**ALGEBRA – P13MS1**

**Semester : I** ` **Core Course: I**
**Instruction Hours/Week: 6** **Credit: 5**

**UNIT I**

A Counting Principle – Permutation Groups – Another Counting Principle – Sylow's theorem - Direct Products.

**UNIT II**

More Ideals and Quotient Rings – Polynomial Rings – Polynomials over the Field – Polynomials over commutative Rings.

**UNIT III**

Dual Spaces - Inner Product Spaces – Modules.

**UNIT IV**

Extension fields – Roots of Polynomials – More about Roots – The Elements of Galois Theory – Finite Fields.

**UNIT V**

The Algebra of Linear Transformations – Characteristic Roots – Matrices – Canonical Forms: Triangular Form - Hermitian, Unitary and Normal Transformations.

**TEXT BOOK**

**I.N. Herstein, Topics in Algebra, Second Edition, Wiley Eastern Limited.**

**UNIT I** **:** Chapter 2 – Sections 2.5, 2.10, 2.11, 2.12, 2.13
**UNIT II** **:** Chapter 3 – Sections 3.5, 3.9, 3.10, 3.11
**UNIT III** **:** Chapter 4 – Sections 4.3, 4.4, 4.5
**UNIT IV** **:** Chapter 5 - Sections 5.1, 5.3, 5.5, 5.6 and
Chapter 7 – Section 7.1
**UNIT V** **:** Chapter 6 – Sections 6.1, 6.2, 6.3, 6.4, 6.10

**REFERENCE BOOK(S)**

[1] P.B. Bhattacharya. S.K. Jain and S.R. Nagpul, Second Edition, 2005, Cambridge University Press.
[2] Vijay, K. Khanna, and S.K. Bhambri, A Course in Abstract Algebra, Vikas Publishing House Pvt Limited, 1993.
[3] John, B. Fraleigh, A First Course in Abstract Algebra, Addison-Wesley Publishing company.

**REAL ANALYSIS – P13MS2**

**Semester : I** **Core Course: II**
**Instruction Hours/Week: 6** **Credit: 5**

**UNIT I**

Basic Topology - Metric spaces – Compact sets – Perfect sets – Connected sets – Continuous functions – continuity and Compactness – Continuity and connectedness.

**UNIT II**

Riemann – Stieltjes Integral: Definition and Existence – Properties of integrals – Integration and Differentiation – Rectifiable curves.

**UNIT III**

Sequences and series of functions: Uniform Convergence and Continuity – Uniform Convergence and integration – Stone – Weierstrass Theorem.

**UNIT IV**

Multivariable Differential Calculus – Directional Derivative – total derivative – the Jacobian Matrix – chain rule – mean value theorem – sufficient condition for differentiability – equality of mixed partial derivatives – Taylor's theorem.

**UNIT V**

Functions with non zero Jacobian determinant – inverse function theorem – implicit function theorem.

**TEXT BOOK**

**[1] Walter Rudin, Principles of Mathematical Analysis Third Edition, Mcgraw Hill, 1976. (Units I, II & III)**

**[2] Tom P.Apostol, Mathematical Analysis, Second Edition, Addison-Wesley Publishing Company, 1974. (Units IV & V)**

**UNIT I** **:** Chapter 2 – Sections 2.15 – 2.47 of [1]
Chapter 4 – Sections 4.5 – 4.24 of [ 1 ]
**UNIT II** **:** Chapter 6 – Sections 6.1 – 6.22, 6.26, 6.27 of [ 1 ]
**UNIT III** **:** Chapter 7 of [ 1 ]
**UNIT IV** **:** Chapter 12 of [ 2 ]
**UNIT V** **:** Chapter 13 – Sections 13.1 – 13.4 of [ 2 ]

**REFERENCE BOOKS(S)**

[1] Simmons G.F, Topology and Modern Analysis, McGraw Hill Co. 1998.
[2] Apostol, Analysis Vol. II, Mac Millan 1976.
[3] A.T. White, Real Analysis : An Introduction, Addison Wesley Publishing Co., Inc.1968.

**C++ PROGRAMMING THEORY - P13MS3**

**Semester : I** **Core Course: III**

**Instruction Hours/Week: 6** **Credit: 5**

**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 structure: Introduction – Tokens – Keywords – Identifiers – basic data types – User defined data types - Derived data types – Symbolic constants – type compatiblity – Declaration of variables – Dynamic initialization of variables – Reference variables – operations in C++ - Scope resolution operator – member Dereferencing operators – memory management operators – Manipulators – type cast operator – expressions and implicit conversions – Operator overloading – 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 – const arguments – function overloading – friend and virtual functions – Managing Console I/O operations: Introduction – C++ streams – C++ stream classes – Unformatted I/O operations - Formatted console 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 – Const 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 – Destructors.

**UNIT V**

Operator 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 – Hierarchial 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, 1999.**

**UNIT I** **:** Chapter 1 1.1 – 1.8
**UNIT II** **:** Chapter 3 3.1 – 3.24
**UNIT III** **:** Chapter 4 4.1 – 4.11 and 10.1 – 10.6
**UNIT IV** **:** Chapter 5 5.1 – 5.17, 6.1 – 6.7 and 6.9 – 6.10
**UNIT V** **:** Chapter 7 7.1 – 7.7 and 8.1 – 8.12

**C++ PROGRAMMING LAB – P13MS4**

**Semester : I** **Core Course: IV**
**Instruction Hours/Week: 6** **Credit: 5**

**1. DISTANCE CONVERSION PROBLEM:**
Create two classes DM and DB which store 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 of 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 or feet and 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. POLAR CONVERSION:**
Define two classes polar and rectangular to represent points in the polar and rectangle systems. Use conversion routines to convert from one system to another.

**4. OVERLOADING CONVERSIONS:**
Add two points in polar coordinates using overloading + .

**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.

**COMPLEX ANALYSIS – P13MS6**

**Semester : II** **Core Course: V**
**Instruction Hours/Week: 6** **Credit: 5**

**UNIT – I**

Fundamental theorems and Cauchy's Integral formula: Line Integrals- Rectifiable Arcs – Line Integrals as Functions of Arcs-Cauchy's Theorem for a Rectangle-Cauchy's Theorem in a Disk. The Index of a point with Respect to a closed curve-The Integral Formula – Higher Derivatives.

**UNIT – II**

Local properties of Analytical Functions : Removable Singularities – Taylor's Theorem - Zeros and Poles - The Local Mapping - The Maximum Principle.

**UNIT – III**

The General Form of Cauchy's Theorem & The Calculus of residues: Chains and Cycles Simple Connectivity-Homology The General Statement of Cauchy's Theorem - Proof of Cauchy's Theorem-Locally Exact Differentials –Multiply Connected Regions.The Residue Theorem- The Argument Principle-Evaluation of Definite Integrals.

**UNIT – IV**

Harmonic Functions and Power series expansions: Definition and Basic Properties-The Mean value Property-Poisson's Formula-Schwarz's Theorem-The Reflection Principle. Weierstrass's Theorem-The Taylor Series-The Laurent Series.

**UNIT – V**

Partial fractions and factorization & Entire fractions: Partial fractions – Infinite products - Canonical products – The Gamma function. Jensen's formula - Hadamard's theorem.

**Text Book(s)**

**Complex Analysis: Lars.V.Ahlfors, McGraw Hill Company-1979**

**Unit I** **:** Chapter 4: 1.1-1.5, 2.1 – 2.3
**Unit II** **:** Chapter 4: 3.1,3.2,3.3,3.4
**Unit III** **:** Chapter 4: 4.1-4.7,5.1-5.3
**Unit IV** **:** Chapter 4: 6.1-6.5 and Chapter 5: 1.1-1.3
**Unit V** **:** Chapter 5: 2.1 to 2.4 :3.1, 3.2

**Reference Book(s)**

[1] Serge Lang, Complex Analysis,Addisn Wesley, 1977
[2] S.Ponnisamy, Foundations of Complecx Analysis, Narosa Publishing House, New Delhi 1997.
[3] V.Karunakaran, Complex Analysis

**CORE COURSE VI – MEASURE AND INTEGRATION– P13MS7**

**Semester : II** **Core Course: VI**

**Instruction Hours/Week: 6** **Credit: 5**

**UNIT – I**

Measure on Real line: Lebesgue outer measure – Measurable sets – Regularity- Measurable functions – Borel and Lebesgue measurability.

**UNIT – II**

Integration of Functions of Real variable: Integration of non-negative functions – The General Integral – Integration of series – Riemann and Lebesgue integrals.

**UNIT – III**

Abstract Measure spaces: Measures and outer measures – completion of a measure – Extension of a measure – uniqueness of the extension - Measure spaces – Integration with respect to a measure.

**UNIT – IV**

Convergence in Measure – Almost uniform convergence - Signed Measures and Hahn Decomposit ion – The Jordan Decomposition.

**UNIT – V**

Measurability in a product space – The product Measure and Fubini's Theorem.

**Text Book(s)**

**G.De Barra , Measure Theory and Integration, New age international (P) Limited.**

**Unit I** **:** Chapter II: Sections 2.1 to 2.5
**Unit II** **:** Chapter III: Sections 3.1 to 3.4
**Unit III** **:** Chapter V: Sections 5.1 to 5.6
**Unit IV** **:** Chapter VII: Sections 7.1 and 7.2,
Chapter VIII: Sections 8.1 and 8.2
**Unit V** **:** Chapter X: Sections 10.1 and 10.2

**Reference(s)**

[1] Measure and Integration, by M.E.Munroe, Addison – Wesley publishing company, Second Edition, 1971.
[2] P.K.Jain, V.P.Gupta, Lebesgue Measure and integration, New Age International Pvt Limited Publishers, New Delhi,1986. (Reprint 2000)
[3] Richard L.Wheeden and Antoni Zygmund, Measure and Integral: An Introduction to Real Analysis, Marcel Dekker Inc.1977.
[4] Inder, K.Rana, An Introduction to Measure and Integration, Narosa Publishing House, New Delhi, 1997.

**ORDINARY DIFFERENTIAL EQUATIONS– P13MS8**

**Semester : II** **Core Course: VII**
**Instruction Hours/Week: 6** **Credit: 5**

**UNIT – I**

The general solution of the homogeneous equation – The use of one known solution to find another – The method of variation of parameters power Series solutions. A review of Power series – Series solutions of first order equations Second order linear equations: Ordinary points.

**UNIT – II**

Regular Singular points- Gauss's hypergeometric equation – The point at infinity- Legendre Polynomials – Bessel functions – Properties of Legendre Polynomials and Bessel functions.

**UNIT – III**

Linear Systems of First Order Equations – Homogeneous Equations with Constant Coefficients – The Existence and Uniqueness of Solutions of Initial value problem for First Order Ordinary Differential Equations – The Method of Solutions of Successive Approximations and Picard's Theorem.

**UNIT – IV**

Oscillation Theory and Boundary value problems – Qualitative Properties of Solutions – Sturm comparison Theorems – Eigen values, Eigen functions and the vibrating string.

**UNIT – V**

Nonlinear equations: Autonomous Systems: the phase plane and its phenomena Types of critical points: Stability – critical points and stability for linear systems Stability by Liapunov's direct method – Simple critical points of nonlinear systems.

**Text Book (s)**

**G.F.Simmons, Differential Equations with Applications and Historical Notes, TMH , New Delhi, 1994.**

**Unit I** **:** Chapter 3: Sections 15, 16,19 and Chapter 5: Sections 25 to 27.
**Unit II** **:** Chapter 5: Sections 28 to 31 and Chapter 6: Sections 32 to 35
**Unit III** **:** Chapter 7: Sections 37,38 and Chapter 11: Sections 55,56
**Unit IV** **:** Chapter 4: Sections 22 to 24
**Unit V** **:**Chapter 8: Sections 42 to 44.

**References**

[1] W.T.Rcid, Ordinary Differential Equations, John Wilcy & Sons, New York, 1971.
[2] E.A.Coddington and N.Levinson, Theory of Ordinary Differential Equations, McGraw Hill Publishing Company, New York, 1955.

**CORE COURSE VIII - CLASSICAL DYNAMICS– P13MS9**

**Semester : II** **Core Course: VIII**

**Instruction Hours/Week: 6** **Credit: 5**

**UNIT – I**

Introductory concepts: The mechanical system – Generalized Coordinates –constraints – virtual work – Energy and momentum.

**UNIT – II**

Lagrange's equation: Derivation of Lagrange's equation and examples – Integrals of the Motion – Small oscillations.

**UNIT – III**

Special Applications of Lagrange's Equations: Rayleigh's dissipation function – impulsive motion – Gyroscopic systems – velocity dependent potentials.

**UNIT – IV**

Hamilton's equations: Hamilton's Principal – Hamilton's equations – Other variational principles – phase space.

**UNIT – V**

Hamilton – Jacobi Theory: Hamilton's Principal Function – The Hamilton – Jacobi equation – Separability.

**Text Book (s)**

**Classical Dynamics, Donald T.Greenwood, PH1 Pvt. Ltd., New Delhi-1985.**

**Unit I** **:** Chapter 1: Sections 1.1 to 1.5
**Unit II** **:** Chapter 2: Sections 2.1 to 2.4
**Unit III** **:** Chapter 3: Sections 3.1 to 3.4
**Unit IV** **:** Chapter 4: Sections 4.1 to 4.4
**Unit V** **:** Chapter 5: Sections 5.1 to 5.3

**Reference (s)**

[1] Herbert Goldstein, classical Mechanics, (2nd edition), Narosa Publishing House, New Delhi.
[2] Narayan Chandra Rana & Prmod Sharad Chandra Joag, Classical Mechanics, Tata McGraw Hill, 1991.

**CORE COURSE IX – TOPOLOGY – P13MS11**

**Semester : III** **Core Course: IX**
**Instruction Hours/Week: 6** **Credit: 5**

**UNIT – I**

**TOPOLOGICAL SPACES:** Basis for a topology – The order topology – The product topology on X x Y – The subspace topology – closed sets and limit points.

**UNIT – II**

**CONTINUOUS FUNCTIONS**: Continuous functions – the product topology – The metric topology.

**UNIT – III**

**CONNECTEDNESS**: Connected spaces – connected subspaces of the real line – Components and local connectedness.

**UNIT – IV**

**COMPACTNESS**: Compact spaces – compact subspaces of the Real line – Limit point compactness – Local compactness.

**UNIT – V**

**COUNTABILITY AND SEPARATION AXIOMS**: The countability Axioms – The separation Axioms – Normal spaces – The Urysohn Lemma – The Urysohn metrization Theorem – The Tietz extension.

**Text Book(S)**

**James R. Munkres, Topology (2nd Edition) Pearson Education Pvt. Ltd., New Delhi-2002.(Third Indian Reprint)**

**Unit I** **:** Chapter 2: Sections 12 to 17.
**Unit II** **:** Chapter 2: Sections 18 to 21 (Omit Section 22).
**Unit III** **:** Chapter 3: Sections 23 to 23.
**Unit IV** **:** Chapter 3: Sections 26 to 29.
**Unit V** **:** Chapter 4: Sections 30 to 35.

**REFERENCE(S)**

[1] J. Dugundji, Topology, Prentice Hall of India, New Delhi, 1975.
[2] George F.Simmons, Introduction to Topology and Modern Analysis, McGraw Hill Book Co., 1963.
[3] J.L.Kelly, General Topology, Van Nostrand, Reinhold Co., New York.
[4] L.Steen and J.Seeback, Counter examples in Topology, Holt, Rinehart and Winston, New York, 1970.

**PARTIAL DIFFERENTIAL EQUATIONS – P13MS12**

**Semester : III** **Core Course: X**
**Instruction Hours/Week: 6** **Credit: 5**

**UNIT – I**

First order P.D.E.- Curves and Surfaces – Genesis of First Order P.D.E. – Classification of Integrals – Linear Equations of the first order – Pfaffian Differential Equations – Compatible systems – Charpit's Method – Jocobi's Method.

**UNIT – II**

Integral Surfaces Through a given Curve – Quasi – Linear Equations – Non-Linear First Order P.D.E.

**UNIT – III**

Second order P.D.E: Genesis of second order P.D.E. – Classification of Second order P.D.E. One – Dimensional Wave equation – vibrations of an infinite string – Vibrations of semi-infinite string – Vibrations of a String of Finite Length (Method of separation of variables)

**UNIT – IV**

Laplace's Equation: Boundary value Problems – Maximum and Minimum Principles – The Cauchry Problem – The Dirichlet problem for the Upper Half Plane – The Neumann Problem for the Upper Half Plane – The Dirichlet Interior Problem for a circle – The Dirichlet Exterior for a circle – The Neumann Problem for a circle – The Dirichlet Problem for a Rectangle – Harnack's Theorem – Laplace's Equation – Green's Function.

**UNIT – V**

Heat Conduction problem – Heat Conduction – Infinite Rod case - Heat Conduction finite Rod case – Duhamel's Principle – Wave Equation – Heat Conduction Equation.

**Text Book(S)**

An Elementary course in Partial Differential Equations By T. Amarnath, Narosa, 1997.
Unit – I – Chapter 1: Sections 1.1 to 1.8
Unit – II – Chapter 1: Sections 1.9 to 1.11.
Unit – III – Chapter 2: Sections 2.1 to 2.3.5, except 2.3.4.
Unit – IV – Chapter 2: Sections 2.4 to 2.4.11
Unit – V – Chapter 2: Sections 2.5 to 2.6.2.

**REFERENCE(S)**

1. I..c.Evans, Partial Differential Equations, Graduate Studies in Mathematics, Vol 19 AMS, 1998.
2. I.N.Snedden, Elements of Partial Differential Equations.
3. F.John , P.Prasad, , Partial Differential Equations.

**INTEGRAL EQUATIONS AND CALCULUS OF VARIATIONS – P13MS13**

**Semester : III** **Core Course: XI**

**Instruction Hours/Week: 6** **Credit: 5**

**UNIT – I**

Liner Integral Equations – Definition, Regularity conditions – special kind of kernels – Eigen values and eigen functions – Convolution Integral – The inner and scalar product of two functions – notation – Integral equations – Examples – Fred Holm alternative – examples – an approximate method.

**UNIT – II**

Method of successive approximation: Iterative scheme – examples- Voltra Integral equation – examples – some results about the resolvent kernel.

**UNIT – III**

Classical Fred Holm Theory: The method of solution of Fredholm – Fredholm's first theorem – second theorem – third theorem.

**UNIT – IV**

Applications to ordinary differential equations – Initial value problems – Boundary value problems – singular integral equations – Abel integral equation.

**UNIT – V**

Calculus of variation – Maxima and Minima – The simplest case – Natural boundary conditions and transition conditions – The Variational notation – The more general case with illustrative equations – Constraints and Lagrange's multipliers – Variables end points – Sturm – Liouville Problems.

**Text Book(S)**

**[1] Ram.P.Kanwal-Linear Integral Equations Theory and Practise, Academic Press 1971.**

**[2] F.B.Hildebrand, Mehtods of Applied Mathematics II ed. PHI, ND 1972.**

Unit – I – Chapter 1 and 2 of [1]
Unit – II – Chapter 3 of [1]
Unit – III – Chapter 4 of [1]
Unit – IV – Chapter 5 (5.1,5.2,5.3) and Chapter 8 (8.1, 8.2) of [1].
Unit – V – Chapter 2 Section 2.1 to 2.9 of [2]

**REFERENCE(S)**

[1] S.J.Mikhlin, Linear Integral Equations (translated from Russian), Hindustan Book Agency, 1960.
[2] I.N.Snedden, Mixed Boundary value Problems in Potential Theory, North Holland, 1966.

**FUNCTIONAL ANALYSIS – P13MS16**

**Semester : IV** **Core Course: XII**
**Instruction Hours/Week: 6** **Credit: 5**

**UNIT – I**

Banach Spaces : The definition and some examples – Continuous linear transformations – The Hahn – Banach theorem – The natural imbedding of N in N** - The open mapping theorem – The conjugate of an operator.

**UNIT – II**

Hilbert Spaces : The definition and some simple properties – Orthogonal complements – Orthonormal sets – The conjugate space H* - The adjoint of an operator – Self-adjoint operators – Normal and Unitary operators – Projections.

**UNIT – III**

Finite-Dimensional Spectral Theory : Matrices – Determinants and the spectrum of an operator – The Spectral theorem – A survey of the situation.

**UNIT – IV**

General Preliminaries on Banach Algebras : Definition and examples – Regular and singular elements – Topological divisors of zero – The spectrum – The formula for the Spectral radius – The radical and semi simplicity.

**UNIT – V**

The Structure of Commutative Banach Algebras : The Gelfand mapping – Applications of the formula $r(x) = \lim \| x^n \|^{1/n}$ – Involutions in Banach Algebras – The Gelfand – Neumark theorem.

**TEXT BOOK (S)**

**Introduction to Topology and Modern Analysis, G.F. Simmons, Tata McGraw- Hill Publishing Company Limited, 2004.**

UNIT I : Chapter 9
UNIT II : Chapter 10
UNIT III : Chapter 11
UNIT IV : Chapter 12
UNIT V : Chapter 13

**REFERENCE (S)** :

[1] Walter Rudin, Functional Analysis, TMH Edition, 1974. [2] B.V. Limaye, Functional Analysis, Wiley Eastern Limited, Bombay, Second Print, 1985.
[3] K. Yosida, Functional Analysis, Springer – Verlag, 1974.
[4] Laurent Schwarz, Functional Analysis, Courant Institute of Mathematical Sciences, New York University, 1964.

**FLUID DYNAMICS – P13MS17**

**Semester : IV** **Core Course: XIII**
**Instruction Hours/Week: 6** **Credit: 5**

**UNIT I :**
Kinematics of fluids in motion – Real fluids and ideal fluids, velocity of a fluid at a point streamlines and pathlines, Steady and unsteady flows. The Velocity potential, the vorticity vector, Local and particle rates of change, The equation of continuity, worked examples, acceleration of a point of a fluid.

**UNIT II :**
Equations of motion of a fluid-pressure at a point in a fluid at rest, Pressure at a point in a moving fluid, Condition at a boundary of two in viscid, Immissible fluids, Euler's equations of motion, worked examples, Some flows involving axial symmetry, Some special two dimensional flows, Impulsive motion.

**UNIT III :**
Some three dimensional flows – Introduction, sources, sinks and doublets, images in a rigid infinite plane. Axi-symmetric flows, stokes stream function, some special form of the stream function for axi-symmetric irrotational motions.

**UNIT IV :**
Some two dimensional flows- Meaning of two dimensional flow, use of cylindrical polar coordinates, The stream function. The complex potential for two-dimensional irrotational, incompressible flow, complex velocity potential for standard two-dimensional flows, uniform stream, line sources and line sinks, line doublets, line vortices, worked examples.

**UNIT V :**
Two dimensional image systems, The Milne Thomson circle Theorem, some application of the circle theorem, extension of the circle theorem, the theorem of blasius, The use of conformal transformation- Some hydro dynamical aspects of conformal transformation worked example, vortex rows- single infinite rows of line vortices, The Karman vortex street.

**TEXT BOOK (S) :**
**"FLUID DYNAMICS" F. Chorlton (CBS Publishers the distributors, New Delhi – 110032) 1985.**

UNIT I: Chapter 2 Section 2.1 to 2.9
UNIT II: Chapter 3 Section 3.1 to 3.6, 3.9 to 3.11
UNIT III: Chapter 4 Section 4.1 to 4.3, 4.5, 4.5.1
UNIT IV: Chapter 5 Section 5.1 to 5.6
UNIT V: Chapter 5 Section 5.7 to 5.10.2, 5.12 to 5.12.2

**REFERENCE BOOK**:
Fluid Dynamics, Raisinghania.M.D.

**NUMERICAL ANALYSIS – P13MS5E**

**Semester : I** **Elective Course: I**
**Instruction Hours/Week: 6** **Credit: 4**

**UNIT – II**

Transcendental and polynomial equations: Muller method , Chebyshev method – Multipoint iteration method - Rate of convergence - Iteration methods. Polynomial equations: Birge-Vieta method, Bairstow's method, Graeffe's root squaring method only.

**UNIT – II**

System of Linear Algebraic equations and Eigen Value Problems: Decomposition method, Partition method - Error Analysis of direct and iteration methods – Finding eigen values and eigen vectors – Jacobi and Power methods.

**UNIT – II**

Interpolation and Approximation : Hermite Interpolations – Piecewise and Spline Interpolation – Bivariate Interpolation- Approximation – Least square approximation.

**UNIT – IV**

Differentiation and Integration: Numerical Differentiation - Optimum choice of Step length – Extrapolation methods – Partial Differentiation – Methods based on undetermined coefficients – Gauss-Legendre integration method and Lobatto, Radau, Gauss – Chebyshev integration methods only – Double integration.

**UNIT – V**

Ordinary differential equations: Introduction, Euler, Backward Euler, Mid-point, Taylor series method - Runge-Kutta methods – Stability analysis with single step methods only.

**TEXT BOOK:**

**M.K. Jain, S.R.K. Iyengar and R.K. Jain, Numerical Methods for Scientific and Engineering Computation, III Edition, New Age International (P) Ltd Publishers, 1993.**

**UNIT I** Chapter 2 – 2.4(P 32- 34), 2.5, 2.6, 2.8
**UNIT II** Chapter 3 – 3.2(P 90-93, 95-99), 3.3, 3.4, 3.5
**UNIT III** Chapter 4 – 4.5 to 4.7, 4.9(upto P 199)
**UNIT IV** Chapter 5 – 5.2 to 5.5, 5.8(upto P 262) and 5.11
**UNIT V** Chapter 6 – 6.1,6.2, 6.3, 6.6(upto P 343).

**REFERENCE BOOKS(S)**

1.C.F.Gerald and P.O.Wheatley , Applied Numerical Analysis, Fifth Edition, Addison Wesley, (1998).
2.Samuel D.Conte, Carl. De Boor, Elementary Numerical Analysis, Mc Graw Hill International Edition 1983.
3.M.KJain, Numerical Solutions of Differential Equations, Second Edition, New Age International (P) Ltd., 1983.

**NUMBER THEORY – P13MS5E**

**Semester : I** **Elective Course: I**
**Instruction Hours/Week: 6** **Credit: 4**

**UNIT – I**

Introduction — Divisibility — Primes — The Binomial Theorem — Congruences — Euler's totient - Fermat's, Euler's and Wilson's Theorems — Solutions of congruences — The Chinese Remainder theorem.

**UNIT – II**

Techniques of numerical calculations — Public key cryptography — Prime power Moduli - Primitive roots and Power Residues —Congruences of degree two.

**UNIT – III**

Number theory from an Algebraic Viewpoint — Groups, rings and fields - Quadratic Residues The Legendre symbol (a/r) where r is an odd prime - Quadratic Reciprocity — The Jacobi Symbol (P/q) where q is an odd positive integer

**UNIT – IV**

Binary Quadratic Forms — Equivalence and Reduction of Binary Quadratic Forms - Sums of three squares — Positive Definite Binary Quadratic forms — Greatest integer Function — Arithmetic Functions — The Mobius Inversion Formula —
Recurrence Functions — Combinatorial number theory

**UNIT – V**

Diophantine Equations — The equation ax+by=c — Simultaneous Linear Diophantine Equations — Pythagorean Triangles — Assorted examples

**TEXT BOOK(S)**

**Ivan Niven, Herbert 5, Zuckerman and Hugh L, Montgomery, An Introduction to the Theory of Numbers, Fifth edn,, John Wiley & Sons Inc, 2004.**

**UNIT I** **:** Chapter1 and Chapter 2: Sections 2.1 to 2.3
**UNIT II** **:** Chapter 2 Sections 2.4 to 2.9
**UNIT III** **:** Chapter 2 : Sections 2.10, 2.11 and Chapter 3:Sections 3.1 to 3.3
**UNIT IV** **:** Chapter 3 : Sections 3.4 to 3,7 and Chapter 4
**UNIT V** **:** Chapter 5 : Sections 5.1 to 5.4

**REFERENCE(S)**

[1J David M Burton, Elementary Number Theory, WMC. Brown Publishers, Dubuque Lawa, 1989.
[2] George Andrews, Theory of Numbers
[3] Fundamentals of Number Theory, William.J Leveque, Addison- Wesley Publishing Company, Phillipines, 1977.

**FUZZY MATHEMATICS – P13MS5E**

**Semester : I** **Elective Course: I**

**Instruction Hours/Week: 6** **Credit: 4**

**UNIT – I**

Fuzzy sets — Basic types — Basic concepts — a-cuts —Additional properties of a- cuts — Extension principle for Fuzzy Sets

**UNIT – II**

Operations on Fuzzy sets — Types of operations — Fuzzy complements — t-Norms — Fuzzy Unions — Combinations of operations

**UNIT – III**

Fuzzy Arithmetic — Fuzzy numbers — Arithmetic operations on intervals Arithmetic operations on Fuzzy numbers.

**UNIT – IV**

Fuzzy relations — Binary fuzzy relations — Fuzzy equivalence relations — Fuzzy compatibility relations — Fuzzy ordering relations — fuzzy morphisms.

**UNIT – V**

Fuzzy Relation Equations — General discussion — Problem partitioning — Solution method — Fuzzy Relation Equations based on Sup-i Compositions - Fuzzy Relation Equations based on inf-ùi Compositions.

**TEXT BOOK**

**George J.Klir and Bo Yuan, Fuzzy Sets and Fuzzy Logic, Prentice Hall of IndiaNew Delhi, 2004.**

**REFERENCE(S)**

[1] H.J. Zimmermann, Fuzzy Set Theory and its Applications, Allied Publishers Limited, New Delhi, 1991.

(2] G.J. Klir and B. Yuan, Fuzzy Sets and Fuzzy Logic, Prentice Hall of India, New Delhi, 1995.

**LINEAR ALGEBRA – P13MS10E**

**Semester : II** **Elective Course: II**
**Instruction Hours/Week: 6** **Credit: 4**

**UNIT – I**

Reduced echelon Matrices – Matrix Multiplication Invertible Matrices Vector spaces – Subspaces – Bases and Dimension – Coordinates – summary of row equivalence - Computations concerning Subspaces.

**UNIT – II**

The algebra of linear transformations – Isomorphism of Vector Spaces - Representations of transformations by Matrices – Linear functionals – The Double Dual – The Transpose of a linear Transformation.

**UNIT – III**

Algebras - The algebra of polynomials – Lagrange Interpolation – Polynomial Ideals - The prime factorization of a polynomial.

**UNIT – IV**

Characteristic values – Annihilating polynomials, Invariant subspaces Simultaneous triangulation and simultaneous Diagonalization.

**UNIT – V**

Direct-sum Decompositions - Invariant Direct sums – The Primary Decomposition Theorem – Cyclic subspaces and annihilators – the Jordan form.

**Text Book**

**Kenneth Hoffman and Ray Kunze, Linear Algebra, Second Eidtion, Prentice-Hall of India Private Limited, New Delhi 1975.**

**Unit I** **:** Chapter 1: 1.4, 1.5, 1.6
Chapter 2: 2.1 to 2.6
**Unit II** **:** Chapter 3: 3.1 to 3.7
**Unit III** **:** Chapter 4: 4.1 to 4.5
**Unit IV** **:** Chapter 6: 6.1 to 6.5
**Unit V** **:** Chapter 6: 6.6 to 6.8
Chapter 7: 7.1 and 7.3

**Reference(s)**

[1] I.N.Herstein, Topics in Algebra, Wiley Eastern Limited, New Delhi
[2] I.S.Luther and I.B.S.Passi, Algebra, Vol.I – Groups, Vol.II – Rings, Narosa Publishing House (Vol.I – 1996, Vol II – 1999)
[3] N.Jacobson, Basic Algebra, Vols.I & II, Freeman, 1980 (also published by Hisdustan Publishing Company)

## METHODS OF MATHEMATICAL PHYSICS– P13MS10E

**Semester : II** **Elective Course: II**
**Instruction Hours/Week: 6** **Credit: 4**

**UNIT I**

Boundary value problems and series solution - Examples of boundary value problems Eigen values, eigen functions and the Sturm-Liouville problem Hermitian operator, their eigen values and eigen functions.

**UNIT II**

Bessel functions Bessel functions of 'the second kind, Hankel functions Spherical Bessel functions - Legendre polynomials - Associated Legendre polynomials and spherical harmonics.

**UNIT III**

Hermite polynomials - Laguerre polynomials - The Gamma function The Dirac Delta function.

**UNIT IV**

Non homogeneous boundary value problems and Green's function - Green's function for one-dimensional problems – eigen function expansion of Greens function - Fourier transform method of constructing Greens function.

**UNIT V**

Green's function in higher dimensions - Green's function for Poisson's equation and a formal solution of electrostatic boundary value problems - Wave equation with source - the quantum mechanical scattering problem.

**TEXT BOOK(S)**

**P.K. Chattopadhyay -Mathematical Physics, Wiley Eastern Limited, 1990**

**Unit I** **:** Sections 4.2 to 4.5
**Unit II** **:** Sections 5.1 to 5.5
**Unit III** **:** Sections 5.6 to 5.9
**Unit IV** **:** Sections 6.1 to 6,4
**Unit V** **:** Sections 6.5. to 68.

**REFERENCE(S)**

[1] B.D. Gupta, Mathematical Physics, Vikas Publishing House Pvt Ltd, New Delhi, 1993.
[2] Goyal AK Ghatak, Mathematical Physics- Differential Equations and Transform Theory, McMillan India Ltd, 1995.
[3] Kryzeg, Higher Engineering Mathematics,

**COMBINATORICS– P13MS10E**

**Semester : II** **Elective Course: II**
**Instruction Hours/Week: 6** **Credit: 4**

**UNIT I**

Permutations and combinations - distributions of distinct objects — distributions of non distinct objects - Stirlings formula .

**UNIT II**

Generating functions. - generating function for combinations enumerators for permutations - distributions of distinct objects into non-distinct cells - partitions of integers - the Ferrers graphs elementary relations.

**UNIT III**

Recurrence relation - linear recurrence relations with constant coefficients solutions by the technique of generating functions – a special class of nonlinear difference equations recurrence relations with two indices.

**UNIT IV**

The principle of inclusion and exclusion - general formula -permutations with restriction on relative positions derangements - the rook polynomials permutations with forbidden positions.

**UNIT V**

Polya's theory of counting - equivalence classes under a permutation group Burnside theorem - equivalence classes of functions - weights and inventories of functions – Polya's fundamental theorem — generation of Polya's theorem.

**TEXT BOOK(S)**

**C.L. Liu - Introduction of Combinatorial Mathematics, McGraw Hill, Chapters 1 to 5**

**REFERENCE(S)**

[1] Marshall Hall. Jr., Combinatorial Theory
[2] H.J. Rayser, Combinatorial Mathematics, Carus, Mathematical Monograph, No14.

**STOCHASTIC PROCESSES – P13MS14E**

**Semester : III** **Elective Course: III**

**Instruction Hours/Week: 6** **Credit: 4**

**Unit I**

Stochastic Processes : Some notions – Specification of Stochastic processes – Stationary processes - Markov chains – Definitions and examples – Higher Transition probabilities – Generalization of Independent Bernouli trails – Sequence of chain – Dependent trains.

**Unit II**

Markov chains: Classification of states and chains – determination of higher transition probabilities – stability of a Markov system – Reducible chains – Markov chains with continuous state space.

**Unit III**

Markov processes with Discrete state space: Poisson processes and their extensions – Poisson process and related distribution – Generalization of Poisson process – Birth and Death process – Markov system – Reducible chains – Markov chains with continuous state space.

**Unit IV**

Renewal processes and theory: Renewal processes - Renewal processes in continuous time - Renewal equation – stopping time – Wald's equation- Renewal theorems.

**Unit V**

Stochastic processes in Queuing – Queuing system – General concepts – the queuing model m/M/1 – Steady state Behaviour – transient behaviour of M/M/1 Model – Non-Markovian models – the model GI/M/1.

**Text Book**

**J.Medhi, Stochastic Processes, Howard M. Taylor – Second Edition.**

**Unit I** **:** Chapter 2 - Sec 2.1 to 2.3
Chapter 3 - Sec 3.1 to 3.3.

**Unit II** **:** Chapter 3 - Sec 3.4 to 3.6, 3.8,3.9 and 3.11.

**Unit III** **:** Chapter 4 - Sec 4.1 to 4.5.

**Unit IV** **:** Chapter 6 - Sec 6.1 to 6.5.

**Unit V** **:** Chapter 10 - Sec 10.1 to 10.3, 10.7 and 10.8 (omit 10.2.3 & 10.2.3.1)

**REFERENCE(S)**

[1] Sameul Korlin, Howard M. Taylor, A first course in stochastic processes, II Edn.
[2] Narayan Bhat, Elements of Applied Stochastic processes,
[3] Srinivasan and Metha, Stochastic processes, N.V. Prabhu, Macmillan (NY), Stochastic Processes

**OPERATOR THEORY– P13MS14E**

**Semester : III** **Elective Course: III**
**Instruction Hours/Week: 6** **Credit: 4**

**Unit I**

Spectral theory of lilnear operators in normed spaces – spectral theory on finitedimensional normed spaces – basic concepts – special properties of bounded linear operators – properties of resolvent and spectrum- Banach algebra.

**Unit II**

Compact linear operators on normed spaces – properties – spectral properties of compact linear operators on normed spaces.

**Unit III**

Operator equations involving compact linear operators – Theorems of Fredholm type – Fredholm alternative.

**UnitIV**

Spectral properties of bounded self adjoint linear operators – positive operators square roots of a positive operator.

**Unit V**

Projection operators – their properties – spectral family – spectral family – spectral family of bounded self adjoint linear operators.

**TEXT BOOK(S)**

**[1] Erwin Kreyszig-Introductory Functional Analysis, Springer – Veralg, 1974.**
**[2] Lustermikn Sobolev, Introduction to Linear Operators.**

**OPTIMIZATION TECHNIQUES – P13MS14E**

**Semester : III** **Elective Course: III**
**Instruction Hours/Week: 6** **Credit: 4**

**UNIT I**
Integer programming

**UNIT II**
Dynamic (Multistage) programming.

**UNIT III**
Decision Theory and Games

**UNIT IV**
Inventory Models.

**UNIT V**
Non-Linear Programming algorithms.

**TEXT BOOK(S)**
**Hamdy A.Taha, Operations Research (7th Edition), McGraw Hill Publications, New Delhi.**

**UNIT I** **:** Sections 8.1 to 8.5
**UNIT II** **:** Sections 9.1 to 9.5
**UNIT III** **:** Sections 11.1 to 11.4
**UNIT IV** **:** Sections 13.1 to 13.4
**UNIT V** **:** Sections 19.1 to 19.2

**REFERENCES:**
[1] O.L.Mangasarian, Non Linear Programming, McGraw Hill, New York.
[2] Mokther S.Bazaraa and C.M.Shetty,Non Linear Programming,Theory and Algorithms,Willy,New York.
[3] Prem Kumar Gupta and D.S.Hira,Operations Research:An Introduction,S.Chand and Co.,Ltd. New Delhi.
[4] S.S.Rao,Optimization Theory and Applications,Wiley Eastern Limited,New Delhi.

**DIFFERENTIAL GEOMETRY – P13MS15E**

**Semester : III** **Elective Course:IV**

**Instruction Hours/Week: 6** **Credit: 4**

**Unit I**

Space Curves: Definition of a space curve – 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 equation – Normal property of Geodesics – (Existence theorem) – Geodesics Parallels – Geodesics curvature - Gauss Bonnet Theorem – Gaussian Curvature – surface of constant curvature.

**Unit IV**

Non intrinsic properties of a surface: The second fundamental form – Principal curvature - Lines of curvature – Developable associated with space curves and with curves on surface – Minimal surface – Ruled surfaces

**Unit V**

Differential geometry of surfaces: Compact surfaces whose points are umblics – Hilbert's Lemma – Compact surfaces of constant curvature - Complete surface and their characterization – Hilbert's Theorem – conjugate points on geodesics.

**Text Book(S)**

**T.J. Wilmore, An Introduction to Differential Geometry, Oxford University press, (17th Impression) New Delhi 2002. (Indian Print).**

**Unit I** **:** Chapter I: Sections 1to 9.
**Unit II** **:** Chapter II: Section 1to 9.
**Unit III** **:** Chapter II: Section 10 to 18.
**Unit IV** **:** Chapter III: Section 1 to 8.
**Unit V** **:** Chapter IV: Section 1 to 8.

**REFERENCE(S)**

[1] Struik, D.T.Lectures on classical Differential Geometry, Addison – Wesley, Mass. 1950.
[2] Kobayashi S. and Nomizu.K. Foundations of Differential Geometry, InterScience ublishers, 1963.
[3] Wihelm Klingenberg : A Course in Differential Geometry. Graduate Texts in Mathematics, Springer Verlag, 1978.
[4] J.A.Thorpe Elementary topics in Differential Geometry, Under- Graduate Texts in Mathematics, Springer Verlag, 1979.

**MATHEMATICAL MODELING– P13MS15E**

**Semester : III** **Elective Course: IV**

**Instruction Hours/Week: 6** **Credit: 4**

**UNIT I :**

Introduction: Need, Techniques, Classifications and Characteristics of Mathematical Modeling – Mathematical Modeling through Geometry, Algebra, Trigonometry and Calculus.

**UNIT II :**

Mathematical Modeling through Ordinary Differential Equations of First order : Linear Growth and Decay Models – Non – Linear Growth and Decay models – Compartment models – Population Dynamics, Epidemics.

**UNIT III :**

Mathematical Modeling through Ordinary Differential Equations of Second Order: Planetary motions – Circular motion and motion of Satellites – Rectilinear motion – Electrical Circuits – Phillip's Stabilization model for a Closed Economy – The Catenary – A Curve of Pursuit.

**UNIT IV :**

Mathematical modeling through Difference Equations : Simple models – Basic theory of linear difference equations with constant coefficients – Economics and Finance – Population Dynamics and Genetics – Probability theory.

**UNIT V :**

Mathematical modeling through graphs : Problems that can be modeled through graphs – directed graphs – Signed graphs – weighted digraphs – unoriented graphs.

**TEXT BOOK :**

**J.N. Kapur, Mathemat ical Modeling, New Age International (P) Limited, Publishers, 1998.**

**UNIT I** **:** Chapter 1 – Section 1.1 to 1.9
**UNIT II** **:** Chapter 2 – Section 2.1 to 2.4
Chapter 3 – Section 3.1, 3.2
**UNIT III** **:** Chapter 4 – Section 4.1 to 4.4
**UNIT IV** **:** Chapter 5 – Section 5.1 to 5.6
**UNIT V** **:** Chapter 7 – Section 7.1 to 7.5

**REFERENCE**:

J.N. Kapur, Mathematical Models in Biology and Medicine, Affiliated East – West Press Pvt Limited, New Delhi, 1981.

**FINANCIAL MATHEMATICS - P13MS15E**

**Semester : IV** **Elective Course: IV**

**Instruction Hours/Week: 6** **Credit: 4**

**UNIT I**

SINGLE PERIOD MODELS: Definition from Finance – Pricing a forward – One step Binary Model – A ternary model – Characterization of no arbitrage – Risk neutral probability measure.

**UNIT II**

BINOMIAL TREES AND DISCRETE PARAMETER MARTINGALES: Multiperiod Binary model – American options – Discrete parameter martingales and Markov processes - Martingale theorems – Binomial Representation theorem – Overturn to continuous models.

**UNIT III**

BROWNIAN MOTION: Definition of the process – Levy's Construction of Brownian Motion – The Reflection Principle and Scaling – Martingales in Continuous time.

**UNIT IV**

STOCHASTIC CALCULUS: Non-differentiability of Stock prices – Stock prices –Stochastic Integration-Ito's formula –Integration by parts and Stochastic Fubini theorem – Girsanov Theorem – Brownian Martingale Representation Theorem – Geometric Brownian Motion – The Feyman – Kac Representation.

**UNIT V**

BLOCK SCHOLES MODEL: Basic Block-Scholes Model – Block – Scholes price and Hedge for European Options-Foreign Exchange-Dividends-Bonds-market price of risk.

**TEXT BOOK**

**Alison Etheridge, A course in Financial Calculus, Cambridge University Press, Cambridge 2002.**

**REFERENCES**


[1] Martin Boxter and Andrew Rennie, Financial Calculus: Anintroduction to Derivatives Pricing Cambridge University Press, Cambridge 1996.

[2] Introduction to Stochastic Calculus Applied to Finance, Chapman and Hall, 1996.

[3] Marek Musiela and Marek Rutkowski, Martingale Methods in Financial Modeling, Springer Verlag, New York, 1998.

[4] Robert J Elliot and P.Ekkehard Kopp, Mathematics of Financial Markets, Springer Verlag, New york 2001.

**APPLIED STATISTICS - P13MS18E**

**Semester : IV** **Elective Course: V**
**Instruction Hours/Week: 6** **Credit: 4**

**UNIT I :**
STATISTICAL QUALITY CONTROL

**UNIT II :**
TIME SERIES ANALYSIS (Excluding the moving average mathematical treatment)

**UNIT III :**
INDEX NUMBERS

**UNIT IV :**
DEMAND ANALYSIS

**UNIT V :**
ANALYSIS OF VARIANCE

**TEXT BOOK (S) :**
**S. C GUPTA AND V.K. KAPOOR FUNDAMENTALS OF APPLIED STATISTICS – THIRD EDITION, SULTAN CHAND & SONS**
**UNIT I** **:** Chapter I - Sections 1.0 to 1.7
**UNIT II** **:** Chapter II - Sections 2.1 to 2.5
**UNIT III** **:** Chapter III - Sections 3.1 to 3.4
**UNIT IV** **:** Chapter IV - Section 4.1 to 4.7
**UNIT V** **:** Chapter V - Section 5.1 to 5.4

**REFERENCE BOOK[s]**:
D.R. Caze – APPLIED STATISTICS – Principle and examples
B.N. Ashana – APPLIED STATISTICS

**NON LINEAR DIFFERENTIAL EQUATIONS – P13MS18E**

**Semester : IV** **Elective Course: V**

**Instruction Hours/Week: 6** **Credit: 4**

**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: harmony 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 IV:**

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

**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, Freeman(1968).

[3] Notes on Nonlinear Systems by J.K.Aggarwal,Van Nostrand,1972.25l

**TENSOR ANALYSIS AND SPECIAL THEORY OF RELATIVITY –P13MS18E**

**Semester : IV** **Elective Course: V**

**Instruction Hours/Week: 6** **Credit: 4**

**UNIT I**

Invariance Transformations of coordinates and its properties Transformation by invariance - Transformation by covariance and contra variance - Covariance and contra variance - Tensor and Tensor character of their laws - Algebras of tensors - Quotient tensors - Symmetric and skew symmetric tensors - Relative tensors.

**UNIT II**

Metric Tensor - The fundamental and associated tensors - Christoffel's symbols - Transformations of Christoffel's symbols- Covariant Differentiation of Tensors - Formulas for covariant Differentiation- Ricci Theorem - Riemann -Christoffel Tensor and their properties.

**Unit III**

Einstein Tensor - Riemannian and Euclidean Spaces (Existence Theorem) –
The e-systems and the generalized Kronecker deltas - Application of the e-systems.

**UNIT IV**

Special Theory of Relativity: Galilean Transformation - Maxwell's equations - The ether Theory — The Principle of Relativity Relativistic Kinamatics : Lorentz Transformation equations – Events and simultaneity - Example Einstein Train - Time dilation – Longitudinal Contraction -Invariant Interval - Proper time and Proper distance —
World line – Example - twin paradox - addition of velocities - Relativistic Doppler effect.

**UNIT V**

Relativistic Dynamics: Momentum - energy – Momentum energy four vector - Force - Conservation of Energy - Mass and energy - Example - inelastic collision - Principle of equivalence - Lagrangian and Hamiltonian formulations. Accelerated Systems : Rocket with constant acceleration - example - Rocket with constant thrust

**TEXT BOOK(S)**

[1] I.S. Sokolnikoff, Tensor Analysis, John Wiley and Sons, New York, 1964
[2] D. Greenwood, Classical Dynamics, Prentice Hall of India, NewDelhi, 1985
UNIT I Chapter 2 : Sections 18 to 28 of [1]
UNIT II Chapter 2 : Sections 2910 37 of [1]
UNIT III Chapter 2 : Section 38 to 41 o [1]
UNIT IV Chapter 7 : Sections 7.1 and 7.2 of [2]
UNIT V Chapter 7 : Sections 7.3 and 7.4 of [2]

**REFERENCE(S)**

[1] J.L. Synge and A.Schild, Tensor Calculus, Toronto, 1949.
[2] A,S. Eddington, The Mathematical Theory of Relativity, Cambridge University Press, 1930.
[3] P.G. Bergman, An introduction to Theory of Relativity, New york, 1942,
[4] G.E. Weatherburn, Riemannian Geometry and Tensor Calculus, Cambridge,1938.