	C	IA	EA	T
14MATA33A	Topology	4	-	4	25	75	100
14MATA33B	Fluid Dynamics	4	-	4	25	75	100
14MATA33C	Mathematical Methods	4	-	4	25	75	100
14MATA33D	Functional Analysis	4	-	4	25	75	100
14MATA3EC	Elective III: Computer Programming II (Theory and Practical)	2	2	4	25	75	100
143GS--	Supportive III	2	-	2	12	38	50

SEMESTER IV

Subject Code	Title of the Papers	L/T	P	C	IA	EA	T
14MATA43A	Nonlinear Differential Equations	4	-	4	25	75	100
14MATA43B	Control Theory	4	-	4	25	75	100
14MATA43C	Distribution Theory	4	-	4	25	75	100
14MATA43D	Practicals (Latex and Matlab)	-	4	4	25	75	100
14MATA4LP	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**

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- Application of G-Sets to Counting: 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: Rings 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 STIELTJES INTEGRAL

Unit-I:

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: FUNCTIONS OF 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: LEBESGUE MEASURE

Outer measure – Measurable sets and Lebesgue measure – Nonmeasurable set-Measurable functions – Littlewood's three principles.

Unit-V: THE LEBESGUE 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 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. Royden**, 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 – 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.

CORE IV: LATEX AND MATHEMATICA

Unit – I:
Special Characters, Document layout and organization – Document class, Page style, Parts of the document, Centering and indenting, Lists, Theorem–like declarations, Boxes, Tables.

Unit – II:
Footnotes and marginal notes, Mathematical formulas – Mathematical environments, Main elements of math mode, Mathematical symbols, Additional elements, Fine–tuning mathematics, Drawing pictures with LATEX.

Unit – III: INTRODUCTION TO MATHEMATICA
Running Mathematica - Numerical calculations – Building up calculations – Using the Mathematica system – Algebraic calculations - Symbolic mathematics - Numerical mathematics.

Unit – IV: ADVANCED MATHEMATICS IN MATHEMATICA
Numbers - Mathematical functions – Algebraic manipulation – Manipulating equations - Calculus.

Unit – V:
Series, limits and residues - Linear algebra.

Text Book:
"A Guide to LATEX"by **H. Kopka** and **P.W. Daly**, Third Edition, Addison – Wesley, London, 1999.
Unit I : Chapter 2: Section: 2.5,
Chapter 3: Sections: 3.1 - 3.3,
Chapter 4: Sections: 4.2, 4.3, 4.5, 4.7, 4.8.
Unit II : Chapter 4: Sections: 4.10,
Chapter 5: Sections: 5.1 - 5.5,
Chapter 6: Section: 6.1.
"The Mathematica Book" by **S. Wolfram,** Fourth Edition, Cambridge University Press, Cambridge, 1999.
Unit-III: Chapter 1: Sections: 1.0 - 1.6.
Unit-IV: Chapter 3: Sections: 3.1 - 3.5.
Unit-V : Chapter 3: Sections: 3.6 - 3.7.

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**, 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.

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 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.

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 –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 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
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.

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

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. Prata p**, 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 I

THEORY (50 Marks)

Unit-I:
Introduction to C: The C character set – Writing First Program of C-Identifiers and keywords –A more useful C program –Entering the program into the computer –Compiling and executing the program -Datatypes – Constants – Variables and arrays – Declarations – Expressions – Statements – Symbolic constants. Operators and Expressions: Arithmetic operators –Unary operators –Relational and logical operators –Assignment operators –The conditional operators –Library functions.
Data Input and Output: The getchar, putchar, scanf, printf, puts and gets functions-Interactive(conversational) programming.

Unit-II:
Control Statements: The while, dowhile, for, ifelse, switch, break and continue statements – Nested control structures –The comma operator – The goto statement. Functions: Defining a function –Accessing a function –Function prototypes –Passing arguments to a function – Recursion.

Unit-III:
Program Structure: Storage classes –Automatic variables – External (global) variables –Static variables –Multifile programs –More about library functions. Arrays: Defining an array – Processing an array –Passing arrays to function –Multidimensional arrays –Arrays and strings.

Unit-IV:
Pointers: Fundamentals –Pointer declarations –Passing pointers to a function –Pointers and one dimensional arrays –Dynamic memory allocation –Operations on pointers –Pointers and multidimensional arrays –Arrays of pointers –Passing functions to other functions –More about pointer declarations.

Unit-V:
Structures and Unions: Defining a structure –Processing a structure –User-defined datatypes(typedef) –Structures and pointers –Passing structures to functions –Self-referential structures. Data Files: Opening and closing a data file –Reading and writing a data file.

Text Book:
" Programming with C" by **B. S. Gottfried & J. K.Chhabra**, Second Edition, Tata McGraw-Hill, New Delhi, 2006.
Unit-I : Chapters 2 – 4.
Unit-II : Chapters 6, 7.
Unit-III: Chapters 8, 9
Unit-IV: Chapter 10
Unit-V : Chapter 11: Sections: 11.1 – 11.6;
Chapter 12: Sections: 12.2, 12.3.

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

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

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 Books:
"*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:
1. "Topology" by **J. Dugunj**i, 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 **.**

CORE X: FLUID DYNAMICS

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: 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. 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 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: 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: APPLICATIONS OF INTEGRAL EQUATIONS

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

CALCULUS OF VARIATIONS

Unit-III: THE METHOD OF VARIATIONS IN PROBLEMS WITH FIXED BOUNDARIES

Variation and its properties - Euler's equation - Functionals of the form $\int F(x,y_1,y_2,\ldots y_n,y_1',y_2',\ldots y_n')dx$, 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 CONDITIONS FOR AN EXTREMUM

Field of extremals - The function E(x,y,p,y') - Transforming the Euler equations to the canonical form.

Unit-V: DIRECT METHODS IN 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:

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

CORE XII:FUNCTIONAL ANALYSIS

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. ALGEBRAS OF OPERATORS

Unit-V
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:
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.

ELECTIVE III - COMPUTER PROGRAMMING II

THEORY (50 Marks)

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.

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.

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: 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:
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 – Nonhomogeneous 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: 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.