DR. BABASAHEB AMBEDKAR MARATHWADA UNIVERSITY, AURANGABAD.

Curriculum under Choice Based Credit & Grading System

M.Sc. I & II Year

Mathematics

Semester–I to IV

run at college level from the Academic Year 2015-16 & onwards

DR. BABASAHEB AMBEDKAR MARATHWADA UNIVERSITY, AURANGABAD

DEPARTMENT OF MATHEMATICS

Syllabus for M.A. / M. Sc. (Mathematics) Semester I, II, III, and IV
Under Academic Flexibility of the Department
Credit Based Grading System
W.E.F. JUNE – 2011
And modified in June 2014.

The M. A. / M. Sc. (Mathematics) course consists of four semesters.

In Semesters I and II a student has to study four **core** Courses and one **Elective** course. In Semesters III and IV he/she has to study two **core** Courses, three **elective** courses and at least one **service course** from any other department. The students of other Departments **may opt the course MAT-503** offered for semester III as a **service course**. Unit wise distribution of the syllabus for the courses currently taught is given.

The M. A. / M. Sc. (Mathematics) course will be of 120 credits. The credits obtained from other Department will be appropriately converted.

SEMESTER- I (Core Courses)

MAT401 - Advanced Abstract Algebra -I

MAT402 - Real Analysis -I

MAT403 - Topology -I

MAT404 - Complex Analysis -I

Elective Courses (Any One)

MAT421 – Differential Equations -I.

MAT422 - Advanced Discrete Mathematics -I.

SEMESTER –II (Core Courses)

MAT411 - Advanced Abstract Algebra -II

MAT412 - Real Analysis -II

MAT413 - Topology -II

MAT414 - Complex Analysis -II

Elective Course (Any one of the following)

MAT431 - Differential Equations -II

MAT432 - Advanced Discrete Mathematics -II.

SEMESTER III (Core Courses)

MAT501 - Functional Analysis

MAT502 - Partial Differential Equations

Elective Courses (Any three of the following)

MAT521 - Programming in C

MAT522 - Fluid Mechanics -I

MAT524 - Numerical Analysis .

MAT525 - Lattice Theory

MAT526 - Operations Research -I.

MAT527 - Reaction diffusion theory - I

MAT528 - Difference Equations -I

SEMESTER IV (Core Courses)

MAT511 - Linear Integral Equations

MAT512 - Mechanics

Elective Courses (Any three of the following)

MAT531 - MATLAB Programming

MAT532 - Fluid Mechanics -II

MAT534 - Fuzzy Mathematics

MAT535 - Linear Algebra

MAT536 - Operations Research -II.

MAT537 - Reaction diffusion theory - II

MAT538 - Difference Equations -II

Course No: MAT401 **Number of Credits: 6**

Semester –I Advanced Abstract Algebra- I

Unit- I

Binary relation, binary operation, function,group,subgroup and their properties. Order of a group, element and a subgroup Generator, cyclic group,Lagranges theorem, Fermats and Eulers theorem and their consequences. (15 lectures)

Unit- II

Normal subgroup, quotient group and their properties and axamples. Homomorphism, kernel, image of a homomorphism. Isomorphism and related theorems, Fundamental theorem of group homomorphism, automorphism, conjugacy and G-sets. (15 lectures)

Unit- III

Permutation groups and related concepts and results. Center, normalizer,commutator of a group, derved group, Cayles theorem. (15 lectures)

Unit – IV

Normal series, solvable and nilpotent group and their properties, direct products, simplicity of alternating group. (15 lectures)

Unit- V

Fundamental theorem of finitely generated abelian group, invariants of finite abelite abelian group, Sylow theorems and applications. (15 lectures)

Text Book:

Basic Abstract Algebra, by P. B. Bhattacharya, S. K. Jain and S. R. NagPaul Cambridge (Indian Edition)Chapter Number:4,5,6,7,8 related topics.

Reference Books:

1. Topics in algebra, I. N. Herstein: Wiley (Indian Edition)
2. Contemporary Abstract Algebra by J.A. Gallian, Narosa.

Course No :MAT402 **Number of Credits :6**

Semester – I Real Analysis- I

Unit – I
Definition and existence of Riemann-Stieltjes integral, Properties of the integral, Integration and Differentiation, The fundamental theorem of calculus, Examples.
(15 lectures)

Unit – II
Integration of vector valued functions. Rectifiable curve. Examples. Sequences and series of functions. Point wise and uniform convergence. Cauehy criterion for uniform convergence. Weierstrass M-test, uniform convergence and continuity, uniform convergence and Riemann-Stielljes integration. Examples. (15 lectures)

Unit – III
Uniform convergence and Differential, The Stone – Weierstrass theorem, Examples.
Power series, Abel's and Taylor's theorems, Uniqueness theorem for power series.
Examples. (15 lectures)

Unit – IV
Functions of several variables, Linear transformations, Derivatives in an open subset of R^n, Chain rule, Examples (15 lectures)

Unit – V
Partial derivations. Interchange of the order of differentiation, The inverse function theorem, The implicit function theorem Jacobins, Derivatives of higher order, Differentiation of integrals. Examples, (15 lecturer)

Text Book:
Walter Rudin, Principles of Mathematical Analysis, (3rd Edition) McGraw Hill, Kogakusha 1976.

Articles:
6.1 to 6.27, 7.1 to 7.18, 7.26, 7.27, 8.1 to 8.5, 9.1 to 9.21, 9.24 to 9.29, 9.38 to 9.42

Reference Books:

1. T. M. Apostol, mathematical Analysis, Narosa, New Delhi, 1985.

2. J. C. Burkill and H. Burkill, A second course in Mathematical Analysis, Cambridge University Press, 1970.

3. S. L. Lang, Analysis- I and II, Addison Wesley, 1969.

Course No :MAT403 **Number of Credits :6**

Semester - I Topology - I

Unit – I

Prerequisites: Partially ordered sets, Maximal and minimal elements, cardinality, special cardinals countable and uncountable sets, Axiom of choice continuum hypothesis, principle of inductions metric spaces, definition and Examples, continuous map, open sets properties of open sets, characterizations of continuity. (15 lectures)

Unit – II

Definition and examples of topological spaces, closed sets, closure of a set, properties of closure of sets, interior of a set and their properties, frontier of sets and its relation ship with closure and interior of sets neighbourhood of a point, Neighbourhood system, accumulation point and derived set. (15 lectures)

Unit – III

Bases and sub bases and related theorems new spaces from old. Sub spaces, continuous functions product spaces, weak topologies and related theorems open closed maps projection maps. (15 lectures)

Unit – IV

Evaluation map and related results Quotient spaces sequences in a topological space, Inadequacy of sequences, first countable spaces. (15 lectures)

Unit – V

Directed sets, nets, convergence of nets, cluster point, subnet, ultra net, filter, convergence of filters, ultra filters, fixed and free filters, results on these concepts. (15 lectures)

Textbook: Stephan Willard: General Topology, Addison Wesley (1970)

Chapter 1 (Sec. 1.8 to 1.21 and Sec, 2.1 to 2.8)
Chapter 2 (Complete),
Chapter 3 (up to sec. 9.3)
Chapter 4 (Complete)

Reference Books:

1. Steen & J. Seecatch: Counter examples in Topology, Holt, Rinehart and instant, N, Y. (1970).
2. W. J. Pervin: Foundation of general Topology Academic press N.Y.
3. S. T. Hu. : Elements of general Topology, Holden.
4. James Munkres: Topology, A first course, Prentice Hall of India Pvt. Ltd.

Course No :MAT404 **Number of Credits :6**

Semester – I - Complex Analysis - I

Unit- I

The Complex number system:

The field of complex numbers, The complex plane, Rectangular and polar representation of complex numbers; Intrinsic function on the complex field; The Complex plane. (15 lectures)

Unit - II

Metric spaces and Topology of C:

Definition and examples of metric spaces; connectedness; sequence and completeness; compactness; continuity; Uniform convergence. (15 lecturer)

Unit- III

Elementary properties and examples of Analytic functions:

Power series; The exponential function; Trigonometric and hyperbolic functions; Argument of nonzero complex number; Roots of unity; Branch of logarithm function. Analytic functions; cauchy Riemann Equations; Harmonic function; (15 lectures)

Unit - IV

Analytic functions as a mapping; Mobius transformations; linear transformations; The point at infinity; Bilinear transformations,

Complex Integration: power series representation of analytic functions; zeros of an analytic function. (15 lectures)

Unit – V

The index of a closed curve; cauchy's theorem and integral formula; Gaursat's Theorem; Singularities: Classification of singularities; Residues; The argument principle. (15 lectures)

Text Books:

1. John B. Conway; Functions of one complex variable, Narosa Publishing House, 2002.
2. J. V. Deshpande; Complex Analysis, Tata McGraw- Hill Publishing Company Limited, 1989.

Unit-I: Chapter-I: § 2,3,4 in [1] & 1.3 & 1.4 in [2]

Unit-II: Chapter – II: §1,2,3,4,5,6 in [1]

Unit – III: Chapter –VI: § 6.1,6.2,6.3,6.4,6.5,6.6 in [2] & Chapter - VII: § 7.1,7.2,7.3, in [2]

Unit- IV: Chapter- III: § 3 in [1] & Chapter – IV: § 2, 3 & 4 in [1] &
Chapter – 2: § 2.1,2.2,2.3, in [2]

Unit – V: Chapter – IV: § 5 & 8 in [1] & Chapter V: § 1,2 & 3 in [1].

References:

1. Herb Silverman; Complex Variables, Haughton Mifflin Company Boston, 1975.
2. Ruel V. Churchill; Complex variables and applications, McGraw – Hill Publishing Company 1990.

Course No :MAT421 **Number of Credits :6**

Semester – I -Differential Equations - I

Unit – I

Existence, uniqueness and Continuation of solutions: Introduction, Method of successive approximations for the initial value problem $y^1=f(x,y)$, $y(x_0)=y_0,$ The Lipschitz condition. Notation and Definitions, Peano's existence theorem, maximal and minimal solutions, continuation of solutions. (15 lectures)

Unit – II

Existence theorems for system of differential equations: Picard-Lindelof theorem, Peano's existence theorem, Dini's derivatives, differential inequalities. (15 lectures)

Unit – III

Integral Inequalities: Gronwall- Reid-Bellman inequality and its generalization, Applications: Zieburs theorem, Peron's criterion, Kamke's uniqueness theorem. (15 lectures)

Unit – IV

Linear systems: Introduction, superposition principle, preliminaries and Basic results, Properties of linear homogeneous system, Theorems on existence of a fundamental system of solutions of first order linear homogeneous system, Abel-Liouville formula. (15 lectures)

Unit – V

Adjoint system, Periodic linear system, Floquet's theorem and its consequences, Applications, Inhomogeneous linear systems, applications. (15 lectures)

Text Book:

1. E. A. Coddington: An Introduction to Ordinary Differential Equations. Prentice-Hall international, Inc. Englewood Cliffs (1961).

   Chapter 6: Article 4&5.

2. Shair Ahmad and M. Rama Mohana Rao: Theory of Ordinary Differential Equations with Applications in Biology and Engineering, Affiliated East-West Press (1999)
   Chapter – 1: Article 1.1 to 1.5
   Chapter – 2: Article 2.1 to 2.3

References:

1. P. Hartman: Ordinary differential Equations, 2^{nd} edition, SIAM, (2002.)
2. W. T. Reid: Ordinary Differential Equations, John Wiley, New York, (1971).
3. E. A. Coddington and N. Levinson: Theory of Ordinary Differential Equations, McGraw-Hill, New York, (1955)

Course No :MAT422 **Number of Credits :6**

Semester – I - ADVANCED DISCRETE MATHEMATICS - I

Unit – I

Formal Logic: Statements, symbolic representation, tautologies. Semi groups and monoids: Definitions and examples of semi groups and Monoids
(15 Lecture)

Unit- II

Homomorphism of semigroups and monoids, congruence relation and quotient semigroups, Sub semigroups and submonoids, direct products, basic homomorphism theorem. (15 Lecture)

Unit- III

Lattices: Lattices as partially ordered sets, their properties, lattices as algebraic systems, sub lattices, direct products and homomorphism, some special lattices eg complete, complemented and distributive lattices.
(15 Lecture)

Unit- IV

Boolean algebras: Boolean algebras as lattices, various Boolean identities, the switching algebra example, sub algebra, direct product and homomorphism, join-irreducible elements (15 Lecture)

Unit- V

Atoms and midterms, Boolean forms and their equivalence, midterm Boolean forms, (excluding free Boolean algebras), sum and products of canonical forms. Minimization of Boolean functions, applications of Boolean algebra to switching theory (using AND, ok and NOT gates), the Karnaugh Map method.
(15 Lecture)

Text Book:

1. **J. P. Tremblay and R. Manohar**: Discrete Mathematical structures with Applications to Computer science, McGraw-Hill Book Co., 1997.

Chapter 1 (Sections 1.1 to 1.3), Chapter 3 (Sections 3.1 and 3.2), Chapter 4 (Sections 4.1 to 4.4)

Reference Books:

1. **Seymour Lepschutz**: Finite Mathematics, McGraw-Hill, New York.
2. **S. Wiitala**: Discrete Mathematics - A Unified Approach, McGraw-Hill.
3. **J. E. Hhopcroft and J.D. Ullman**: Introduction to Automata Theory, Languages and Computation, Narosa, New Delhi.
4. **C. L. Liu**: Elements of discrete Mathematics, McGraw-Hill Book Co.

Course No :MAT411 **Number of Credits :6**

Semester – II - Advanced Abstract Algebra -II

Unit- I
Preliminaries of rings, definition, types, subring, ideal, prime, maximal ideas, nil, nilpotent ideals and their properties. Quotient ring, Homomorphism, isomorphism and related results. UFD, PID, Euclidean domain, polynomial rings and their properties.

Chapter 3 from[1], (15 lectures)

Unit – II
Vector spaces, subspaces, generating set, linear dependence and indepeedence, basis and dimension, quotient space, homomorphism, dual space, inner product space and modules.

Chapter 4 from[1], (15 lectures)

Unit - III
Liner transformation and their properties, characteristic roots, triangular canonical form.

Chapter 6 (upto Theorem 6.4.2) from [1,] (15 lectures)

Unit – IV
Extension fields, irreducible polynomials, algebraic extension and their properties, splitting field, normal extension, multiple roots, finite fields, separable extension.

Chapter 15 and 16 from [2,] (15 lectures)

Unit – V
Automorphism groups, fixed field, fundamental theorm of Galois theory, polynomials solvable by radicals, ruler and compass constructions. Related topics from chapter 17,18 from [1] (15 lectures)

Text Book:

1) Topics in Algebra by I. N. Herstein, Wiley.

2) Basic Abstract Algebra by Bhattacharya, Jain and NagPaul, Cambridge (Indian Edition)

Reference book: Contemporary Abstract Algebra by J. A. Gallian,Narosa.

Course No :MAT412 **Number of Credits :6**

Semester – II -Real Analysis -II

Unit – I

Measure on the real line. Lebegue outer measure, measurable sets. Regularity. Measurable functions. Borel and lebegue measurability. Examples. (15 lectures)

Unit – II

Integration of functions of a Real variable. Integration of a simple function. Integration of non-negative functions. The general integral. Integration of series. Examples.
(15 lectures)

Unit – III

Riemann and Lebeque Integrals, Differentiation. The four derivates, Functions of bounded variations. Lebegue's differentiation theorem differentiation and Integration. Examples. (15 lecturer)

Unit – IV

Abstract Measure spaces. Measures and outer measures Extension of a measure. Uniqueness of the extension. Completion of a measure spaces. Integration with respective to a measure. Examples. (15 lecturer)

Unit – V

The L^p spaces. Convex functions. Jensen's inequality. The inequalities of Holder and Minkowski Completeness of L^p (μ) Convergence in measure. Almost uniform convergence. Examples. (15 lecturer)

Text Book:

G. de Barra, Measure Theory and Integration. Wiley Eastern Ltd. 1981. Reprint 2003.

Articles: 2.1-2.5, 3.1 – 3.4, 4.1, 4.3 - 4.5, 5.1 – 5.6, 6.1 – 6.5, 7.1 and 7.2

Reference Books:

1. P. K. Jain and P. V. Gupta, Lebesgue Measure and Integration, New Age International (P) Ltd. Publication New Delhi. 1986 (Reprint 2000)
2. P. R. Halmos, Measure Theory, Von No strand, Princeton 1950
3. R. G. Bartle, The elements of Integration, John Wiley, New York 1966.
4. I. K Rana, An Introduction to measure and Integration, Narosa, Delhi 1997.

Course No :MAT413 **Number of Credits :6**

Semester – II -Topology -II

Unit – I
Separation axioms, $T_{0,}$ T1, $T_{2,}$ space their properties and characterizations, regular spaces, T_3 spaces, characterizations, Hereditariness of these concepts, completely regular and tychonoff spaces and their characterizations.(15 lectures)

Unit – II
Normal spaces and T_4 spaces, urysohrns lemma, tietze theorem on normal spaces (without proof) cover, point finite cover, shrinkable cover of topological spaces and their properties, accountability properties, second countable spaces, lindelof spaces and their properties. (15 lectures)

Unit – III
Compactness. Definition and examples, characterization of compactness, sequentially and countably compact spaces, locally compact specs and their properties, compactification, one point compectification, Stone-cech compactification. (15 lectures)

Unit – IV
Para compactness, local finiteness, Metrizable spaces, lebesgue covering lemma, Urysohns motrization theorem, metrizebility of T_0 spaces, (15 lectures)

Unit – V
Connected spaces, mutually separated sets, characterizations and properties of connected spaces, components, simple chain, path wise and local connectedness. (15 lectures)

Text Book: Stephan Willard: General Topology Addison Wesley publication Co. (1970)

Chapter 5 (Complete) chapter- 6 (Section17.1 to 19.5, 20.1 to 20. 10)
Chapter 7 (Section 22.1 to 23.2, 23.5), Chapter 8 (Section 26.1 to 27.13)

Reference Books:

1. Steen & J. Seecatch: Counter examples in Topology, Holt, Rinehart and instant, N, Y. (1970).
2. W. J. Pervin: Foundation of general Topology Academic press N.Y.
3. S. T. Hu. : Elements of general Topology, Holden.
4. James Munkres: Topology, A first course, Prentice Hall of India Pvt. Ltd.

Course No :MAT414 **Number of Credits :6**
Semester - II -Complex Analysis -II

Unit – I
Compactness and convergence in the space of Analytic functions:
Spaces of analytic functions; The weierstrass factorization theorem; factorization of the sine function; The gamma function; The Riemann zeta function.
(15 lectures)

Unit – II
Harmonic functions:
Basic properties of Harmonic functions and comparison with analytic function; Harmonic functions on a dick; Poisson integral formula; positive harmonic functions.
(15 lectures)

Unit – III
Entire functions; Jensen's formula; The Poisson-Jenson formula; The genus and order of an entire function. Hadamard factorization Theorem; (15 lectures)

Unit – IV
Univalent functions; the class S; the class T; Bieberbach conjucture; sub class of s; (15 lectures)

Unit – V
Analytic continuation: Basic concepts; special functions. (15 lectures)

Text Books:

1. John B. Conway; Functions of one complex variable, Narosa Publishing House, 1980.
2. Herb Silverman; Complex Variables Houghton Mifflin Company Boston 1975.

Unit – I	:	Chapter – VI: § 2,5,6,7 & 8 in [1]
Unit – II	:	Chapter – X: § 1& 2 in [1]
		And Chapter- X: § 10.1, 10.2 & 10.3 in [2]
Unit – III	:	Chapter- XI: § 1,2 & 3 in [1]
Unit – IV	:	Chapter XII: § 12.1& 12.2 in [2]
Unit – V	:	Chapter – XIV: § 14.1 & 14.2 in [2]

Reference Books:
1. L. V. Ahlfors: Complex Analysis, McGraw-Hill International Editions, 1979.
2. Ruel V. Churchill and J. W. Wran; Complex variables and applications, McGraw-Hill publishing Company – 1990.

Course No :MAT431 **Number of Credits :6**

Semester – II -Differential Equations - II

Unit- I
Preliminaries, Basic Facts: Superposition principles, Lagrange Identity, Green's formula, variation of constants, Liouville substitution, Riccati equations Prufer Transformation. Higher order linear equations. (15 lectures)

Unit – II
Maximum Principles and their extensions, Generalized maximum principles, initial value problems, boundary value problems. (15lectures)

Unit –III
Theorems of strum; sturm's first comparison theorem, sturm's separation theorem, strums second comparison theorem. (15lectures)

Unit – IV
Sturm-Liouville boundary Value Problems: definition, eigenvalues, eigenfunctions, orthogonality. (15lectures)

Unit – V
Number of zeros, Non oscillatory equations and principal solutions, Non oscillation theorems. (15 lectures)

Text Books:

1. Philip Hartman: Ordinary differential Equations, 2nd Edition SIAM, 2002.
   Chapter – XI: Article 1 to 7. Chapter – 4 – article 8 only.
2. M. H. Protter and H. F. Weinberger, Springer: Maximum Principles in Differential Equations – Springer Verlag, New York, Inc, 1984.
   Chapter 1. Articles 1 to 4.

Reference Books:

1. W. T. Reid: ordinary differential Equations, John Wiley N.Y. (1971).
2. E. A. Coddington and N. Levinson: Theory of Ordinary differential Equation, McGraw-Hill, New York, (1955).

Course No :MAT432 **Number of Credits :6**

Semester – II -ADVANCED DISCRETE MATHEMATICS -II

Unit – I

Definiton of (undirected) graph, paths, circuits, cycles and subgraphs, degree of a vertex connectivity, planar graphs and their properties.

Unit-II

Trees, rulers formula for connected planar graphs. Complete graphs, Kuratowski's theorem (statement only) spanning trees, cutsets, fundamental cut-sets and cycles, minimal spanning trees and Kruskal's (statement only) algorithm, matrix representation of graphs,

Unit-III

Euler's theorem on the existence of Eulerian paths and circuits, directed graphs, in degree and out degree of a vertex, weighted undirected graphs, strong connectivity, directed trees, search trees,

Unit-Iv

Introductory computability theory:

Finite state machines and their transition table diagrams, equivalence of finite state machies, reduced machines, homomorphism, finite automata, acceptors, no-deterministic finite automata.

Unit-V

Grammers and languages: Phase structure grammars, rewriting rules, derivations, sentential forms, language generated by a grammar, regular, contest free and contest sensitive grammers and languages.

Text Books:

1. **J. P. Tremblay and R. Manohar**: Discrete Mathematical structures with Applications to Computer science, McGraw-Hill Book Co., 1997.

Sections 3.3, 4.6, and 5.1 to 5.6

2. **C. L. Liu**: Elements of discrete Mathematics, McGraw-Hill Book Co.

Sections 6.5 and 7.1 to 7.7

Reference Books:

1. **Seymour Lepschutz**: Finite Mathematics, McGraw-Hill, New York.
2. **S. Wiitala**: Discrete Mathematics - A Unified Approach, McGraw-Hill.
3. **J. E. Hhopcroft and J.D. Ullman**: Introduction to Automata Theory, Languages and Computation, Narosa, New Delhi.

Course No :MAT501 **Number of Credits :6**

Semester – III Functional Analysis

Unit – I
Normed linear spaces. Banach spaces and examples, quotient spaces of a normal linear space and its completeness, equivalent norms. (15 lectures)

Unit – II
Bounded linear transformations, Normed linear spaces of bounded linear transformations, Halm-Banach theorem. Conjugate spaces with examples, natural embedding of a normed linear space in its second dual, reflexive spaces
(15 lectures)

Unit – III
Open mapping theorem, closed graph theorem, uniform boundedness theorem and its consequences. Inner product spaces, examples. (15 lectures)

Unit – IV
Hilbert spaces and its properties. Orthogonal complements, orthonormal sets, Bessel's inequality, complete orthonormal sets and parseval's identity, conjugate space of a Hilbert space, reflexivity of a Hilbert space. (15 lectures)

Unit – V
Self adjoint operators, positive, projection, normal and unitary operators and their properties Eigen values and eigen space of an operator on a Hilbert space, spectrum of an operator on a finite dimensional Hilbert space Finite dimensional spectral theorem.
(15 lectures)

Text Book:

1. G. F. Simmons :Introduction to topology and Modern Analysis, McGraw Hill (1963) Chapter 9,10,11 (excluding section 63)

Reference Books:

1) Johan Horvath, Topological Vector spaces and Distributions, Addison-Wesley Publishing Company, 1966.
2) J.L. Kelley and Isaac Namioka, Linear Topological Spaces, D. Van Nostrand Company, Inc, 1963.

Course No :MAT502 **Number of Credits :6**

Semester – III Partial Differential Equations

Unit – I

Examples of Partial Differential Equations Classification of second order Partial Differential Equations. Transport equation – Initial value problem Non-homogeneous equations.

Laplace's equation- Fundamental solution, Poisson's equation, Mean value formulas, Properties of Harmonic functions, (15 lectures)

Unit – II

Laplace,s Equation,Strong maximum principle, Strong minimum principle, uniqueness, Regularity, Local estimates for harmonic functions Green's function, Derivation of Green's function, Green's function for half space, Green's function for a ball, Energy methods, uniqueness. (15 lectures)

Unit – III

Heat Equation-fundamental solution, Initial value problem, Non-homogenous problem,
Mean value formula, Properties of solutions, Strong maximum principle, uniqueness, Energy methods, uniqueness, Backwards uniqueness, Wave Equation – solution by spherical means, (15 lectures)

Unit – IV

Non-homogeneous equations, Energy methods. Nonlinear first Order PDE- Complete Integrals, envelopes, new solutions from envelopes characteristics, Representation of solutions-separation of variables, Similarity Solutions, Plane and Traveling waves, solutions, similarity under scaling, (15 lectures)

Unit – V

Transformation Methods Fourier and Lap lace Transform, Applications Converting Nonlinear into linear Partial Differential Equation cole-Hopf transformation, A parabolic Partial Differential Equation with quadratic no linearity Burger's equation with viscosity, Hodograph and Legendro Transforms, Potential function.

(15 lectures)

Text Books:

1. Lawrence C. Evans: Partial Differential Equations, Graduate studies in Mathematics Vol. 19 AMS, 1998.
2. Ion N. Sneddon: Elements of Partial Differential Equations McGraw Hill, 1957.

Reference Books:

1) F. John: Partial differential Equation, Springer Verlag, (4^{th} edition), 1995

2) P. Prasad & R. Ravindran: Partial differential Equations,

Course No :MAT521 **Number of Credits :6**

Semester – III -Programming in C

Unit – I Introduction:

Introduction to computers, Characteristics of Computers, Application area's of computer, Classification of computers, Overview of programming, types of programming languages (classification), Introduction to c, Features of C, Program structure, characteristics of programs, concept of header file.

(15 lectures)

Unit – II C Fundamental

Preprocessor, Character Set, Identifiers, reserved words, constants and variables, Data types, type modifiers, types of statements, Declaration and Initialization, comments, (15 lectures)

Unit – III I/O operation

Types of I/O statements: formatted and Unformatted, getchar(), putchar(), printf() scanf(), escape sequences and format specifiers(%d, %f, %c,….)

(15 lectures)

Unit- IV Operator and expressions

Types of operators (unary binary and ternary) Classification of operators: assignment, arithmetic, relational, logical, comma operator, sizeof operator, operator, Hierarchy and associatively Type conversion (explicit and implicit), library functions. (15 lectures)

Unit- V Control statements:

Conditional statements, (if, if else, switch case), Looping Statement (for, while, do while), Nested Loops Infinite Looping, break and continue. (15 lectures)

Text Books:

1) Balaguruswamy: Programming in ANSI C
2) Yeshwant Kanetkar: Let US C.

Reference Books:

1) Gottlried: Programming in C Schism's Series
2) Brian W. Kernighan, Dennis Ritchie, and Dennis M. Ritchie: The C. Programming Language (2nd edition)
3) Peter Darnell & P. E. Marglis: C- Asogtware Engineering approach, Narosa Publication New Delhi 1993.

Course No :MAT522 **Number of Credits :6**

Semester – III Fluid Mechanics - I

Unit – I

Review of vector Analysis, Kinematics: Lagrangian and Eulerian methods (Rathy) Real and ideal fluids, velocity at a point, streamlines, path lines, streak lines, velocity potential, irrotational and rotational motions (Rathy), vorticity and circulation, Local and particle rates of change, The equation of continuity.
(15 Lectures)

Unit – II

Acceleration of a Fluid. Conditions at rigid boundary, General analysis of fluid motion. Pressure at a point in a fluid at rest and moving fluid, conditions at a boundary of two inviscid immiscible fluids, Euler's equation of motion, Bernoulli's equation. (15 Lectures)

Unit – III

Steady motion under conservative body forces, Potential Theorems, Axial symmetric flows, some two dimensional flows, Impulsive motion, some aspects of vortex motion, sources, sinks, doublets and their images. (15 Lectures)

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 potentials for standard two dimensional flows. (15 Lectures)

Unit – V

Examples, two dimensional image systems, Milne-Thomson circle theorem, applications and extension of circle theorem, the theorem of Blasius, conformal Transformation. (15 Lectures)

Text Books:

1. R. K. Rathy, An Introduction to Fluid Dynamics, IBH, New Delhi, 1976
   Chapter – III: Article 3.1,3.5,3.6
2. F. Chorlton, Text Book of Fluid Dynamics, C.B.S. Publishers and distributors, Delhi, 1985.
   Chapter – 2: Article 2.1 to 2.10, Chapter – 3 Article 3.1 to 3.12
   Chapter – 4: Article 4.1 to 4.3, Chapter – 5: Article 5.1 to 5.10

Reference Books:

1. S. W. Yuan Foundations of Fluid Mechanics, Prentic Hall of India Pvt. Ltd, New Deli, 1976.
2. W. H. Besaint and A. S. Ramsey, A Treatise on Hydromechanics, Part- II CBS Publishers, Delhi, 1988.
3. J. Chorin and A. Marsden, A Mathematical Introduction to Fluid Dynamics, Springer-verlag, New York, 1993.

Course No :MAT524 **Number of Credits :6**

Semester – III Numerical Analysis

Unit – I

Solution of algebraic and transcendental equations: Introduction; Bisection method; Iteration methods; first degree equations iteration methods Newton Raphson method; Secant and Regular falsi methods, Rate of convergence for secant method and Newton Raphson method; General iteration methods.

(15 lectures)

Unit – II

System of Linear Algebraic equations: Introduction; Linear system of Equations: Direct methods; Gauss Elimination method; Iteration methods; Jacobi iteration method; Gauss seidal iteration method; successive over Relaxation (SOR) method. (15 lectures)

Unit – III

Interpolation and approximation: Introduction; Interpolation; Langrange and Newton Interpolation Finite difference operators; Interpolating polynomial using finite difference; Hermite interpolation; piecewise and spleen interpolation.

(15 lectures)

Unit – IV

Numerical differentiation and integration: Introduction; Numerical differentiation and integration based on interpolation; Gauss Lagendre interpolation method; Gauss Hermite integration method, Trapezoidal rule, Simpson's 1/3 rule, Simpson's 3/8 rule. (15 lectures)

Unit – V

Numerical solution of ordinary differential equations: introduction; solutin by Taylor series, picards method of successive approximations, Euler method, Modified Euller method, Range – kutta methods. (15 lectures)

Prescribed Book:

1. Jain, Iyenger and Jain: Numerical methods for scientific and engineering computation. (4^{th} edition) New Age Pub. New Delhi.

Reference Books:

1. S. S. Sastry: Introductiry methods of Numerical Analysis (4^{TH} edition) Prentice Hall)
2. J. I. buchaman and P. R. Turner: Numerical method & Analysis (PHI)

Course No :MAT525 **Number of Credits :6**

Semester – III Lattice Theory

Unit – I

Partially ordered sets, two definitions of Lattices, lattice as a poset, lattice as algebra, Hasse diagrams, planer and optimal Diagrams, meet and join tables, Homomorphism. (15 lectures)

Unit – II

Isotone maps, sub lattices, ideals and their characterizations congruence relations, congruence lattices, the homomorphism theorem, product lattices, ideal Lattice, complete lattice and their properties. (15 lectures)

Unit –III

Distributive and modular inequalities and identities, complements and pseudo complements Demorgan's identities, Boolean lattice of pseudo complements, meet and join-irreducible elements, characterization theorems and representation theorems Dedikinds modularity criterion, Birkhoff's distributivity criterion (proofs without using free lattices) (15 lectures)

Unit – IV

Hereditary subsets, ring of sets, Stone theorems, Nachbin theorem Distributive join-semi lattices and characterization, Distributive lattices with pseudocomplementation. (15 lectures)

Unit – V

Join infinite distributive identify, algebraic lattices stone algebra and its characterizations. Distributive standard and neutral elements. (15 lectures)

Text Book:

George Gratzer, General lattice Theory Birkhauser (1998)

Chapter - 1: (section 1,2,3, Section 4 from lemma I onwards)
Chapter - 2: (sections 1,5 (lemmas 1 & 2), 6 (up to lemma 3)
Chapter - 3: (section 2 (up to theorems 5)

Reference Books:

1. G. Birkhoff : Lattice theory. Amer. Math. Soc. 3rd Edition (1973)
2. P. Crawley and R. P. Dilworth: Theory of algebraic lattice, Prentice Hall (1973)

Course No :MAT526 **Number of Credits :6**

Semester – III Operation Research - I

Unit – I

Operations research and its scope, Necessity of operations research in industry, Linear programming problems, convex sets, feasible solutions, formulation of L.P.P. method for solution of LPP. (15 lectures)

Unit – II

Graphical solution of L.P.P.Simplex method; theory and problems. Computational procedure, artificial variables inverse of a matrix using simplex method.

(15 lectures)

Unit - III

Duality in L.P.P. Concept of duality, properties, dual simplex method, its algorithm.parametric linear programming.

(15 lectures)

Unit – IV

Transportation and assignment problems, various methods. (15 lectures)

Unit - V

Game theory two person zero sum games, saddle point mixed strategies, graphical solution, by L.P.P., dominance. (15 lectures)

Text Books:

1. Kanti Swarup, P.K. Gupta and Man Mohan: Operations Research, S. Chand; & Sons, New Delhi.
   Chapter- 0 (Related concepts) Chapter 1, 2,3,4,6,7,9,
2. Mittal, K. V.: Optimization methods, Wiley, New Delhi.

Reference Books:

1. H. A.Taha: Operations Research- An introduction, Macmillan, New York,
2. N. S. Kambo, Mathematical-programming Techniques. Affiliated East-West Press, New Delhi.

Course No :MAT527 **Number of Credits :6**

Semester III
REACTION DIFFUSION THEORY - I

Unit – I
Reaction Diffusion Equations. Derivation of Reaction Diffusion Equations. Boundary Conditions. Derivation of Some Specific Models. Linear Reaction diffusion Equations. Maximum Principles [2] Positivity Lemmas. (15 Lecturers)
Unit – II
Monotone Method for Time – Dependent Problems. Nonuniqueness of Time-Dependent Solutions. Monotone Method for Steady-State Problems. Applications to Specific Models. (15 Lecturers)
Unit – III
Parabolic Boundary – value Problems. A Review of the Linear Parabolic Problem. (Theorem 1.2, and Theorem 1.3, statements only) Lemma 1.1, 1.2, 1.3 and Theorem 1.1, 1.2, 1.3 only statements A Positivity Lemma. Upper and Lower Sequences. Positivity Lemma, Maximum Principles. [2] (15 Lecturers)
Unit - IV
Existence- Comparison Theorems. Elliptic Boundary-Value Problems.The Linear Boundary-Value Problem (Lemma 1.1, Lemma 1.2, Lemma 1.3, Theorem 1.3, Theorem 1.4, and Theorem 1.5, Statements only). The Method of Upper and Lower Solutions.
(15 Lecturers)
Unit - V
The Uniqueness Problem. Positive Steady-State Solutions. Applications – (1) The Enzyme- Kinetics Model with Inhibition. (2) Chemical Reactor Model (3) The Thermal Ignition Problems (a) and (b). (15 Lecturers)

Text Books:

[1] C.V. Pao; Nonlinear Parabolic and Elliptic Equations; Plenum Press, New York and London, 1992.
Chapter 1: Article 1.1-1.8, Chapter 2:Article 2.1-2.4, Chapter 3: Article 3.1-3.4 and 3.8.
[2]. M. H. Protter and H.F. Weinberger; Maximum Principles in Differential Equations. Springer-Verlag, New York, 1984.
Chapter 2: Article 3, Chapter 3: Article 2,3.

Reference Books:

[1] A Friedman; Partial Differential equations of Parabolic Type, Prentice Hall, Englewood cliffs, N. J. 1964.
[2] G. S. Ladde ; V. Lakshmikantham, and A. S. Vatsala, Monotone; Iterative Techniques for Nonlinear Differential Equations, Pittman, Boston 1985.
[3]. P. C. Fife, Mathematical Aspects of Reacting and Diffusion Systems, Lecture Notes in Biomathematics, 28, Springer-Verlag, new York, 1979.

Course No :MAT528 **Number of Credits :6**

Semester – III Difference Equations – I

Unit – I

Introduction, Difference Calculus-The Difference Operator summation, Generating functions and approximate summation, (15 Lectures)

Unit- II

Linear difference Equations- first order equations, General results for linear equations. Equations with constant coefficients (15 Lectures)

Unit- III

Application, Equations with variable coefficients nonlinear equations, which can be linearized, The Z transform (15 Lectures)

Unit- IV

Stability Theory- Initial value problems for linear systems. Stability of linear systems Stability of nonlinear systems chaotic behaviors (15 Lectures)

Unit- V

Asymptotic Methods-Introduction Asymptotic analysis of sums. Linear equations nonlinear equations. (15 Lectures)

Text Book:

1. Walter G. Kelley and Allan C. Peterson: difference Equations – An Introduction with applications. Academic Press, Harcourt Brace Jouranovich Pub. 1991.

Reference book:

1. Calvin Ahlbrandt and Allan C. Peterson: Discrete Hamiltonian systems Difference equations, continued fractions and riccati Equations, Kulwer, Boston 1996.

Course No :MAT511 **Number of Credits :6**

Semester – IV - Linear Integral Equations

Unit - I:

Definition of Integral Equations and Linear Integral Equations, Types of Linear Integral Equations, Special kinds of Kernels: Separable or degenerate kernel, symmetric kernel, convolution-type kernels, Eigenvalues and eigenfunctions of kernels, Solution of linear integral equations, Verification of solution of linear integral equations.

(10 hours)

Unit -II:

Conversion of Boundary Value Problem to integral equations, conversion of Initial Value Problems to integral equations, conversion of Fredholm integral equations to Boundary Value Problems, conversion of Volterra integral equations into Initial Value Problems.

(15 hours)

Unit - III:

Methods of obtaining solution for Fredholm integral equations, Fredholm integral equations with separable kernels, Approximating kernels by separable kernels, Method of successive approximation, Iterated kernel method for Fredholm integral equations, Resolvant kernels and their properties, Methods of solutions for Volterra integral equations, Volterra type kernel, Method of differentiation, Method of successive approximations, Method of iterative kernels, Resolvant kernels and its use to solve Volterra integral equations. (20 hours)

Unit -IV:

Symmetric kernel, trace of a kernel, Fredholm operator, Fundamental properties of symmetric kernels, Eigenvalues and eigenfunctions of symmetric kernel and their properties, normalized eigenfunctions, Iterated kernel of symmetric kernels and their properties, Truncated kernel of symmetric kernel and necessary and sufficient condition for symmetric kernel to be separable, The Hilbert-Schmidt theorem, Solution of a Symmetric Integral equations. (15 hours)

Unit -V:

Integral Transform Methods, Recall of Laplace and Fourier Transforms, Applications to Volterra integral equations with convolution-type kernel, examples, Green’s function approach for ordinary differential equations.

(15 hours)

Text Books:

Linear Integral Equations Theory and Applications, R. P. Kanwal (Academic Press, 1971)

Reference Books:

Integral Equations, Shanti Swarup (Krishna Publication)

Course No :MAT512 **Number of Credits :6**

Semester – IV -Mechanics

Unit – I

Mechanics of system of particles, generalized coordinates, Holonomic & nonholonimic system, Scleronomic & Rheonomic system, D' Alemberts's principle and Lagrange's equation of motion, different forms of Lagrange's equation, Generalized potential, conservative fields and its energy equation, Application of Lagrange's formulation. (15 lectures)

Unit – II

Functionals, Linear functionals, Fundamental lemma of Calculus of Variations simple variational problems, The variation of functional, the extermum of functional, necessary condition for extreme, Euler's equation, Euler's equation of several variables, invariance of Euler's equation, Motivating problems of calculus of variation, Shortest distance, Minimum surface of revolution, Brachistochrone Problem, Isoperimetric problem, Geodesic. (15 lectures)

Unit – III

The fixed end point problem for 'n' unknown functions, variational problems in parametric form, Generalization of Euler's equation to (i) 'n' dependent functions (ii) higher order derivatives. Variational problems with subsidiary conditions, (15 lectures)

Unit – IV

Hamilton's principle, Hamilton's canonical equations, Lagrange's equation from Hamilton's principle Extension of Hamilton's Principle to nonholonomic systems, Application of Hamilton's formulation (Hamiltonian) cyclic coordinates & conservation theorems, routh's procedure, Hamilton's equations from variational principle, The principle of least action. (15 lectures)

Unit – V

Two-dimensional motion of rigid bodies. The independent coordinates of a rigid body, Orthogonal transformations, Properties of transformation matrix, The Euler angles, Cayle-klein parameters & related quantities, Euler's dynamical equation for the motion of rigid body. (15 lectures)

Text Books:

1. H. Goldstein, Charles Poole, John Safko: Classical Mechanics, Pearson 3rd Education, 2002.
   Cha. –1 , Cha. – 2 (2.1 to 2.4), Cha. (8.2-8.6) Cha. 4 (4.1 to 4.6)
2. I. M. Gelfand & S. V. Fomin: Calculus of variations, prentice-Hall.
   Chapter -1 (1,2,3,4,5,6) Chapter –2 (9.10,11,12)

Reference Books:

1. N. Rana and B. Joag: Classical Mechanics, Tata McGraw Hill 1991.
2. F. Gantmacher, Lectures in Analytic Mechanics, NIR Publishing House, New Delhi.
3. A. S. Ramsey, Dynamics Part II, The Engilish Language book Society and Cambridge University Press 1972

Course No :MAT531 **Number of Credits :6**

Semester – IV -MATLAB Programming

Unit – I

Introduction: Input / out put of Data from MATLAB Command, file Types, Creating saving and, Executing the Script file, Creating and executing functions file, working with files and directories. (15 Lecturers)

Unit – II

Matrices: Matrix manipulation, creating vectors. Arithmetic operations. Relational operations, Logical operations, matrix functions, Determinant of matrix, Eigen values and Eigen vectors. (15 Lecturers)

Unit – III

Programming in Matlab: function files, sub functions, Global Variables, Loops, branches and control flow, Interactive input, Recursion, Publishing a report, Controlling Command Windows, Command line Editing. (15 Lecturers)

Unit – IV

Linear algebra and Interpolation: solving a linear system, Gaussian elimination, Matrix factorizations, Curve fitting, Polynomial curve fitting, Least squares curve fitting, General nonlinear fits, Interpolation. (15 Lecturers)

Unit – V

Differential equations & Graphics: First order linear ODE, Second order ODE, Double integration, Roots of Polynomial, 2-d plots, 3-D plots, Matlab Plotting tools, Mesh and Surface Plots. (15 Lecturers)

Text Book:

1. Applied Numerical Methods Using MATLAB, Won Young Yang, Tae-Sang chung, John Morris, A John Wiley and Sons. Inc. Publication.
2. Solving ODE's with Maltab, L.F. Shampine, I Gladwell, S. Thompson, Cambridge University Press.
3. Getting Started with MATLAB 7, Rudra Pratap. OXFORD Press.

Reference Books:

1. Brain D. Hahn Dan: essential MATLAB for engineers and Scientists, 3rd Edition Valentine.
2. Gunnar Backstrom: practical Mathematics Using Matlab.
3. Jon H. Davis: methods of Applied Mathematics with a MATLAB Overview.

Course No :MAT532 **Number of Credits :6**

Semester – IV – Fluid Mechanics - II

Unit – I

Viscous flows, stress components in a real fluid, Relation between Cartesian components of stress, translationl motion of a fluid element, rate of strain quadric and principal stresses, properties of the rate of strain quadric, [1]. (15 lecturers)

Unit – II

Stress Analysis in Fluid Motion, relation between stress and rate of strain, the coefficient of viscosity and laminar flow, the Navier Stock's equations, [1]: The energy equation, [2], [3], Equations in Cartesian, cylindrical or spherical polar coordinates for a viscous incompressible fluid: - Statements only without proof; [2] [3], Diffusion of velocity and dissipation of energy due to viscosity, [1].

(15 lecturers)

Unit – III

Some Solvable Problems in viscous flow with heat transfer: - Flow between parallel Plates velocity and temperature distribution [2], [3] steady flow through a tube of uniform circular cross section, Velocity and Temperature Distribution, [2], [3], Distribution, [2], steady flow between concentric rotating cylinders, velocity and temperature distribution, [2],[3], Flow in tubes of arbitrary but uniform cross section, equations for velocity and Temperature in a steady flow, [1], [2], [3] Uniqueness Theorem for the velocity and Temperature , [1], Velocity distribution for tubes having equilateral triangular or elliptic cross section, [1] Velocity distribution for the flow through a tube of rectangular cross section [2], [3].

(15 lecturers)

Unit – IV

Flow between two porous Plates, plane Couett of plane poisseuille flow – velocity and temperature distribution, [2], Flow through a convergent or divergent channel, [2], [3], Flow of two immiscible fluids between parallel Plates, [2], Flow due to a Plane wall suddenly set in motion or due to an oscillating plane wall, [3].

(15 lecturers)

Unit – V

Flows at small or large Reynolds numbers: Dimensional Analysis Non-dimensional form of the Navier Stokes equations, approximate equations for flows at small or large Reynolds numbers, [1], [3], Flows at small Reynolds number: Theory of Lubrication between two plates, [2], [4], Model of a Paint brush, [4], Stoke's flow past a sphere, drag, [1], [3], Flow through a porous slab, [2]

Flows at large Reynolds number: Derivation of the boundary layer equations, [3], Karnans momentum integral equations, [1]. (15 lecturers)

Text Books:

1. F. Chorlton: Textbook of Fluid Dynamics, C.B.S. Pub. Delhi, 1976, Ch. 8
2. R. K. Rathy: An Introduction to Fluid dynamics, I.B.H. Pub. Co, New Delhi 1976,
   (§ 6.5,6.6a to 6.6c, 8.2 to 8.2c, 8.2e, 8.3 to 8.5b, 8.10a, 11.1, 11.2,11.4,11.6,11.9, 11.9a, 119b, 11.10, 11.10a, 12.2, 12.3d,).
3. J. L. Bansal: Viscous Fluid Dynamics, Oxford and IBH Pub. Co. 1977.
   (§ 2.5, 2.6, Tables 2.2, 2.4, 2.6, § 4.2 to 4.7, 4.12, 4.13, 5.1 to 5.3, 5.6, 6.1, 6.2.
4. G. K. Batchelor: An Introduction to Fluid Mechanics, Foundation book New Delhi, 1994, (§ 4.2, § 4.8).

Reference Books:

1. S. W. Yuan: Foundations of Fluid Mechanics Prentice Hall, of India, New Dehli, 1976.
2. W. H. Besaut and A. S. Ramsay: A Treatise on Hydrowecouies part II, CBS Pub. Delhi 1988.
3. A. J. Chorian and A Marsdeu: A Mathematical Introduction to Fluid Dynamics, Springer Verlag New York 1993.
4. L. D. Landau and E. M. Lipschitz: Fluid Mechanics, Press London 1985.
5. H. Schlicating: Boundary layer Tehory McGraw Hill New York, 1979.
6. A. D. Young: Boundary Layer AIAA Education Series, Washington, 1989.

Course No :MAT534 **Number of Credits :6**

Semester – IV - Fuzzy Mathematics

Specific objectives: To introduce the theory of fuzzy sets as a measure of uncertainty and a ambiguity. Also to introduce fuzzy and fuzzy logic and different operations on them.

Unit – I

From classical (crisp) sets to fuzzy sets; Introduction: crisp sets: An overview; Basic concepts in fuzzy sets; convex fuzzy sets (Theorems and exercises)

(15 lectures)

Unit – II

Fuzzy sets versus crisp sets: Additional properties of α - cuts; Representation of fuzzy sets; Decomposition Theorems. Operations on Fuzzy sets;
Types of operations; Fuzzy complement (Axioms and theorems)

(15 lectures)

Unit – III

Fuzzy intersections: t- norms; fuzzy unions: t – co norms; Combinations of operations; Aggregation of operations. (15 lectures)

Unit – IV

Fuzzy Arithmetic: fuzzy numbers; Linguistic Variables; Arithmetic operations on intervals of real numbers; Arithmetic operations on fuzzy numbers. (15 lectures)

Unit – V

Fuzzy relations: Introduction; fuzzy Relations; operations on fuzzy relations; α - cuts of a fuzzy relation; composition of fuzzy Relations; fuzzy relation on a domain.
Fuzzy Logic: Introduction; three valued logic; Infinite valued logic; fuzzy proposition and their interpretations in terms of fuzzy sets. Fuzzy rules and their interpretations in terms of fuzzy relations. (15 lectures)

Text Books:

1. Unit (I-IV) is covered by Klir George J. and Yuan Bo, Fuzzy sets and fuzzy logic. Theory and applications. Prentice Hall of India Pvt. Ltd. New Delhi. 1997.
2. M. Ganesh, Introduction to Fuzzy sets and Fuzzy logic, (OHI), New Delhi, 2006.

Reference books:

1. Kaufmann A and Gupta M. M., Introduction to Fuzzy arithmetic, Van Nostrand.
2. Zimmermann H. J., Fuzzy set theory and its applications, 1997.

Course No :MAT535 **Number of Credits :6**

Semester – IV Linear Algebra

Unit 1 :

Vector spaces, subspaces, linear dependence, independence, basis and dimension of a vector space. (15 Lectures)

Unit 2 :

Rank of a matrix, change of a basis, Linear transformations, algebra of linear transformations, range space, kernel space, rank of a linear transformation. (15 Lectures)

Unit 3 :

Algebra of linear transformations, Matrix representation of a linear transformation, dual spaces. (15 Lectures)

Unit 4 :

Eigen values, eigen vectors, Cayley – Hamilton theorem Minimal polynomials. (15 Lectures)

Unit 5 :

Canonical forms **,** Diagonal form , triangular form, Jordan form Introduction to Quadratic forms. (15 Lectures)

Recommended Books :

(1) Linear Algebra by Surjit Singh, Vikas Publishing House, New Delhi.
(2) Linear Algebra by Vivek Sahai and Vikas Bist, Narosa Publishing House. New Delhi.
(3) Linear Algebra by K. Hoffman and Ray Kunze (Second edition) Prentice Hall of India, New Delhi.
(4) Linear Algebra by S. H. Friedberg, A. J. Insel and L. E. Spence, Prentice Hall of India, New Delhi.
(5) Linear Algebra and its applications David C. Lay, Pearson Education.
(6) Linear Algebra by G. Paria, New central Book agency, Calcutta.

Course No :MAT536 **Number of Credits :6**

Semester – IV
Paper – Operations Research - II

Unit - I
Sequencing, problems with n jobs and two machines, problems with n jobs and two machines, graphical method, n- jobs and m machines. (15 lectures)

Unit - II
Dynamic programming, computational procedure, solution of LPP by dynamic programming. (15 lectures)

Unit - III
Nonlinear Programming introduction, general nonlinear programming problems, problem of constrained maxima and minima, graphical solution Kuhn-Tucker conditions, Quadratic programming. Integer programming (15 lectures)

Unit - IV
Replacement problems, Applications to industrial problems. (15 lectures)

Unit - V
Network scheduling and PERT CPM. (15 lectures)

Text book:
1. Kanti swarup P.K. Gupta and Man Mohan: Operations Research,S. Chand and sons, New Delhi.(Fourteenth Edition:2008)
Chapter - 10,11,12 (sections 12.1 to 12.5),13 (sections 13.1 to 13.4), 18 (sections 18.1 to 18.5), 25 (sections 25.1 to 25.6 and 25.8),27. (Sections 27.1 to 27.5),28 (Section 28.1 to 28.4)

Reference Books:

1. H. A. Taha: Operations Research- An introduction, Macmillan, New York,
2. S.S. Rao: Optimization Theory and Applications, Wiley, New Delhi.
3. N. S. Kambo, Mathematical-programming Techniques. Affiliated East-West Press, New Delhi.

Course No :MAT537 **Number of Credits :6**

Semester. IV REACTION DIFFUSION THEORY - II

Unit – I

Equations with Nonlinear Boundary Conditions. Parabolic Boundary-Value Problems. An Application to the Linear Problem. Elliptic Boundary-Value Problems.

(15 Lectures)

Unit - II

Existence Theorems for Holder-Continuous Functions. Uniqueness of Positive Solution. Applications. (1) A Heat –conduction Problem. (2) A model from Fermentation. (3) A Gas-Liquid Interaction Problem. (15 Lectures)

Unit – III

Stability Analysis. Lyapunov Stability. Stability of Uniform Steady-State Solutions. Stability of Non uniform Steady-State Solutions. (15 Lectures)

Unit – IV

Monotone Convergence of Time-Dependent Solutions. Stability of Maximal and Minimal Solutions. Problems with Nonlinear Boundary Conditions. (15 Lectures)

Unit - V

Application to Models with Nonlinear Reaction Functions. (1) Enzyme Kinetic Models. (2) Models in Population Dynamics. (3) Models in Reactor Dynamics and Heat Conduction. (4) Chemical Reactor Model. Application to Models with Nonlinear Boundary Conditions. (15 Lectures)

Text Book:

[1] C.V. Pao; Nonlinear Parabolic and Elliptic Equations; Plenum Press, New York and London, 1992.

Chapter 4, Articles 4.1, 4.2, 4.4, 4.5, 4.6 and 4.8.
Chapter 5, Article 5.1 - Article 5.8,

Reference Books:

[1]. M. H. Protter and H.F. Weinberger; Maximum Principles in Differential Equations. Springer-Verlag, New York, 1984.

[2] A Friedman; Partial Differential equations of Parabolic Type, Prentice Hall, Englewood cliffs, N. J. 1964.

[3] G. S. Ladde ; V. Lakshmikantham, and A. S. Vatsala, Monotone; Iterative Techniques for Nonlinear Differential Equations, Pittman, Boston 1985.

[4]. P. C. Fife, Mathematical Aspects of Reacting and Diffusion Systems, Lecture Notes in Biomathematics, 28, Springer-Verlag, new York, 1979.

Course No :MAT538 **Number of Credits :6**

Semester – IV -Difference Equations - II

Unit- I

Self adjoint second order linear equations Introduction. Sturmian Theory, Green's functions disconjugacy. The Riccati equations. Oscillations. (15 Lectures)

Unit- II

The Sturm-Liouville problem Introduction, finite Fourier Analysis non-homogeneous problem (15 Lectures)

Unit- III

Discrete calculus of variations Introductions, Necessary conditions, sufficient conditions and Disconjugacy. (15 Lectures)

Unit- IV

Boundary value problems for Nonlinear Equations-Introduction. The Lipschite case. Existence of solutions boundary value problems for Differential Equations. (15 Lectures)

Unit- V

Partial Differential Equations: Discrimination of partial differential equations. Solutions of partial differential equations. (15 Lectures)

Text Book:

1. Walter G. Kelley and Allan C. Peterson: difference Equations – An Introduction with applications. Academic Press, Harcourt Brace Jouranovich Pub. 1991.

Reference book:

1 Calvin Ahlbrandt and Allan C. Peterson: Discrete Hamiltonian systems Difference equations, continued fractions and riccati Equations, Kulwer, Boston 1996.