DEPARTMENT OF MATHEMATICS, SMIT

SCHEMA
M.SC. MATHEMATICS

Sl.No	Sub Code	Sub Title	Credit				Page No.
			L	T	P	C	
Semester I							
1.	MA 2101	Real Analysis I	4	-	-	4	2
2.	MA 2102	Algebra	4	-	-	4	3
3.	MA2103	Ordinary Differential Equation	4	-	-	4	4
4.	MA2104	Linear Algebra	4	-	-	4	5
5.	MA2105	Diff. Geometry and Tensor Calculus	4	-	-	4	6
6.	MA 2145	Computational Lab- I	-	-	3	2	7
Semester II							
7.	MA 2201	Real Analysis II	4	-	-	4	8.
8.	MA 2202	Complex Analysis	4	-	-	4	9.
9.	MA 2203	Fluid Mechanics	4	-	-	4	10.
10.	MA 2204	Topology	4	-	-	4	11.
11.	MA 2205	Numerical Analysis	4	-	-	4	12.
12.	MA 2245	Computational Lab II	-	-	3	2	13.
Semester III							
13.	MA2301	Functional Analysis	4	-	-	4	14.
14.	MA2302	Probability and Inference theory	4	-	-	4	15.
15.	MA2303	Discrete Mathematics	4	-	-	4	16.
16.	MA2304	Partial Differential Equation and Variational Principles	4	-	-	4	17.
17.	MA2305	Graph Theory	4	-	-	4	18.
18.	MA2306	Number Theory	4	-	-	4	19.
Semester IV							
19.	MA 2401	Linear & Nonlinear programming problems	4	-	-	4	20.
20.	MA 2402	Stochastic Processes	4	-	-	4	21.
21.	MA2431	Wavelet Analysis & Signal processing	4	-	-	4	22.
22.	MA2433	Plasma Dynamics	4	-	-	4	23.
23.	MA 2471	Major Project	-	-	-	8	24.

DEPARTMENT OF MATHEMATICS, SMIT

MA2101 **Credit: 4 (L-3, T-1, P-0)**
Real Analysis I
Questions to be set: Eight (Four from each unit)
Questions to be answered: Any five selecting at least two from each unit.

Objective: The goal of this course is to acquaint the students about basis analysis of mathematics such as set theory, natural number system, differentiation, integration etc.
Pre – **requisite** : Differential and Integral Calculus.

UNIT - I

Basic topology

Ordered sets, Euclidean space, Finite, Countable and Uncountable sets, compact sets, open and closed sets, the Cantor set, perfect set, Relation and Equivalence Relation, Partial Ordering and Maximal principle, Well ordering, Numerical Sequences and Series: Convergent sequence and subsequence, Lim sup, Lim inf, Cauchy Sequences, Root and Ratio Test, Absolute Convergence, Addition and Multiplication of Series.

Continuity and Differentiability

Continuity and Compactness, continuity and connectedness, Monotonic Functions, infinite limits and limits at infinity, uniform continuity. Differentiation: The derivative of a Real function, Mean value theorems, continuity of derivatives, Taylor's theorem, Differentiation of a vector valued functions.

UNIT - II

Integration

The Riemann-Stieltjes Integral: Definition and Existence of the Integral, Properties of the Integral, Integration and Differentiation, Integration of vector valued function, Rectifiable curves. Convergence of sequences and series of functions: Uniform convergence, Uniform convergence and Continuity, Uniform convergence and Integration, Uniform convergence and Differentiation, Equicontinuous Families of Functions, The Stone-Weirstrass Theorem.

Special functions

Power Series, The Exponential and Logarithmic Functions, The Trigonometric functions, The Algebraic Completeness of the Complex Field, Fourier Series, The Gamma function. Linear Transformations, Differentiation, The Contraction Principle, The Inverse Function Theorem, The Implicit Function Theorem, The Rank Theorem, Derivatives of Higher Order, Differentiation of Integrals.

Text Book:

1. Principles of Mathematical Analysis, Walter Rudin, McGraw-Hill
2. Real Analysis, H. L. Royden, PHI

References:

1. Mathematical Analysis : T P. Apostol, McGraw Hill
2. R Bartley: Introduction to Real Analysis, Wiley

MA2102 **Credit: 4 (L-3, T-1, P-0)**

Algebra

Questions to be set: Eight (Four from each unit)
Questions to be answered: Any five selecting at least two from each unit.

Objective: The objective of teaching this paper is to give a generalized view of abstract spaces along with some binary operations and their inter play.

Pre-requisite: Algebra of B. Sc. Course.

UNIT I

Group theory: Semigroups, Monoids and Groups. Definition and examples. Subgroup, Normal Subgroups, Quotient group. Homomorphism, Isomorphism, Automorphism and Cayley's Theorem. Permutation group, counting principles, Conjugacy relation, Class equation, Cauchy theorem and p-groups and Syllows theorem. Direct product, finite abelian groups.

UNIT II

Ring theory: Definition and examples of rings, some special classes of rings, Homomorphism, Ideals and quotient rings. Field of quotients of integral domain, Eucledian rings. Polynomial rings, Polynomials over the rational field. Polynomial ring over a commutative ring.

Text Books:

1. I . Herstein; Topics in Algebra; Wiley Eastern Ltd
2. N Jacobson; Basic Algebra; Hindustan Publishing Corporation

Reference Books:

1. D. S Malik, John N. Mordeson, M.K Sen: Fundamentals of Abstract Algebra; Mc Graw Hill International Editions.

2. PM Cohn; Basic Algebra; Springer International Edn.

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MA2103 **Credit: 4 (L-3, T-1, P-0)**

Ordinary Differential Equation

Questions to be set: Eight (Four from each unit)
Questions to be answered: Any five selecting at least two from each unit.

Objective: The objective of teaching this paper is to give a deep idea of the subject so that they can understand the theory and applications of the subject in various fields and can apply it in their higher studies or wherever it is necessary. Also it's aim is to give the students sufficient knowledge so that they can teach a UG course on Ordinary Differential Equation.

Pre-requisite: Calculus, Basic idea of Geometry, Analysis.

UNIT I

Introduction – Linear equations of the First Order, Problems associated with differential equations, The general linear equation of the first order, Linear Equations with Constant Coefficients – Linear dependence and independence of solutions, Wronskian, Non Homogeneous equation od order 2 and n, Initial Value problems; Linear equations Variable Coefficients – The initial value problem for the homogeneous equation, The Wronskian and linear independence, Homogeneous equation with analytic coefficients, The Legendre Equation.

UNIT II

Linear Equations with Regular Singular Points- The Euler equation, Second order equations with regular singular points., The Bessel equation. Existence and Uniqueness of Solutions to First Order Equations – The method of successive approximation, Lipschitz condition.
Strum Louville Boundary Value problem.
Non Linear Differential Equation- Phase Plane, Paths and Critical Points.

Text Books:

1. E. A. Coddington: An introduction to Ordinary Differential Equations, PHI
2. S. L. Ross: Differential Equations, Wiley

References Books:

1. G. F. Simmons: Differential Equations with Historical Notes, McGraw Hill
2. E. A. Boye & R. dePrima: Elementary Differential Equation and boundary Value problems, McGraw Hill.

MA2104 **Credit: 4 (L-3, T-1, P-0)**
LINEAR ALGEBRA

Questions to be set: Eight (Four from each unit)
Questions to be answered: Any five selecting at least two from each unit.

Objective: This is one of the fundamental subjects in mathematics. Linear algebra is also prerequisite for the subjects like functional analysis, spectral graph theory, optimization techniques, differential equations etc.

Pre-requisite: Basic idea of Modern Algebra.

UNIT I

Vector space and its example , Subspace , Linear span, Linear sum, Linear dependence and independence ofvectors, Basis and dimension (Existence theorem, replacement theorem , Extension theorem), Invariance of number of elements in a basis.
Linear Transformations , Algebra of Linear Transformation , Isomorphism, nullity and rank , Representation of transformation by matrices , change of basis , Linear functional, Dual space , Dual basis, The double dual, Annihilator, Transpose of a linear transformation.
Matrices, Diagonalization of matrices, Diagonalization of real symmetric matrices. Determinants, Properties of determinants, canonical forms, characteristic values, Characteristic equation, Cayley Hamilton theorem, annihilating polynomials, minimal polynomial ,Invariant subspaces, The primary decomposition theorem , Jordan Cannonical forms.

UNIT II

Inner product spaces, Norm, Orthogonality, Complete orthonormal set, Schwartz's inequality, Bessel's inequality, Gram Schmidt orthogonalisation process, linear functional and adjoints, unitary operators, Normal operators , Forms on inner product spaces, Spectral theory.
Bilinear forms, Symmetric and skew symmetric bilinear forms, Groups preserving Bilinear forms.

Text Books:

1 K Hoffman and R Kunze; Linear Algebra; Prentice-Hall of India, Pvt Ltd.

2 AR Rao and P Bhimashankaram; Linear Algebra and Applications; TMH Edn.

3 Theory and problems of matrices ;Schaums outline series , Mc Graw Hill.

Reference Books:

1. Linear Algebra ; C Y Hsiung , G Y Mao

2. Linear Algebra and its appliucations ; David C. Lay

3. A Text Book on matrices; Shanti Narayan , S. Chand and Company.

MA2105 **Credit: 4 (L-3, T-1, P-0)**
Differential Geometry & Tensor Calculus

Questions to be set: Eight (Four from each unit)
Questions to be answered: Any five selecting at least two from each unit.

Objective: The objective of this topic is to study the local geometry of space curves and Surfaces with the help of Differential Calculus.

Pre-requisite: B.Sc. Course in Mathematics of any Indian University.

UNIT I

Differential Geometry

Curves in Space, Normal and rectifying planes; Curvature, torsion and screw curvature, Serret-Frenet Formulae; Helices; Circle of curvature, sphere of curvature; Spherical Indicatrics, Involutes and Evolutes; Bertand Curves.

Surfaces, Tangent plane and normal; Characteristic and envelop; edge of regression; developable surfaces, Developable associated with a curve; two-parameter family of surfaces.

UNIT II

Tensor Calculus

Tensor: Transformation of coordinates, Contravariant Vectors and Tensors, covariant Vector and Tensors, Mixed Tensors (Invariants), Addition and Multiplication of Tensors, some Profperties of Tensors.

Testes for Tensor Character, the Matric Tensor, the Conjugate Tensors, Lowering and raising Suffixes, Geodesics, Transformation of Christoffel Symbols, Covariant Derivatives, The Curvature Tensors, Cartesian Tensors.

Text Books:

1. G.E. Hay, Vector and Tensors Analysis, Dover Publishers.
2. M.C. Chaki, Tensor Calculus, Calcutta Publishers.

Reference Books:

1 C.E Weatherburn, An Introduction to Riemannian Geometry and Tensor.

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MA2145 **Credit: 2 (L-0, T-0, P-2)**

Computational Lab – I

Contact hours: 3 hours/ week

Continuous assessment of Lab-Classes	-	60 Marks
Lab- Report on daily basis	-	18 Marks
Department level lab examination	-	22 Marks
Total	-	100 Marks

Objective: The goal of this course is to impart the knowledge of computational (programing) aspect of various mathematical software like Matlab or Maple along with C/C++ programing language.

Pre-requisite: Numerical and Statistical techniques.

Contents

1. Introduction to Vectors
    - Defining a Vector
    - Accessing elements within a vector
    - Basic operations on vectors
2. Introduction to Matrices
    - Defining Matrices
    - Matrix Functions
    - Matrix Operations
    - Vector Functions
3. Loops
    - For Loops
    - While Loops
4. Plotting
5. Executable Files
6. Subroutines
7. The If Statement
    - Example
8. Data Files
    - Saving and Recalling Data
    - Saving a Session as Text.
    - C Style Read/Write Statements.

MA2201 **Credit: 4 (L-3, T-1, P-0)**

Real Analysis II

Questions to be set: Eight (Four from each unit)

Questions to be answered: Any five selecting at least two from each unit.

Objective: The goal of this course is to impart the knowledge of measure theory and Lebesgue integral and related principles.

Pre requisite: MA2101

UNIT – I

Lebesgue Measure

Open and closed sets of real numbers, Borel sets, Outer measure, σ-algebra, Measurable sets and Lebesgue measure, A nonmeasurable set, Measurable Function, Continuity properties of Measurable Function, Littlewood's three principles.

The Lebesgue Integral

The Riemann integral, The Lebesgue integral of a bounded function over a set of finite measure, The integral of a nonnegative function, The general Lebesgue integral, Convergence in measure.

UNIT – II

Bounded Variation

Differentiation of monotone functions, Functions of bounded variation, Differentiation of an integral, Absolute continuity, Convex functions.

Metric Space

Introduction, open and closed sets, The L^p spaces, The Minkowsi and H*ö*lder inequality, subspaces, compact metric spaces, Baire category, Convergence and Severability.

Text Books:

1. Real Analysis, H. L. Royden, PHI
2. Real and Complex Analysis, Walter Rudin, McGraw-Hill.

Reference Books:

1. Introductory Functional Analysis and its Applications, Erwin Kreyszig, Wiley

MA2202 **Credit: 4 (L-3, T-1, P-0)**

Complex Analysis

Questions to be set: Eight (Four from each unit)
Questions to be answered: Any five selecting at least two from each unit.

Objective: The objective of teaching this paper is to give a deep idea of the subject so that they can understand the theory and applications of the subject in various fields and can apply it in their higher studies or wherever it is necessary. Also it's aim is to give the students sufficient knowledge so that they can teach a UG and PG course on complex analysis.

Pre-requisite: Calculus, Basic idea of Geometry, Analysis.

UNIT - I

Complex Number

Complex Plane, Lines and Half Planes in complex plane, Extended plane and its Spherical Representation, Stereographic Projection.

Complex Differentiation

Derivative of complex function, Comparison between differentiability in the real and complex senses, Cauchy-Riemann Equations, Necessary and sufficient conditions for differentiability of complex functions, Analytic functions, Entire functions, Harmonic functions.

Complex functions and Conformal Mapping

Polynomial function, Rational functions, Power series, Exponential, Logarithmic, Trigonometric and Hyperbolic functions. Branch of a logarithm, Analytic functions as mapping, Conformal mappings. Mobious Transformations.

UNIT - II

Complex Integration

The complex integral (over piecewise C^1 curve), Cauchy's theorem and Cauchy's integral formula, Power series representation of analytic functions, Morera's theorem, Goursat's theorem, Liouville's theorem, Fundamental theorem of Algebra, Zeros of analytic functions, Identity theorem, Weirstrass Convergence theorem, Maximum modulus theorem and its applications, Schwarz's Lemma, Index of a closed curve, Contour, Index of a contour, Simply connected domains, Cauchy's theorem for simply connected domains.

Singularities

Definitions and Classifications of singularities of complex functions, Isolated singularities, Laurent series, Casorati-Weierstrass theorem, Poles, Residues, Residue theorem and its applications to contour integrals, Meromorphic functions, Argument Principle, Rouche's theorem.

Analytic Continuation

Schwarz Reflection Principle, Analytic Continuation along a path, Monodromy theorem.

Text Books:

1. Conway. J.B., Functions of one complex variable, Second Edition, Narosa Publishing House.
2. Ahlfors, L.V., Complex Analysis, McDraw-Hill, 1979.
3. Sarason, D., Complex Function Theory, Hindustan Book Agency, Delhi, 1994.

Reference Books:

3. Rudin, W: Real and Complex Analysis, McDraw-Hill, 1966.
4. Titchmarsh, E.C., The theory of functions, Oxford University Press, London.
5. Ponnusamy, S., Foundation of Complex Analysis, Narosa Publishing House, 1997.

MA2203 **Credit: 4 (L-3, T-1, P-0)**
Fluid Mechanics

Questions to be set: Eight (Four from each unit)
Questions to be answered: Any five selecting at least two from each unit.

Objective: Introduce the basic terminology of fluid mechanics. Understand the principles of continuity, Momentum and energy as applied to fluid motions. To solve basic flow problems and evaluate the flow potential of given systems. To familiarize the student with the Navies-Stokes equation and its solution for different flow problems. To acquire the basic knowledge about the boundary layer approximation.

Pre-requisite: Numerical Analysis, Calculus and Differential equations.

UNIT - I

Introduction: Basic concept of fluid, Unit of Measurement, solid, Liquids and Gases, Continuum Hypothesis, Transport Phenomena, surface Tension, Inviscid Incompressible fluid: Lagrangian and Eulerian specifications, Streamline, Path line and Streak line. Vorticity and circulation. Stream function.Conservation of Mass, Euler Equation of motion along Streamline. Bernoulli's equations and its applications.Two-dimensional motion. Stream function, complex potential and velocity, sources, sinks. Doublets and their images. Circle theorem, Blasius's theorem,
Vortex motion, vortex lines and filaments, strength of a vortices, systems of vortices, rectilinear vortices, vortex pair and doublets. A single infinite row of vortices, Karman's vortex sheet.

UNIT - II

Viscous incompressible fluid:
Basic equation of conservation of mass, momentum and energy. Law of similarity, Reynolds numbers. Exact solutions of the Navier-Strokes equations: Flow through parallel walls, flow through circular pipe, Stroke's first and second problems. Prandtl's concept of boundary layer. Boundary layer approximation. Derivation of boundary-layer equations for two-dimensional flow, different measures of boundary layer on a flat plate Blasius solution.

Text Books:

1. H. Schlichting: Boundary-Layer theory, McGraw-Hill,Inc
2. S.W Yuan: Foundation of fluid Mechanics, Prentice Hall

Reference Books:

1. L.M Milne-Thomson**:** Theoretical hydrodynamics. The Macmilan Co. 1960
2. L.D Landau and E.M Lifshitz**:** Fluid mechanics. Course of Theoretical Physics, Vol.6 Pergamon Press, 1959
3. H. Lamb**:** Hydrodynamics. Cambridge Mathematical Library. Cambridge University Press, 1993
4. W.H. Besant and A.S. Ramsey**:** A treatise of Hydro-mechanics, Part II, ELBS

MA2204 **Credit: 4 (L-3, T-1, P-0)**
Topology

Questions to be set: Eight (Four from each unit)
Questions to be answered: Any five selecting at least two from each unit.

Objective: The objective of teaching this paper is to give a generalized /extended analysis of general spaces, showing real analysis is a particular case of such general space.

Pre-requisite: Real Analysis

UNIT - I

Topological Spaces, Examples of topological spaces, Bases and sub Bases, neighbourhood, interior, boundary, Open and closed sets , closure, interior. Subspace topology, Continuous functions, open and closed functions, Homeomorphisms. Sum and product of topological spaces, Product topology, Quotient topology, Metric topology.

Separation axioms, Hausdorff spaces, Regular space, Normal space, Fully normal space, Uryshon's function and lemma, Tietze's extension theorem, Completely Regular space, Tychonoff space.

UNIT - II

Connectedness, path connected and locally connected spaces. Count ability axioms, first countable space, second countable space, separable space, Lindelof space.

Compactness, finite intersection property, limit point compactness, locally compact spaces and one point compactification, Para compactness.

Convergence, nets and filters.

Text Books:

1 J.R. Munkres, Topology: A first course. Prentice-Hall, Inc. 1975.

2 J. Dugundji, Topology. Allyn and Bacon Series in Advanced Mathematics. Allyn and Bacon, Inc., 1978.

Reference Books:

1. K. D. Joshi : Introduction to General Topology (Wiley Eastern Limited).
2. J. L. Kelley : General Topology (Springer Verlag, New York 1991.

MA2205 **Credit: 4 (L-3, T-1, P-0)**

Numerical Analysis

Questions to be set: Eight (Four from each unit)
Questions to be answered: Any five selecting at least two from each unit.

Objective: To have capability of solving any physical problem numerically.

Pre-requisite: B.Sc. Course in Mathematics of any Indian University

UNIT - I

Errors. The Accuracy of Approximate Calculations. Interpolation: Differences, Newton's formula for interpolation, Interpolation with unequal intervals of argument, Central difference interpolation formula, inverse interpolation (Derivation of all interpolation formulae, Accuracy of interpolation formulae). Spline interpolation (two & three), Numerical differentiation and integration, (Derivation of all formulae) and the accuracy of quadrature formulae.
Solution of Numerical, Algebraic and Transcendental equations. (Convergence Criteria of all methods and proof of related theorems), Simultaneous equations in several unknowns. Graeffe's root squaring method for solving algebraic equation.
Solution of System of linear equations:Direct method: Gauss elimination and LU decomposition including Choleysky Scheme, Iterative Schemes : Jacobi iteration scheme, Gauss- Seidel method, Successive Over –Relaxation method, Convergence criteria for iterative methods, Ill Condition systems.

UNIT - II

Eigen value Problems (Power method, QR Algorithm)
Numerical Solution of Ordinary Differential equations. Equations of First Order, Equations of Second order and Systems of simultaneous equations. Taylor, Picard's Method successive approximation, Euler Method, Runge Kutta Fourth order methods.
Predictor-Corrector Methods-Milne' Method, Adam-Bashforth, and Adam Moulton Method and their deduction.
Boundary value problem-Method of Finite difference.
Text Book:

1. M.K. Jain, S.R.K Iyengar and R.K. Jain : Numerical Methods for scientists and Engineers, Wiley Eastern LTD.
2. F.B. Hildebrand: Introduction to Numerical Analysis; Dover Books.

Reference Books:

1. K. Atkinson & W. Han: Elementary Numerical Analysis, Wiley India
2. S. Yakowtiz & F. Szidarovszky: An Introduction to Numerical Computations, Macmillan Publishing Company
3. S. Pal: Numerical Methods, Oxford Univ. Press.

MA2245 **Credit: 2 (L-0, T-0, P-2)**
Computational Lab – II

Contact hours: 3 hours/ week

Continuous assessment of Lab-Classes	-	60 Marks
Lab- Report on daily basis	-	18 Marks
Department level lab examination	-	22 Marks
Total	-	100 Marks

Objective: The goal of this course is to make the students capable of developing logic and write their own code using suitable programing language. Students can implement various numerical and statistical techniques using matlab, maple, mathematics or c.

Pre-requisite: MA2145.

Problems:

1. Determination of a real root by
   (I) Regula-Falsi Method,
   (II) Newton-Raphson Method.
2. Interpolation:
   (I) Newton's Forward,
   (II) Newton's Backward,
   (III) Lagrange.
3. Numerical Differentiation using Newton's Forward interpolation formula.
4. Numerical Integration
   (I) Trapezoidal rule,
   (II) Simpson's $1/3^{rd}$ rule,
   (III) Romberg integration,
   (IV) Gauss Quadrature.
5. Reduction of a square matrix to upper triangular form.
6. Solution of systems of linear equations
   (I) By LU decomposition Method,
   (II) By Gauss elimination Method,
   (III) By Gauss-Seidal Method.
7. Greatest eigenvalue by Power Method
8. Solution of initial value problem by
   (I) Euler's Method,
   (II) Runge-Kutta Method (4^{th} order).

Text Books:

1. Elementary Numerical Analysis , an algorithmic approach, Conte & DeBoor Mcgraw Hill Koga-Kusha.
2. Programming with FORTRAN, S. Lipschutz and A. Poe, International Edditions, Schaum's Outline Series, 1998.

MA2301 **Credit: 4 (L-3, T-1, P-0)**
Functional Analysis

Questions to be set: Eight (Four from each unit)
Questions to be answered: Any five selecting at least two from each unit.

Objectives: Functional analysis plays an increasing role in the applied sciences as well as in mathematics itself. It is useful in the Applications of Contractions, Approximation theory, Spectral Theory etc. Syllabus is intended to familiarize the graduate students of mathematics and physics with the basic concepts, principles and methods of this subject and its applications.

Pre-requisite: A background in undergraduate mathematics, in particular, linear algebra and ordinary calculus, is sufficient as a prerequisite.

. **UNIT - I**

Banach Space and its Dual:

Metric spaces, Normed linear spaces, Banach spaces. Bounded linear operators. Dual of a normed linear space. Hahn-Banach theorem, uniform boundedness principle, open mapping theorem, closed graph theorem. Computing the dual of well-known Banach spaces.

UNIT - II

Hilbert Space and Operator theory:

Weak and weak* topologies, Banach-Alaoglu Theorem. The double dual, Goldstein's Theorem, reflexivity. Hilbert spaces, adjoint operators, self-adjoint and normal operators, spectrum, spectral radius, analysis of the spectrum of a compact operator on a Banach space, spectral theorem for bounded self-adjoint, normal, and unitary operators.

Text Book:

1 Functional Analysis , E. Kreyszig
2 Functional Analysis, B. K. Lahiri

Reference Books:

1 W. Rudin, *Functional analysis*. McGraw-Hill, Inc., 1991.
2 J. B. Conway, *A course in functional analysis*. Graduate Texts in Mathematics, 96. Springer-Verlag, 1990.
3 K. Yosida, *Functional analysis*. Grundlehren der Mathematischen Wissenschaften, 123. Springer-Verlag, 1980.
4 B.V. Limayae, Functional Analysis

MA2302 **Credit: 4 (L-3, T-1, P-0)**
Probability & Inference Theory

Questions to be set: Eight (Four from each unit)
Questions to be answered: Any five selecting at least two from each unit.

Objective : Probability theory plays an integral part of the development of many real models which have vast applications in many areas of science and engineering.

Pre requisite: Calculus, linear algebra.

UNIT - I

Introduction, Random experiment, Event (exclusive & exhaustive), Classical, Frequency and Axiomatic definition of probability Related theorem. Conditional Probability, Independent events. Bayes' theorem. Compound experiment, Multinomial law. Random variables- distribution function and its properties, Moments and inequalities. Moment generating Function.
Discrete distributions: Binomial, Poisson, Geometric, Hypergeometric, (properties and related problems).
Continuous distributions: Normal, Exponential, Gamma, Chi and t-distributions, F-distribution (properties and related problems). Two dimensional distribution- Moments, Correlation coefficient, Theorems and related problems. Least square regressions.

UNIT - II.

Limiting Distribution, Central Limit Theorem.
Population, Sample, Distribution of Sample , Sampling distribution of Sample mean, Variance from normal population.
Statistical Inference- Confidence interval for means, Tests of Statistical Hypotheses, (Normal population) , Chi square Test.
Estimation: Estimate and Estimator, unbiased and Consistent estimate, Point (maximum likelihood, moment) estimation technique, confidence interval.

Text Books:

1. W Feller: An introduction to probability Theory and applications, Vol I & II, John Wiley Sons.
2. R. Hogg & A Craig: Introduction to Mathematical Statistics; Pearson.

Reference Books:

1. Miller & Freund, Probability and statistics for engineers, Prentice Hall, India 2002.
2. P.L. Meyer : Introduction to Probability and Statistical Applications, Oxford and IBH Publication.
3. A.M, Mood, F.A., Graybill and D.C., Boss; Introduction to Theory of Statistics, McGraw Hill.

MA2303 **Credit: 4 (L-3, T-1, P-0)**
Discrete Mathematics

Questions to be set: Eight (Four from each unit)
Questions to be answered: Any five selecting at least two from each unit.
Objectives:
The core objective of this course is to impart basic concepts of mathematical logic and other related areas of discrete mathematics.
Prerequisites: NIL

UNIT I

Informal Statement Calculus: Statements and Connectives, Truth Tables and Truth Functions, Normal Forms, Adequate Sets of Connectives, Arguments and Validity.
Formal Statement Calculus: The Formal System L, The Adequacy Theorem for L.
Informal Predicate Calculus:Predicates and Quantifiers, First Order Languages, Interpretations, Satis-faction. Formal Predicate Calculus: The Formal System KL, Equivalence, Substitution, Prenex Theorem, TheAdequacy Theorem for K, Models. Mathematical Systems: First Order System with Equality, The Theory of Group, The First Order Arithmetic, Formal Set Theory, Consistency and Models.

UNIT II

Relations and Functions: Binary Relations, Closure of Relations, Relation Digraphs, Equivalence Relations and partitions, Partial Ordering Relations and Lattices, Chains and Antichains, Recursive Functions, Hashing Functions, Recurrence Relations, Solving Linear Recurrence Relations, Divide and Conuer method and Recurrence Relations, Principle of Exclusion and Inclusion, Pigeonhole Principle, Extended Pigeonhole Principle. Generating Functions: Operations on Generating Functions, scaling, addition, right-shifting, Differentiation, and Products of Generating functions, Closed Form of Generating Functions.
Lattice and Boolean Algebra: Lattices and Algebraic systems, Principle of Duality ,Boolean Lattices and Boolean Algebra, Boolean Functions, Boolean Expressions, Representation and Minimization of Boolean Functions, Finite State Machines.

Text Book:

1. Logic for Mathematicians, A G Hamilton, Cambridge University Press.
2. Discrete Mathematical Structures with Applications to Computer Science, J P 3. Tremblay, R.Manohar,TataMcGraw-Hill Education.

Reference Books:

1. Elements of Discrete Mathematics, C L Liu, D P Mohapatra, Tata McGraw-Hill Education.
2. Discrete Mathematics and Its Applications, Keneth H Rosen, Tata McGraw-Hill Education.

MA2304 **Credit: 4 (L-3, T-1, P-0)**

Partial Differential Equations and Variational Principles

Questions to be set: Eight (Four from each unit)
Questions to be answered: Any five selecting at least two from each unit.

Objective: To have capability of solving analytically partial differential equations involved in any physical problem and also use the concept of variational calculus which are widely used in many different areas science and engineering.

Pre-requisite: MA2101, MA2105, MA2201

UNIT - I

Partial differential equation of First order-Cauchy Problem for the first order equations, Linear equations of First order, Jacobi method, Charpit method, Cauchy method of Characteristics, , Linear equations of the second order- Equations with constant coefficients , equations with variable coefficients, Method of separation of variables . Laplace equation, Wave equation, Heat equation – Their derivation and solution.

UNIT - II

Variational Principles

Elements of the theory-Functionals, Function spaces, the variational of a functional, a necessary condition for an extremum, the simplest variational problem- Euler equation. The Fixed End problem for *n* unknown Functions, variational problems in parametric form, functionals depending on higher order derivatives.
The general Variation of a Functional-Derivation of the basic formula, End points lying on two given curves.
Canonical Form of Euler equation, canonical Transformations, Hamilton Jacobi equation.

TEXT BOOKS

1. Ian Sneddon, Elements of Partial Differential Equation, Dover Publication
2. I.M. Gelfand and S.V. Fomin: Calculus of variations, Prentice Hall Inc.
3. A.S. Gupta: Calculus of variations, PHI.
4. K Sankara Rao, Elements of Partial Differential Equations, PHI.

REFERENCE.

1. K Zackman & S DuChaetu: Partial Differential Equations, Schuam's Outline Series
2. Mukesh Kumar: Calculus of Variations, PHI.
3. C Fox: Calculus of Variations: Dover INC.

MA2305 **Credit: 4 (L-3, T-1, P-0)**
Graph Theory

Questions to be set: Eight (Four from each unit)
Questions to be answered: Any five selecting at least two from each unit.

Objectives: The basic objective of this course is to introduce basic concepts of graph theory and the counting principles. Graph theory is one of the important branch of modern applied Mathematics. It has applications in Chemistry, Optimizations techniques and computer science and many more. Graph theory is also used as a tool to model many physical and applied problems.
Prerequisites: Linear Algebra (MA2104).

UNIT - I

Graphs, Subgraphs and Trees: Graphs and simple graphs, Graph Isomorphism, Subgraphs, Spanning Sub-graps, Induced Subgraphs, Operations on Graphs, Connectedness, Cut Edges, Cut Vertices, Blocks.Trees, Connectivity and Traversability: Characterization of Trees, Centers of Trees, Spanning Trees, Rooted and Binary Trees, Fundamental Cycles, Point and Line Connectivity, Euler Graphs, Hamiltonian Graphs, The Traveling Salesman Problem.
Planarity and Coloring: Plane and Planar Graphs, Dual Graphs, Euler's Formula, The Chromatic Number, The Five-Color Theorem, The Four Color Theorem, Outer planar Graphs, Kuratowski's Theorem, Matchings. Directed Graphs and Tournaments: Directed Graphs, In-degree, Out-degree, Complete Digraphs, Bal-anced Digraphs, Euler Digraphs, Teleprinters Problem, Trees with Directed Edges, Polish Notation, Paired Comparisons and Tournaments.

UNIT - II

Matrices: Trace and Determinant, Orthogonality, Schur Complement, Inverse of Partitined Matrix, Cauchy-Binet Formula, Eigenvalue of Symmetric Matrices, Spectral Theorem, Positive Definite Matrices, Generalized Inverses. Incidence Matrix: Incidence Matrix of a Graph, Rank of The Incidence Matrix, Minors, Path Matrix, 0-1 Incidence Matrix.
Adjacency Matrix: Adjacency Matrix of a Graph, Eigenvalues of The Adjacency Matrices of Cycles, Complete Graphs, Complete Bipartite Graphs, and Paths, Determinant of Adjacency Matrix, Bounds for Eigenvalues. Laplacian Matrix: Laplacian Matrix of Graph, Basic Properties, Laplacian Eigenvalues, Matrix Tree Theorem.

Text Books:

1. Frank Harary, Graph Theory, Narosa Publishers, New Delhi (1989).
2. R B Bapat, Graphs and Matrices, Hindustan Book Agency.
3. Narasing Deo: Graph Theory with Applications to Engineering and Computer Science, Prentice Hall, India (1995).

Reference Books:

1 Douglas B. West, Introduction to Graph Theory Prentice- Hall, New Delhi (1999)
2. John Clarke and D.A. Holton, A First Look at Graph Theory, Allied Publisher (1991)

MA2306 **Credit: 4 (L-3, T-1, P-0)**
NUMBER THEORY

Questions to be set: Eight (Four from each unit)
Questions to be answered: Any five selecting at least two from each unit.
Objectives: The core objective of this course is to provide an introduction to basic number theory with applications in cryptography. Moreover, the course provides an introduction to some basic cryptographic techniques.
Prerequisites: There are no formal prerequisites for this subject, but some familiarity with proofs will be helpful as we'll be doing plenty of those in class and homework.

UNIT I

Divisibility Theory in The Integers: The division algorithm, The greatest common divisor, The Euclidean algorithm, The diophantine equation ax + by = c.

Primes and their distribution: The fundamental theorem of arithmetic, The sieve of Eratosthenes, The Goolbach conjecture.

The theory of congruences: Basic properties, special divisibility tests, linear congruences. Fermat's Theorem: Fermat's factorization method, The Little theorem, The Wilson's theorem.

Number theoretic functions: The functions σ and ψ , The Mobius inversion formula, The greatest integer function. Euler ϕ function, Euler's theorem, application to cryptography.

UNIT II

Primitive roots and indices: The order of an integer modulo n, Primitive roots of primes, theory of indices.

The quadratic reciprocity law: Euler's criterion, The Legender symbol and its properties, quadratic reciprocity, quadratic congruences with composite moduli.

Perfect Numbers: The search for perfect numbers, Mersenne primes, Fermat numbers, Pythagorean triples, Fermat's last theorem.

Text Book:

1. Elementary Number Theory, David M. Burton, Universal Book Stall, New Delhi.

Reference Books:

1 Number Theory, George E. Andrews, Dover Publication.

MA2401 **Credit: 4 (L-3, T-1, P-0)**

Linear and Non Linear Programming Problems

Questions to be set: Eight (Four from each unit)
Questions to be answered: Any five selecting at least two from each unit.

Objective: To understand apply optimization problems which naturally occurs in many areas of science and engineering.

Pre-requisite: MA2101, MA2104

UNIT - I

Linear Programming Problem

Mathematical Preliminaries, Characteristics of an Optimal Solution, Simplex Method and Simplex Algorithm, Duality, Transportation problems-Mathematical formulation as an L.P.P, Initial basic feasible solution, optimality test of initial basic feasible solution, computational procedure. Assignment Problem-Mathematical formulation, computational procedure.

Sensitivity Analysis- Changes in the objective function, Variations in requirement Vector, changes in the coefficient matrix, Addition of a variable, Addition of a constraint.

Integer Linear programming- Cutting Plane method, Branch and Bound method.

UNIT - II

Non Linear Programming Problem

Non Linear programming- Introduction, unconstrained optimization, Constrained Optimization, Kuhn Tucker Optimality conditions, Quadratic Programming- Wolfe's Method, Dantzig's Method, Beale's Method. Methods of Nonlinear Programming- Separable Programming, Kelly's Cutting Plane problem, Wolfe's Reduced Gradient Method.

TEXT BOOKS

1. G Hadley: Linear Programming; Narosa.
2. H. Taha: Oerations Research, An Introduction; Pearson.
3. Kanti Swarup, P K Gupta & Man Mohan: Operations Research, S Chand.

REFERENCE:

1. S. M. Sinha: Mathematical programming; Elsevier
2. F. S. Hillier & G. J. Leiberman: Introduction to Operations Research, Tata McGraw Hill.

MA2402 **Credit: 4 (L-3, T-1, P-0)**
Stochastic Processes

Questions to be set: Eight (Four from each unit)
Questions to be answered: Any five selecting at least two from each unit.

Objective: The objective of the course is train students on stochastic processes which these days has enormous application on computer science, communication engineering and mathematical aspects of finance. On successful completion of the course, this will enable the students to broaden their job horizon as well as opening new and exciting research topics.

Pre-requisite: Probability theory, linear algebra and strong foundations on calculus.

Then following chapters will be covered. Emphasis should be more on problem solving.

UNIT - I

Introduction- Classification of Stochastic Processes, Stationary and weak sense, strong sense processes, Auto-correlation, auto-covariance, cross correlation and cross covariance functions. The Poisson process- Fundamental Results, Compound and Conditional Processes, Inter arrival times and Waiting time distributions. Renewal theory-Fundamental Theorem.
Markov Chains: discrete parameter Markov chains, Chapman Kolmogorov equations, classification of states and chains with fundamental theorems. Gambling problems.

UNIT - II

Continuous Time Markov Chains- Basic results, Birth and Death processes. Deduction of Kolmogorov differential equations. Kolmogorov Forward and backward equations and their applications.
Queuing Theory: M/M/1, M/M/c, M/G/k queues - Pollazack Kinchin equation.
Martingales : Basic ideas, Wald equation.
Brownian Motion and other Markov processes. Hitting times, Geometric Brownian motion, Brownian motion with drifts. Basic ideas of Random Walk problems.
Basic ideas of branching processes.

Text Books:

1. S. M. Ross, Stochastic processes. John Wiley & Sons, Inc., 1996.
2. J Medhi; Stochastic Processes, New Age International.
3. Hoel, Port, Stone: Introduction to Stochastic Processes,.

Reference Books:

1. R. N. Bhattacharya and E. C. Waymire, Stochastic processes with applications. A Wiley-Interscience Publication. John Wiley & Sons, Inc., 1990.
2. J. Medhi: Stochastic models in queuing theory, Elsevier.

MA2431 (ELECTIVE) **Credit: 4 (L-3, T-1, P-0)**
Wavelet Analysis and Signal Processing

Questions to be set: Eight (Four from each unit)
Questions to be answered: Any five selecting at least two from each unit.

Objective: The goal of this course is to acquaint the students about time and frequency analysis of a signal and its properties.
Pre-requisite: Functional Analysis.

UNIT – I

Fourier transform on L1(R) and L2(R), basic properties and examples, Windowed Fourier Transform : Motivation and definition of Windowed Fourier Transform and examples, Time frequency localization, the reconstruction formula Continuous Wavelet Transform Introduction, Continuous-time wavelets, Definition of the CWT, the VWT as a Correlation, Constant-Factor Filtering Interpretation and Time-Frequency Resolution, the VWT as an Operator, Inverse CWT, Problems.
Introduction to Discrete Wavelet Transform And Orthogonal Wavelet Decomposition: Introduction, Approximation of Vectors in Nested Linear Vector Subspaces.

UNIT – II

Multiresolution Analysis : Definition of MRA and examples, Properties of scaling functions and orthonormal wavelets basis, Construction of orthonormal wavelets, Interpreting Orthonormal MRAs for Discrete-Time signals, Scaling Functions and wavelets from Filter Coefficient, Problems.
Wavelet Transform And Data Compression: Introduction, Transform Coding, DTWT for Image Compression, Audio Compression, Video Coding Using Multiresolution Techniques.

Text Book:

1. L. Debnath, Wavelet Transformation and Their Applications, Birkhauser Pub.
2. E. Mallat, A wavelet Tour of Signal Processing, Elsevier.
3. Yves Mayer, Wavelets and Operators, Cambridge University Press.

Reference Books:

1. G. Kaiser: A Friendly Guide to Wavelets, Birkhauser Pub.
2. G. Bachman, L. Narici & E. Beckensterin: Fourier and Wavelet Analysis, Springer Verlag, 2009.
3. C. K. Chui, An Introduction to Wavelets, Academic Press, 1992.
4. C. K. Chui, An Introduction to Wavelets, Academic Press, 1992.
5. Archit Yajnik, Wavelet Analysis – An Introduction, Narosa press.

MA2433 (Elective) Credit: 4 (L-3, T-1, P-0)
Plasma Dynamics

Questions to be set: Eight (Four from each unit)
Questions to be answered: Any five selecting at least two from each unit.
Objective: To model physical problems using mathematical techniques.
Pre-requisite: Fluid Dynamics

UNIT - I

Laws of Electrodynamics, Maxwell's equations. Dynamics of a Charge Particle.
Basic Plasma Concept: Definition of plasma, Classification of plasmas, Debye shielding, Space charge, Fluids of positive and negative charges. Waves in un-magnetized plasma, Longitudinal Waves, Waves in magnetized plasma, Transverse waves, Langmuir waves, Ion Acoustic Waves, Electron-acoustic Waves, Ion Cyclotron waves, Magnetic-acoustic waves, Alfven Waves.

UNIT - II

Kinetic theory: Introduction, Distribution function, Vlasov equation, Fluid equations, Dispersion relations for different plasma waves.
Waves, Solitary waves and Solitons. The Burgers equation, the KdV equation, the KdV-Burgers equation, the MKdV equation and the KP equation, Reductive Perturbation Technique and Sagdeev's Pseudopotential method and their applications.

Text Books.

1. F. F. Chen, Introduction to Plasma Physics and Controlled Fusion (Plenum)
2. R. J. Goldston and P. H. Rutherford, Introduction to Plasma Physics (IOP)

Reference Books:

1. D. R. Nicholson, Introduction to Plasma Theory (Wiley)
2.Basudev Ghosh, Basic Plasma Physics (Narosa)