MASTER OF SCIENCE (MATHEMATICS) - FIRST SEMESTER

First Semester			
S. No.	**Name of Subject**	**Credits**	**Total Marks**
1	Real Analysis	5	100
2	Algebra-I	4	100
3	Linear Algebra	5	100
4	Differential Equations	5	100
5	Complex Analysis	5	100
Total		**24**	

Subject Name: REAL ANALYSIS

Unit 1: Revision

Elementary set theory, finite, countable and uncountable sets, Real number system as a complete ordered field, Archimedean property, supremum and infimum. Sequences and series, convergence, lim sup, lim inf, Continuity, uniform continuity.

Unit 2: Sequences

Sequences and series of functions, Pointwise and uniform convergence, Monotonic functions, types of discontinuity, Absolute Convergence, functions of bounded variation, Continuous functions of bounded variation.

Unit 3: Functions of Several Variables

Linear Transformations, Differentiations, The Contraction principle, Inverse Function Theorem, Implicit function theorem, Rank Theorem, Determinants, Derivatives of Higher order.

Unit 4: Riemann-Stieltjes Integral

Riemann-Stieltjes integrals, The R-S integral as a limit of sum, Classes of R-S integrable functions, Algebra of R-S integrable functions, Relation between Riemann and Riemann-Stieltjes integral.

Unit 5: Metric spaces

Metric spaces, compactness, completeness, Bolzano Weierstrass theorem, Heine Borel theorem; connectedness and continuity, Spaces of continuous functions as examples.

REFERENCE BOOKS:

1. R.G. Bartle and D.R. Sherbert : Introduction to Real Analysis, Wiley India, 3rd Ed. 2005.

2. W. Rudin, Principles of Mathematical Analysis, Mc-Graw Hill, 2000 .

3. T.M. Apostol: Mathematical Analysis, Narosa Publishing House, 2008 .

4. G.F. Simmons: Introduction to Topology and Modern Analysis, TMGH, 1963.

Subject Name: ALGEBRA-I

Unit 1 :
A brief review of groups, their properties and examples, subgroups, isomorphism theorems, homomorphism of groups, automorphisms of groups, symmetric, alternating and dihedral groups.

Unit 2 :
The class equation of finite groups, Sylow theorems, Direct products of groups, fundamental theorem of finite abelian groups and applications.

Unit 3 :
Nilpotent and Solvable Groups, Normal and Subnormal Series Jordan-Holder theorem.

Unit 4 :
Rings and Homomorphism, Ideals and Quotient Rings, Field of quotients of an Integral Domain.

REFERENCE BOOKS:

1. I.N.Herstein: *Topics in Algebra*, Wiley Eastern Ltd., New Delhi, 1975
2. Thomas W.Hungerford, *Algebra,* Springer-Verlag, New york, 1974
3. Gallian, J. A., *Contemporary Abstract Algebra*, 4th edition (Narosa Publishing house, New
Delhi, 2009).

Subject Name: LINEAR ALGEBRA

Unit 1 :
Systems of linear equations, Vector Space, Linear Span, Bases and dimensions, change of bases, sums and direct sums.

Unit 2 :
Linear transformations, matrix representations of linear transformations, the rank and nullity theorem, Linear Operators and Eigenvectors, Diagonalization and triangulation.

Unit 3 :
Dual spaces, transposes of linear transformations, invariant subspaces, Annihilators, the minimal polynomial, Jordan canonical form.

Unit 4 :
Orthogonal Transformations, Unitary Transformations, The Principal Axis Theorem, Bilinear forms: bilinear, positive and quadratic forms.

Unit 5 :
Inner product spaces, orthonogonal bases, Gram-Schmidt process.

REFERENCE BOOKS:

1. Hoffman and R. Kunze, *Linear Algebra*, Prentice-Hall of India, 1996.
2. P.K. Saikia, *Linear Algebra*, Prentice Hall, 2006.
3. C.W. Curtis, *Linear Algebra An Introductory Approach*, Springer, 1984.
4. G. Schay, *Introduction to Linear Algebra*, Narosa, 1997.

Subject Name: DIFFERENTIAL EQUATIONS

Unit 1: Partial Differential Equations of Second Order

Linear partial differential equations of second order with constant co-efficient, Characteristic curves of second–order equations, Reduction to canonical forms, Separation of variables, Solutions of nonlinear equations of the second order by Monge‟s method.

Unit 2: Laplace's Equation, Wave Equation, Diffusion Equation

The occurrence of Laplace's equation in Physics, Boundary value problems, Solution of Laplace‟s equation by separation of variables,. The theory of Green‟s function for Laplace‟s equation, The occurrence of the Wave equation in Physics, Elementary solutions of the one-dimensional Wave equation, The occurrence of the Diffusion equation in Physics, Elementary solutions of the Diffusion equation, Solution of the Diffusion equation by separation of variables.

Unit 3 : Ordinary Differential Equation

Review of fundamentals of ODEs, Some basic mathematical models, direction fields, classification of differential equation, Solutions of some differential equation, 1st order

non-linear differential equation, Existence and Uniqueness problem, Gronwall's inequality, Peanao existence theorem, Picard existence and uniqueness theorem.

REFERENCE BOOKS :

1. *Elements of Partial Differential Equations* by Ian. N. Sneddon, McGraw Hill Book Company.
2. Coddington, E. A. *An Introduction to Ordinary Differential Equations* (Prentice-Hall, 1974).
3. *Introduction to Partial Differential Equations* by K.S. Rao, PHI Pvt. Ltd, New Delhi, 2005.
4. Ross, S. L. *Differential Equations*, 3rd edition, Wiley 1984.

Subject Name: COMPLEX ANALYSIS

Unit 1 : Revisions

Functions of Complex variables, Mappings by exponential functions, limits, continuity, derivatives, Cauchy-Riemann equations, Analytic functions, Harmonic functions, Reflection principles, basic properties of Complex Integration, Cauchy's Theorem, Morera's Theorem, Cauchy Integral formula, Laurent's series, The Maximum modulus principle, Schewarz lemma, Liouville's theorem.

Unit 2 : Elementary functions

The exponential functions, logarithmic function, Branches and derivatives of logarithm, Complex exponents, Trigonometric functions, Hyperbolic functions, Inverse trigonometric functions.

Unit 3 : Series

Convergence of sequences, Convergence of series, Taylor series, Laurent Series, Absolute and uniform convergence of Power series, Integration and differentiation of power series, Uniqueness of series representation.

Unit 4 : Calculus of Residues

Residue at a finite point, Residue at the point at infinity, Residue Theorem, Number of zeros and poles, Argument principle, the winding number, Rouche's theorem, evaluation of Integrals.

Unit 5: Conformal Mapping

Linear Transformation, Linear fractional transformation, mappings of upper half plane, The transformation w = sin *z*; mappings by z2 and Branches of z1/2 , square roots of polynomials, preservation of angles, scale factor, local inverses, harmonic conjugates, transformation of harmonic functions, Applications.

REFERENCE BOOKS :

1. Mathews, J. H. and Howell, R. W., *Complex Analysis for Mathematics and Engineering*, 3rd Edition, Narosa, 1998.
2. S. Ponuswami, Foundations of Complex Analysis, Narosa Publication.
3. J.C. Brown and R.V. Churchill, Complex Variables and Applications, Mc- Graw Hill.
4. Complex Analysis, V.Karunakaran, Narosa Publication.

MASTER OF SCIENCE (MATHEMATICS) - SECOND SEMESTER

Second Semester			
S. No.	**Name of Subject**	**Credits**	**Total Marks**
1	Tensor Analysis	5	100
2	Algebra-II	4	100
3	Classical Mechanics	5	100
4	Continuum Mechanics	5	100
5	Functional Analysis	5	100
Total		**24**	

Subject Name: TENSOR ANALYSIS

UNIT –1 : Cartesian Tensor Algebra:

Scalars, vectors and Tensors; Suffix Notation, Cartesian summation convention, Kronecker delta, Permutation symbols, Matrices and determinants in Index notation, scalar multiplication, Cartesian Vector, Addition of vectors-coplanar vectors, Unit vectors, A basis of non-coplanar vectors, Scalar product-orthogonality, Vector product, Triple scalar product, Triple vector product, Reciprocal base system, Second order tensors, Examples of second order tensors, Scalar multiplication and addition, Contraction and multiplication, The vector of an antisymmetric tensor, Canonical form of a symmetric tensor, Higher order tensors, The quotient rule, Isotropic tensors.

UNIT–2 : Cartesian Tensor Calculus:

Cartesian tensor notations for :Tensor function of time-like variables, Line integrals, Surface integrals, volume integrals, Change of variable with multiple integrals, Vector fields, The Vector operator -Gradient of a scalar, The divergence of a vector field, The curl of a vector field, Green‟s theorem and some of its variants, Stokes theorem.

UNIT : 3 General Tensors:

Coordinate systems and conventions, Proper transformations, Contravariant vectors, Covarient vectors, The metric tensor, Examples, Absolute and relative tensor fields,

Isotropic tensor, Tensor algebra, The quotient rule, Length of a vector and angle between vectors, Principal directions of a symmetric second order tensor, Covariant and contravariant base vectors, The physical components of a vector, The physical components of a tensor,

UNIT - 4

Differential of tensors, Parallel vector field, Christoffel symbols, Christoffel symbols in orthogonal coordinates, covariant differentiation, The grade, divergence,Laplacian and curl, Green‟s and Stoke‟s theorem in general tensor notation, Euclidean and other spaces . Intrinsic derivatives and its applications.

REFERENCE BOOKS :

1. *Vector and Tensor Analysis,* Author : Utpal Chaterjee and Nandini Chaterjee Academic Publishers.
2. *Introduction to Tensor Calculus and Continuum Mechanics* by J. H. Heinbockel **.**
3. *Vectors, Tensors and the Basic Equations of Fluid Mechanics* Author: Rutherford Aris Dover Publication, Inc., New York. ISBN 0-486-66110-5
4. *Vector and Tensor Analysis,* Author Bosenko Tarapov Silverman, ISBN 10:0486638332, Dover Publication

Subject Name: ALGEBRA-II

UNIT-I:

Unique factorization domain, Principal Ideal Domain, Euclidean Domain

UNIT-II:

Polynomial rings- Polynomials over the rational field – Polynomial rings over Commutative rings

UNIT-III:

Algebraic Extensions of Fields, Adjunction of roots, Algebraic extensions, Algebraically closed fields

UNIT-IV:

Splitting fields, Normal extensions, Multiple roots, finite fields , Separable extensions

REFERENCE BOOKS :

1. I.N.Herstein: Topics in Algebra, Wiley Eastern Ltd., New Delhi, 1975
2. P.B. Bhattacharya, S.K. Jain and S.R. Nagpaul: Basic Abstract Algebra (2nd Edition), Cambridge University Press, Indian edition, 1997

3. D.S. Dummit, R.M. Foote: Abstract Algebra –John Wiley&Sons,2003
4. Thomas W.Hungerford, Algebra, Springer-Verlag, New york, 1974

Subject Name: CLASSICAL MECHANICS

Unit 1:

Introduction to the ideas of constrained motion, Different classifications of constrains of motion, Holonomic and nonholonomic constraints, rhenomic and scleronomic dynamical constraints, Concept of degree of freedom.
Introduction to generalized coordinates, generalized velocities, Total Kinetic energy of a system of particles in terms of generalized velocity. Introduction to generalized momenta and generalized force.
D"Alemberts principle and Lagrangian form of equation motion of a dynamical system of N particles. Few examples to explain the application of Lagrange"s form of equation of motion, motion of projectile of a particle, motion of double pendulum and similar few other simple problems.

Unit II:

Introduction to Technique of Calculus of variation : Euler"s Lagrange differential equation, discussion of examples to explain the application of Euler"s Lagrange differential equation, Brchistochrone problem, problem of shortest distance between two points on plane.
Introduction of Hamilton"s Principle of least action. Derivation of Lagrange"s form of equation of motion using Hamilton"s principle of least action. Lagranges form of equation for problems associated with nonholonomic constrains, conservation principles and symmetry properties, Lagranges, equation of motion for small oscillations.

Unit III:

Introduction to phase space and Equationian : Hamilton"s canonical equation of motion, canonical variables, cyclic co-ordinates, Canonical transformations and generating functions, Discussion on problem of motion of simple pendulum, double pendulum, motion of particle in a Use of Hamilton" canonical equation to solve certain simple dynamical problems (these includes all problems considered to explain use of Lagrange equatin of motions).
Lagranges and Poissons"s brackets: Integral invariant of Poincare, The Jacobi"s identity, Hamilton"s equation and Poison" bracket.
Lagranges brackets, poison bracket, integral invariant of Poincare, the Jacobi"s identity, Poisson"s bracket and Hamilton"s canonical equations.

Unit IV:

Hamilton Jacobi Method : Hamilton - Jacobi equation, Time independent Hamilton - Jacobi equation, canonical transformation generated by Hamilton characteristic function, application of Hamilton - Jacobi equation in solving problems of mechanics.

Action and angle variables, regular frequencies, costant action torus in phase space, periodic systems, degenerated systems, completely degenerated systems.

REFERENCE BOOKS :

1. Classical Mechanics by Herbert Goldstein, Addision Wesley Publishing Company, INC. USA.
2. Lagrangian and Hamiltonian Mechanics by M.G. Calkin, World Scientific, Singapore. 1996

Subject Name: CONTINUUM MECHANICS

Unit-1: Continuum Hypothesis and Stress

Continuum hypothesis, mass and density, body force and surface force, stress components, Cauchy‟s law, state of stress at a point, stress tensor, normal and shear stresses, principal stress, stress invariants, stress deviator, boundary condition for stress tensor.

Unit-2: Deformation and Strain

Continuum configuration, Lagrangian and Eulerian description, material and spatial co-ordinates, deformation, displacement and deformation gradients, stretch and rotation tensor, strain tensor, strain-displacement relations, infinitesimal strain tensor, interpretation of linear strain tensor, compatibility conditions, principal strains, strain deviator.

Unit-3: Motion and Fundamental Laws of Continuum Mechanic

Material and local time derivatives, velocity and acceleration, steady, uniform and linear motion, irrotational motion and potential flow, path lines, streamlines and vortex lines, Reynolds transport theorem, circulation and vorticity, conservation of mass, continuity equation, linear momentum principle, equation of motion, angular momentum principle, general solution of the equation of equilibrium, energy equation.

Unit-4: Equation of Fluid Mechanics

Viscous and inviscid fluids, viscous stress tensor, fluid pressure, incompressible and compressible fluids, Euler‟s equation of motion, Bernoulli‟s equation, circulation theorem, Stokes‟s condition, governing equations for a viscous fluid flow, initial and boundary conditions, Navier-Stokes equation.

REFERENCE BOOKS :

1. CONTINUUM MECHANICS by D. S. Chandrasekharaiah and Lokenath Debnath, PRISM BOOKS PVT. LTD., Bangalore.
2. MATHEMATICAL THEORY OF CONTINUUM MECHANICS by Rabindranath Chatterjee, Narosa Publishing House.
3. SCHAUM‟S OUTLINE OF THEORY AND PROBLEMS OF CONTINUUM MECHANICS by George E. Mase., SCHAUM‟S OUTLINE SERIES, McGraw-Hill.

4. VECTORS, TENSORS AND BASIC EQUATIONS OF FLUID MECHANICS by Rutherford Aris, DOVER PUBLICATIONS, INC., New York.

Subject Name: FUNCTIONAL ANALYSIS

Prerequisite :

Analysis, Set, Function, Countable Set, Uncountable Set, Cardinality and Inequalities linear Algebra, Vector Space, Linear Transformation between Vector Spaces. Metric Space, Definitions and Examples, Open Set, Close Set, Neighbourhood, Basic Topology, Continuity and Equivalent Metrics, Compactness, Sequences, Convergence, Cauchy Sequences and Completeness, Completion of Metric Spaces

Unit 1: Normal and Banach Space

Normed Space , Definition and Properties, Banach Space, Definition Properties, Finit Dimensional Mormed Spaces and Subspaces, Compactness and Riesz‟s Lemma, Quotient Spaces, Series in Normed Space, Absolutely Convergence Series in Normed Spaces, Operators, Fixed Point Theorem, Contraction Mappings Principle and Applications.

Unit 2 : Bounded Linear Operators/Functionals

Linear operators, Bounded Linear Operator, Spaces of Bounded Linear Operators, Inverse Operators, Continuous Linear Operator, Open Mapping Theorem, Closed graph Theorem and their Consequences, Uniform Boundedness Principal, Linear Functional, Linear Functional on Finite Dimensional Space, , Hanh-Banach Theorem and its Consequences.

Unit 3: Banach Algebra

Algebra, Normed Algebra, Definition and Properties, Banach Algebra, Definition and Properties, The Gelfand-Mazur Theorem, Homomorphism, Isomorphism, Units, Regular Points, Non-Regular Points, Spectrum, Eigen value and Eigen Vector of an operator,

Unit 4: Hilbert Space

Inner Product Space, Swartz Inequality, Hilbert Space, Isomorphic Hilbert Spaces, Orthogonal and Orthonormal Sets, Gram-Schmidt Orthogonalization Process, Parallelogram Law, Fourier Coefficient, Riez-Fischer Theorem , Total Sets, Parseval‟s Theorem, Orthogonal Sum, Operators On Hilbert Spaces: Adjoint of a Bounded Linear Operator**,** Self-Adjoient Operator.

REFERENCE BOOKS :

1. *Introductory Functional Analysis with Applications* by E. Kreyszing John Wiley & Sons..
2. *Foundation of Functional Analysis* by S. Ponnusamy, Narosa Publishing House.
3. *Functional Analysis* by P.K. Jain, O.P. Ahuja, K. Ahmed, New Age International (P) Limited.

MASTER OF SCIENCE (MATHEMATICS) - THIRD SEMESTER

Third Semester			
S. No.	**Name of Subject**	**Credits**	**Total Marks**
1	Numerical Methods and Computer Programming	5	100
2	General Topology	5	100
3	Mathematical Methods	4	100
	Any Two	5	100
4 5	1. Fluid Dynamics 2. Probability Theory and Statistics 3. Fuzzy Mathematics 4. Optimization Theory	5 5	100 100
	Total	**24**	

Subject Name: NUMERICAL METHODS AND COMPUTER PROGRAMMING

Section A: Numerical Methods

Unit 1 : Solution of system of equations :

Doolittle and Crout‟s Decomposition , Successive approximation by Gauss Jacobi and Gauss Seidal Methods, Newton‟s method, Convergence of successive approximations.

Unit 2 : Solution of Ordinary Differential Equations : (Single Step Methods)

Stability and Convergence of numerical methods, Runge-Kutta method of second, third and fourth order.

Unit 3: Predictor-Corrector Methods :

General explicit method, Adam‟s-Bashforth method, Nystrom method, general implicit methods, Adam‟s Moultan and Milne-Simpson predictor-corrector methods

Section B: C-Programming

Unit 1 : Programme solving technique and C-Programming preliminaries

Algorithm, flow charts, top down and bottom up approach, data types, operators, input-data statements in C, simple C programmes.

Unit 2 : Array, Pointer and Data Files

Arrays to functions, pointers, operations on pointers, array using pointers, opening and closing data files, creation of a data file, processing of data file.

Section C : Practical

Based on Section A and Section B

REFERENCE BOOKS :

1. M.K. Jain, *Numerical Solutions of Differential Equations*, Wiley Eastern.
2. E.V. Krishnamurthy and S.K. Sen, *Numerical Algorithms,* Prentice Hall of India.
3. 4. E. Balaguruswamy, *Programming in C*, Tata Mc.Grew Hilsl.
5. E.V. Krishnamurthy, S.K. Sen, *Numerical Algorithms*, Prentice Hall of India.

Subject Name: GENERAL TOPOLOGY

Unit 1: Basis

Open Sets, Closed Sets, Neighbourhood, Limit Point, Interior, Closure, Basis, Sub-basis, finer and coarser topology, Subspace.

Unit 2: Continuity

Continuous Functions, Open Functions, Closed Functions, Homoemorphism, Composition of Continuous Functions, Pasting Lemma, Product Topology, Quotient Topology.

Unit 3: Compactness and Connectedness

Compact Space, Countable Compact Spaces, Linderloff Space, Local Compactness, Connectedness, Path Connectedness , Local Connectedness,.

Unit 4: Separation Axiom and Countability :

Ti (i = 1, 2, 3, 4, 5) spaces, Regular and Complete Regular Spaces, Normal Spaces, First and Second Countable Spaces, Separable Space.

REFERENCE BOOKS :

1. Topology – A first course by J.R. Munkres, Prentice- Hall. New Delhi.
2. *Introduction to Topology and Modern Analysis* by G.F. Simmons, Tata McGraw Hill, New Delhi.
3. *Schaum's Outlines General Topology* by S. Lipschutz, Tata McGraw Hill, New Delhi

Subject Name: MATHEMATICAL METHODS

Unit 1 : Fredholm Integral Equations

Definition of Integral Equation, Eigen values and Eigen functions : Reduction to a system of algebraic equations, Reduction of ordinary differential equations into integral equations. Fredholm integral equations with separable kernals, Method of successive approximations, Iterative scheme for Fredholm Integral equations of second kind, Conditions of Uniform convergence and uniqueness of series solution.

Unit 2 : Voltera Integral Equations :

Voltera Integral Equations of second kind, Resolvant kernel of Voltera equation and its results, Application of iterative scheme to Voltera integral equation of the second kind. Convolution type kernals.

Unit 3 : Fourier Transform :

Fourier Integral Transform, Properties of Fourier Transform, Fourier sine and cosine transform, Application of Fourier transform to ordinary and partial differential equations of initial and boundary value problems. Evaluation of definite integrals.

Unit 4 : Calculus of Variation with one independent variable :

Basic ideas of calculus of variation, Euler‟s equation with fixed boundary of the functional $I[y(x)] = \int_a^b f(x, y, y') \, dx$

containing only the first order derivative of the only dependent variable with respect to one independent variable. Variational problems with functional having higher order derivatives of the only dependent variable, applications.

Unit 5 : Calculus of Variation with several independent variables :

Variational problems with functional dependent on functions of several independent variables having first order derivatives, Variational problems in parametric form, variational problems with subsidiary condition (simple case only), Isoperimetric problems, Applications.

REFERENCE BOOKS :

1. R.P. Kanwal : *Linear Integral Equations, Theory and Techniques*, Academic Press, New York 1971.
2. M.R. Spiegel : *Theory and Problems of Laplace Transform.*
3. A.S. Gupta : *Calculus of Variation with Applications* : Prentice Hall of India (1999).

Subject Name: FLUID DYNAMICS

UNIT-1 : MOTION OF INVISCID FLUID IN TWO DIMENSIONS

Meaning of two dimensional motion, complex potential, velocity potential and stream function, sources, sinks and doublets, two dimensional image system, Milne-Thomson circle theorem, Blasius theorem, Magnus effect.

Unit-2 : MOTION OF SPHERE IN AXI-SYMMETRIC MOTION

Axi-symmetric flow, Stokes‟s stream function, stationary sphere in a uniform stream, pressure on the surface of a sphere, thrust on a hemisphere, D‟ Alembert‟s Paradox, kinetic energy of liquid.

Unit-3 : EQUATION OF MOTION FOR VISCOUS FLOW

Viscous fluid, co-efficient of viscosity, exact solution of Navier Stokes equation (Couette flow, Generalized Couette flow, Poiseuille flow, Hagen-Poiseuille flow through a pipe, flow between two concentric rotating cylinders, Stokes first problem), rate of change of circulation, diffusion of vorticity, energy dissipation due to viscosity.

Unit-4 THEORY OF SLOW MOTION

Stokes‟ equations, Oseen‟ equations, Reynolds number, lubrication theory.

Unit-5 BOUNDARY LAYER THEORY:

Laminar boundary layer, two-dimensional boundary layer equations for flow over a plane wall, Blasius equation, characteristic boundary layer parameters, similar solutions of boundary layer equations, separation of boundary layer, momentum and energy integral equation.

REFERENCE BOOKS :

1. *Textbook of Fluid Dynamics* by F. Chorlton, CBS Publishers & Distributors, New Delhi
2. *Viscous Fluid Dynamics* by J. L. Bansal, Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi
3. *Fluid Dynamics* by M. D. Raisinghania, S. Chand & Company Ltd., New Delhi.
4. *Boundary layer theory* by H. Schlichting, Paragamon press, London, 1995.

Subject Name: PROBABILITY THEORY AND STATISTICS

Unit I : Probability :

Axiomatic definition, Properties. Conditional probability, Bays rule and independence of events. Random variables, Distribution function, probability mass and density functions, Expectation, Moments, Moment generating function, Probability inequalities (Chebyshev, Markov, Jensen).

Unit II: Special distributions :

Bernoulli, Binomial, Geometric, Negative Binomial, Hypergeometric, Poisson, Uniform, Exponential, Gamma, Normal, covariance, correlation, Normal and Poisson approximations to Binomial.

Unit III:

Standard multivariate distributions, functions of random variables, modes of convergence, sequence of random variables, Joint distributions, Marginal and conditional distribution, Moments, Independence of random variables, weak and strong laws of large numbers, central limit theorem (i.i.d. case)

Unit IV:

Introduction to Stochastic processes, definitions and examples, discrete-time Markov chain renewal and regenerative processes, continuous-time Markov chains, martingales, Brownian motion.

Unit V:

Methods of Estimation, Properties of Estimators, Confidence intervals. Errors (Type I & II), Test of Hypothesis, Analysis of discretedata and Chi-square test of goodness of fit, sample test.

REFERENCE BOOKS :

1.S. Ross, *A First Course in Probability*, 6th Edn., Pearson, 2002.
2.V. K. Rohatgi and A. K. Md. E. Saleh, *An Introduction to Probability and Statistics*, 2nd Edn., Wiley, 2001.
3.S. C. Gupta and V. K. Kapoor, *Fundamentals of Mathematical Statistics*, S. Chand, 2000.

4. S. M. Ross, *Stochastic Processes*, 2nd Edn, Wiley, 1995.

Subject Name: FUZZY MATHEMATICS AND ITS APPLICATIONS

Unit 1: Fundamentals of Fuzzy Sets:

Level Subsets, Representation of Fuzzy Sets, Extension Principle for Fuzzy sets, Operations on Fuzzy Sets.

Unit 2: Fuzzy Arithmetic and Fuzzy Relations:

Fuzzy Numbers, Arithmetic operations on intervals, Fuzzy Number, Arithmetic operations on Fuzzy Numbers, Projectins and extensions of Fuzzy Relations, Binary Fuzzy Relations, Fuzzy Equivalence Relations, Fuzzy Compatibility Relations, Fuzzy Ordering Relations.

Unit 3: Construction of Fuzzy Membership Functions

Unit 4: Uncertainty Measurement and Applications of Fuzzy Sets:
Information and Uncertainty, Non-specificity of Crisp Sets, Non-specificity of Fuzzy Sets, Fuzzyness of Fuzzy Sets, Application of Fuzzy sets in decision making and in Medical Diagnosis.

REFERENCE BOOKS :

1. George J. Klir and Bo Yuan, *Fuzzy sets and Fuzzy Logic - Theory and applications*, Prentice Hal of India Ltd. , New Delhi, 2001
2. H.J.Zimmerman, *Fuzzy set theory and its applications*, Allied publishers, Chennai, 1996.
3. Witold Pedrycz and Fernando Gomide, *An Introduction to Fuzzy Sets- Analysis and Design*, Prentice Hall of India Pvt Ltd. New Delhi, 2004

Subject Name: OPTIMIZATION THEORY

Unit 1 : Background :

Organization of Optimization Problems, System Models, Black Box Approach.

Unit 2 : Optimization Techniques :

Functions, Regions and Optimizations, Functions of a single variable : Analytical & Numerical Methods.

Unit 3 : Multivariable Search :

Analytical Methods. Lagrange Multipliers, Kuhn-Tucker Theorem, Simplex Theorem.

Unit 4 : Multivariable Functions :

Numerical Methods : Local and Global Optima, General Principle of Sequential Numerical Search, Gradient Methods.

REFERENCE BOOKS :

1. Gordon S.G. Beveridge and Robert S. Schechter; *Optimization: Theory and Practice*, Mc-Graw Hill Book Co.
2. Erwin Kreyszig, *Introductory Functional Analysis with Applications*, Wiley Classic Library.
3. D.G. Luenberger, Optimization by Vector space methods, Wiley Pub. co

MASTER OF SCIENCE (MATHEMATICS) - FOURTH SEMESTER

Fourth Semester			
S. No.	**Name of Subject**	**Credits**	**Total Marks**
1	Measure Theory	5	100
2	Non-linear Dynamical System and Chaos	5	100
3	Discrete Structure and Graph Theory	4	100
	Any Two		100
4 5	1. Magnetohydrodynamics 2. Mathematical Modelling 3. Computational Fluid Dynamics 4. Algebraic Graph Theory	5 5	100 100
Total		**24**	

Subject Name: MEASURE THEORY

Unit 1: Measurable Sets

Outer measure, Lebesgue measure, measurable sets and their properties, Borel sets, Characterization of measurable sets, non-measurable sets.

Unit 2: Measurable Functions

Properties, Step functions, Characteristic functions, Simple functions, Continuous functions, Set of measure zero, Borel measurable function, Realization of non-negative measurable functions in terms of simple functions, Convergence in measure.

Unit 3: Lebesgue Integrals

Riemann integrals, Lebesgue integration of a simple function, Bounded convergence theorem, Fatou‟s lemma, Monotonic Convergence Theorem, integrable functions, General Lebesgue Integral, Dominated convergence theorem.

Unit 4: Differentiation and Indefinite integrals

Dini Derivatives, functions of bounded variation, Jordan decomposition Theorem, Indefinite integrals, Signed measures and their derivatives, Hahn decomposition, Radon Nykodym theorem.

Unit 5: Lp –Space

The Lp space, Holder, Minkowski‟s inequalities, summable sequence, essential supremum, Completeness of Lp space, Riesz- Fischer theorem, Bounded linear functional on Lp spaces, Riesz representation theorem.

REFERENCE BOOKS:

1. H.L. Royden, *Real Analysis*, Mc-Millan
2. G.D. Berra, *Measure Theory and Integration*, Wiley Eastern LTD
3. W. Rudin, *Principles of Mathematical Analysis* (Ed-3), McGraw Hill

Subject Name: NON-LINEAR DYNAMICAL SYSTEM AND CHAOS

Unit-1 : One Dimensional Flows and Bifurcations

Introduction, Fixed points and Stability, Population Growth, Linear Stability Analysis, Existence and Uniqueness, Impossibility of oscillations, Potentials, Saddle-node bifurcation, Transcritical bifurcation, Pitchfork bifurcation, Imperfect bifurcations, Flow on the circle.

Unit-2 : Two Dimensional Flows and Bifurcations

Linear Systems: Definition, examples and classification of linear systems,
Phase planes: Introduction, phase portraits, conservative systems, Reversible systems, Index theory,
Limit cycles: Introduction and examples, Ruling out closed orbits, Liapunov Functions, Poincare-Bendixson, theorem, Lienard Systems, Relaxation Oscillators, Weakly non-linear oscillators, Saddle-node bifurcation, Transcritical bifurcation, Pitchfork bifurcation, Hopf bifurcation,

Unit 3 : Chaos

Lorenz Equations: Introduction, Simple properties of the Lorenz equation, Definitions of chaos, attractors and strange attractors, One dimensional maps: Introduction, Fixed points and Cobwebs, Numeric and analysis of Logistic map, Renormalization, Fractals: Countable and uncountable sets, Cantor set and its fractal property, Dimensions of self similar fractals, Box Dimension, The von Koch curve, Strange attractors, The Baker‟s map B.

REFERENCE BOOKS :

1. Nonlinear Dynamics and Chaos by Steven H. Strogatz Westview Press, ISBN – 13 978-0-7382-0453-6
2. Understanding Nonlinear Dynamics, Author Daniel Kaplan and Leon Glass, Springer, New York.
3. Nonlinear Dynamics and Chaos by Thompson JMT and Stewart H B John Wiley and Sons, Chichester.

Subject Name: DISCRETE STRUCTURE AND GRAPH THEORY

Discrete Structure

Unit – 1 : Grammars and Languages

Definitions and Examples, Context- free grammar, Regular grammar, Operations on Languages, Regular Grammar, Finite State Automata: State diagram of an Automata.

Graph Theory

Unit - 2 : Graphs and Trees

Graph, Basic definitions, Isomorphism of graphs, Subgraphs, Walks, Paths, Circuits, Connected graphs, Disconnected graphs, Trees, Some properties of trees, Distance and centers in a tree, Rooted and binary trees, On counting trees, Spanning trees, Cut-sets, Some properties of a cut-set, Connectivity and Separability, Blocks.

Unit – 3 : Operations On Graphs

Planar and non-planar graphs, Kuratowski‟s two graphs, Different representations of a planar graph, Matrix representation of graphs, Incidence matrix, Adjacency matrix , Graph matchings, Graph coverings.

Unit - 4 : Directed Graphs and Enumeration of Graphs

Definition of Directed graphs (digraph), Some types of digraphs, Digraphs and binary relations, Directed paths and connectedness, Acyclic digraphs and decyclization, Enumeration of graphs, Types of enumeration, Counting labeled trees, Counting unlabelled trees.

Unit - 5 : Graph Algorithms

Algorithms, Shortest-path algorithms, Transitive closure of a digraph, Activity network, Topological sorting, Critical path, Graphs in computer programming (basic concepts).

REFERENCE BOOKS :

1. Discrete Mathematical Structures with Applications to Computer Science, by J. P. Tremblay, R. Manohar, Tata McGraw Hill, 1997

2. Graph theory with applications to engineering and computer science by Narsigh Deo, Prentice- Hall of India Private Limited, New Delhi.

Subject Name: MAGNETOHYDRODYNAMICS

Unit 1: **MHD Approximations**

The electrical properties of Fluid, electric and magnetic field, Lorentz force , action at a distance, the low frequency approximations, energetic aspects of MHD, magnetic energy.

Unit 2: The Kinematic aspects of MHD

The magnetic induction equation, the anlogy with vorticity, diffusion and convection of magnetic field , Magnetic reynold number, the dynamo problem, Alfven‟s theorems, Cowling problem, , the two dimensional kinematic problem with flow in the direction of no variation, the two dimensional kinematic problem with field in the direction of no variation, the two dimensional kinematic problem with current in the direction of no variation.

Unit 3: The magnetic force and its effects

The magnetic force and the inertia force , magnetic stress , principal directions and stress, Magnetohydrostatic, The linear pinch confinement scheme, the force free fields, the magnetic field in moving fluid, invalidation of kelvin‟s theorem on vorticty, the case of irrotational force per unit mass.

Unit 4: Boundary Conditions

Boundary conditions for magnetic field, boundary condition for current, boundary conditions for electric field, boundary condition on velocity.

Unit 5: Linear magnetohydrodynamics : Linearised MHD equations for

i) 1-D case : The steady Hartmaan Flow problems, Poiseuille type flow, Coutte type of Flow, Linear Alfven waves, MHD Rayleigh problem
ii) 2-D case : Steady laminar flow in a pipe under uniform transverse field.

REFERENCE BOOKS:

1. A text book of Magnetohydrodynamics , J.A. Schercliff, Pergamon Press, New York (1965).
2. Magnetohydrdynamics by T. G. Cowling, Interscience Publishers, 1957.

Subject Name: MATHEMATICALMODELLING

Unit 1 : Introduction:

The Technique on Mathematical Modelling, Mathematical Modelling Through Calculus, Mathematical Modelling Through Ordinary Differential Equations of first order, Linear Growth and Decay Models, Non-Linear Growth and Decay Models, Compartment Model, Mathematical Modelling in Dynamics through Ordinary Differential Equations of first order.

Unit 2 : Application Of Mathematical Modelling:

Mathematical Modelling in Population Dynamics, Mathematical Modelling of Epidemics through systems of Ordinary Differential Equations of first order, Mathematical Modelling in Economics based on systems of Ordinary Differential Equations of first order, Mathematical Models in Medicine, Arms Race Battles and International Trade in terms of Ordinary Differential Equations.

Unit 3 : Modeling Through Difference Equations

Modelling through Difference Equations, Some Simple Models, Mathematical modelling through Difference Equations in Economics, Finance, Population Dynamics and Genetics.

Unit 4 : Modelling Through Partial Differential Equations

Partial Differential Equation Model for Birth-Death-Immigration-Emigration Process, Partial Differential Equation Model for a Stochastic-Epidemic Process, Model for Traffic on a Highway.

REFERENCE BOOKS:

1. Mathematical Modelling by J.N.KAPUR, Wiley Eastern Ltd, New Delhi

2.An Introduction to Mathematical Modelling by EDWARD A. BENDER, John Wiley and sons, New York.

Subject Name: COMPUTATIONAL FLUID DYNAMICS

Section A :Unit – I
Computational Fluid Dynamics, Governing Equations of Fluid Dynamics, Boundary Conditions, Forms of Governing Equations suitable for CFD, Classification of partial Differential Equations.

Unit – II :Basic aspects of Discretization :

Finite difference, Difference and Transformations Equations, Explicit and Implicit Approaches, Errors and Stability, General Transformation Equations, Stretched grid, Boundary-Fitted Co-ordinate Systems.

Unit – III CFD Techniques :

The Lax-Wendroff and MacCormack‟s Techniques, Relaxation, Central Difference Equations for Navier-Stokes Equations.

Section B : Practical

Numerical Formulation using Crank-Nicholson Technique for Couette flow and two-dimensional problems. Program development and execution.

REFERENCE BOOKS:

1. John D Anderson, Jr. : *Computational Fluid Dynamics,* Mc-Graw Hill
2. John C. Tannehill, Dale A. Anderson and *Computational Fluid Dynamics and Heat Transfer*; Taylors and Francis.
3. T.J. Chung : *Computational Fluid Dynamics*, Cambridge Univ. Press
4. Tapan K. Sengupta : *Computational Fluid Dynamics*, University Press

Subject Name: ALGEBRAIC GRAPH THEORY

Unit – 1 : Reviews :

Basic Definitions of Graph theory and Linear Algebra, Matrix Representations of a graph : Adjacency matrix and Incidence matrix.

Unit - II

Eigenvalues of Graphs : A Little Matrix Theory, Eigenvalues and Walks, Eigenvalues and Labeling of graphs, Lower and Upper Bounds for the Eigenvalues, S eidel matrix of a graph.

Unit - III

Graph Laplacians : Laplacian of a graph, Laplace Eigenvalues, Eigenvalues & Vertex partition of graphs, The Max-Cut Problem, Travelling Salesman Problem, Random Walks on graphs.

Unit – IV

Spectral Graph Theory : Introduction, Angles, Star sets and Star partitions, Integral Graphs.

REFERENCE BOOKS:

1. R.J. Wilson, I. W. Beineke, Topics in Algebraic Graph Theory, Cambridge University Press, 2004.
2. C. Godsil, G. Royle, Algebraic Graph Theory, Springer Verlag Newyork, 2001.