Syllabus of M.A/M.Sc. (Mathematics) Semester I

PAPER I (MAT CC 01)

Abstract Algebra

Abstract Algebra

Prerequisites: Introduction to Group, Elementary Properties of Group, Finite Group,

and subgroup, Cyclic Group, Permutation Group, Properties of Permutations, rings, integral Domains, Characteristic of rings.

Unit 1: Homomorphism; Group actions, Sylow theorems, Normal and subnormal series composition series of a group, Jordan- Holder Theorem, Solvable groups, commutator subgroup of a group, Nilpotent groups

Unit 2: Ring homomorphism, isomorphism, quotient rings, ideals, Kernel of ring homomorphism, principal ideal ring and domain, prime and maximal ideal, Euclidean domain.

Unit 3 : Extension fields , algebraic and transcendental extension, splitting field of

Polynomial, separable and inseparable extension, normal extension, constructible

real numbers.

Unit 4 : Cyclic Modules, simple Modules, semi-simple Modules, Schur's Lemma, Free

Modules.

Unit 5: Solution of equations by radicals, insolvability of equations of degree 5 by

radicals.

References :

1. I. N. Herstein :- Topics in Algebra.
2. M.Artin :- Algebra
3. L. S Luther & I.B.S Passi :- Algebra Vols I & II Narosa Publication House
4. D.S. Dummit and R.M. Foote:- Abstract Algebra
5. N.S. Gopalakrishnan :- University Algebra

PAPER II (MAT CC- 02)

Real Analysis

Real Analysis

Unit 1: Sequences and series of functions, pointwise and uniform convergence, Cauchy criterion for uniform convergence, Weierstrass-M test, Abel's and Dirichlet's test for uniform convergence.

Unit 2: Uniform convergence and differentiation, Weierstrass approximation theorem Power series, Uniqueness theorem for power series, Able's and Tauber's theorem.

Unit 3 : Definition and examples of Riemann-Stieltje's integral Property of integral, Integration and differentiation, the fundamental theorem of Calculus, Integration Of vector valued function, rectifiable curves.

Unit 4 : Functions of several variables, linear transformation, Derivatives in an open subset of R^n,chain rule,partial derivatives, interchange of order of differentiation, derivative. of higher orders, Taylor's theorem.

Unit 5 : Inverse function theorem, Implicit function theorem, Jacobians, Extremum Problems with constraints, Lagrange's multiplier methods, differentiation of Integrals, partition of unity, Differential forms, Stoke's theorem.

References :

1. W. Rudin :- Principles of Mathematical Analysis
2. T. M. Apostal :- Mathematical Analysis
3. I.P. Natanson :- Theory of function of Real Variable
4. H.L. Royden :- Real Analysis

PAPER III (MAT CC-03)

Linear Algebra

Linear Algebra

Unit 1: Finite dimensional vector spaces; Linear transformations and their matrix representations, rank; systems of linear equations, eigenvalues and eigenvectors, minimal polynomial, Cayley-Hamilton Theorem, diagonalization ,.

Unit 2: Hermitian, SkewHermitian and unitary matrices; Finite dimensional inner product. spaces, Gram-Schmidt orthonormalization process, self-adjoint operators.

Unit 3 : Similarity of linear transformations, Invariant subspaces, reduction to triangular forms, Nilpotent transformations, Index of Nilpotency, invariants of a Nilpotent transformations, primary decomposition theorem, Joardan blocks and Jordan forms rational canonical form

Unit 4 : Bilinear form, algebra of bilinear form Matrix of bilinear forms, degenerate and Non-degenerate bilinear forms, Alternating bilinear forms

Unit 5: Symmetric and Skew-symmetric bilinear forms, Quadratic form, law of Inertia, Sylvester's theorem, Hermitian forms definite forms.

References :

1. K.B.Datta:- Matrix and Linear Algebra
2. S. Lipschutz:- Linear Algebra, Schaum's outline series
3. Hoffman and Kunze:- Linear Algebra

PAPER IV (MAT CC-04)

Discrete Mathematics

Discrete Mathematics:

Graph Theory

Unit 1 : Definition of graphs , paths, circuits and subgraphs, induced subgraphs, degree of a vertex, connectivity, planar graphs and their properties, Trees and simple applications of graphs.

Lattice Theory

Unit 2 : Lattices as partially ordered sets and their properties, lattices as algebraic system, Sub lattices, direct products and Homomorphisms of Lattices some special lattices eg Complete lattices, complemented lattices and distributive lattices.

Boolean Algebra

Unit 3 : Boolean algebra as a complemented distributive lattice, Boolean rings, identification of Boolean algebra and Boolean rings, sub-algebra and generators.

Unit 4 : Boolean homomorphism and ring homomorphism ideals in a Boolean algebra and Dual ideals, Fundamental theorem of homomorphism and Stone's representation theorem for Boolean algebras and Boolean rings, simple application to eletrical network, solvability of Boolean equations and logical puzzles.

Combinatorics

Unit 5 : Permutation and combinations, partitions, pigeonhole principle, inclusion-exclusion principle, generating functions, recurrence relations.

References :

1. K.H. Rosen :- Discrete Mathematics and its applications.
2. S. Lipschutz and M. Lipson :- Discrete Mathematics
3. C. L. Liu:- Elements of Discrete Mathematics
4. E.Mendelson :- Boolean Algebra and Switching Circuits
5. Kolman, Bushi and Ross :- Discrete Mathematical Structure

Syllabus of M.A/M.Sc (Mathematics) Semester III

PAPER XI (MAT CC-11)

Functional Analysis

Functional Analysis

Unit 1 : Normed linear spaces, Banach spaces and examples, Quotient space of normed linear Spaces and its completeness, equivalent norms, Riesz Lemma, Basic properties of finite dimensional normed linear spaces and compactness.

Unit 2 : Weak convergence and bounded linear transformation, normed linear spaces of bounded linear transformations, dual spaces with examples, uniform boundness theorem and some of its consequences.

Unit 3 : Open mapping theorem and closed graph theorem, Hahn- Banach Theorem on real linear spaces, complex linear spaces and normed linear spaces, Reflexive spaces.

Unit 4: Inner product spaces, Riesz lemma on Hilbert space, orthonormals sets and Parseval's identity, structure of Hilbert spaces, Projection theorem Riesz Representation Theorem.

Unit 5 : Adjoint of an operator on a Hilbert space, Reflexivity of Hilbert spaces, Self-adjoint Operators, positive operator, Projection, Normal and unitary operators.

References

1. G.F.Simmons:- Introduction to Topology and Modern Analysis
2. K.K.Jha :– Functional Analysis, Advanced General Topology

PAPER XII (MAT CC-12)

Fluid Dynamics

Fluid Mechanics :

Unit 1 : Lagrangian and Eulerian methods, Equation of Continuity, Boundary Surfaces, Stream lines, Path lines and Streak lines, velocity potential, irrotational and rotational motions, vortex lines.

Unit 2 : Lagrange's and Euler's equations of motion, Bernoulli's theorem, equation ofmotion by flux method, equation referred to moving axis, implusive actions.

Unit 3: Irrotational Motion in two dimension, stream function, complex velocity potential, sources, sinks, doublets and their images, conformal mapping, Milne-Thompson circle theorem.

Unit 4 : Two dimensional irrotational motion produced by motion of a circular, coaxial and elliptic cylinders in an infinite mass of liquid, kinetic energy of a liquid, Theorem of Blasius, motion of a sphere through a liquid at rest at infinity, liquid streaming past a fixed sphere, Equation of motion of a sphere, Stoke's stream function

Unit 5 : Vortex motion and its elementary properties, Kelvin's proof of permanence, Motion due to circular and rectilinear vertices.

References

1. F.Chorlton :- A text Book of Fluid Dynamics.
2. M.D. Raisinghania:- Fluid Dynamics

PAPER XIII (MAT CC-13)

Classical Mechanics (Rigid Dynamics)

Unit 1 : Generalised Co-ordinates, Holonomic and Non Holonomic systems, Lagrange'sequations of motion, energy equations for conservative fields.

Unit 2 : Hamilton's canonical equations, Rouths equations, Hamilton'Principle, Principle of Least Action.

Unit 3 : Small Oscillations, normal Co-ordinates, normal mode of vibration.

Unit 4 : Contact transformations, Lagrange brackets and Poisson brackets, the most general infinitesimal contact transformation, Hamilton- Jacobi equation.

Unit 5 : Motivating problem of Calculus of variation, Euler- Lagrange equation shortest distance, minimum surfaces of revolution, Brachistochrone problem.

References

1. A.S. Ramsey :- Dynamics Part II
2. S.L. Loney :- Dynamics of particle and rigid bodies

PAPER XIV (MAT CC-14)

Optimization Techniques

Linear Programming

Unit 1 : Simplex method for unrestricted variable, Two phase method, Dual simplex method, Parametric Linear programming, Upper Bound technique, Interior point algorithm, Linear Goal programming.

Unit 2 : Integer programing, Branch and bound technique, Gomory's algorithm.

Non- Linear programming :

Unit 3 : One and multi-variable unconstrained optimization, Kuhn- Tucker condition for constrained optimization, Wolfe's and Beale's methods.

Unit 4 : Game theory, Two person- Zero sum games with mixed strategies, Graphical solution by expressing as a linear programming problem.

Unit 5 : Inventory theory, Different costs of inventory model, Deterministic Economic lot size model, EOQ with uniform demand and several productions of unequal length / production runs of equal length EOQ models- Shortages not allowed, shortages allowed.

References:

1. H.A.Taha :- Operations Research- An Introduction
2. Kanti Swarup, P.K.Gupta and Man Mohan: Operations Research
3. P.K.Gupta and D.S. Hira :- Operations Research

PAPER XV (MAT CC-15)

Differential Geometry

Unit 1: Curves in spaces, parameters other than arc lengths, tangent principal normal, binormal and three fundamental planes, Curvature and torsion of space curves, Serret- Frenet formulae, Fundamental theorem on spaces curves, Helices, spherical. indicatrix, Involutes and Evolutes, Bertrand curves.

Unit 2 : Representation of surfaces, Curves on surfaces in R^3 spaces, tangent plane and Normal, Envelope, characteristic and edge of regression, developable surface of revolution, directions on a surface.

Unit 3 : Parametric curves, angle between them, first order and second order magnitudes, principal directions and lines of curvature, Normal Curvature, Euler's theorem and Meunier's theorem. Theorem of Beltrami and Enneper, Gauss Characteristic equation, Mainardi- Codazzi equations.

Unit 4 : Conjugate directions, Isometric lines, asymptotic lines and Geodesics- their equations and properties, curvatrure and torsion, their structures on surfaces of revolution, Bonnet's theorem, Clairaut's theorem and Dupin's indicatrix.

References:

1. C.E. Weatherburn:- Differential Geometry In Three Dimension
2. J.A. Thorpe :- Elementary Topics in Differential Geometry
3. A. Gray : Differential Geometry of three dimensions, Cambridge University Press

Syllabus of M.A/M.Sc (Mathematics) Semester II

PAPER V (MAT CC-05)

General Advanced Mathematics

Set Theory:

Unit I: Elementary set theory, finite, countable and uncountable sets, Real number system as a complete ordered field, Archimedean property, supremum, infimum.

Fuzzy Set Theory:

Unit II : Fuzzy Sets Versus Crisp sets, Basic definitions, types, properties and representations of Fuzzy sets, Convex Fuzzy sets, Basics operation on Fuzzy set, α- Cuts, Decompositions theorem, Complements, t- norm and t-conorms, Extension principles and Simple applications of Fuzzy sets.

Graph Theory:

Unit III : Definition of graphs , paths, circuits and subgraphs, induced subgraphs, degree of a vertex, connectivity, planar graphs and their properties, Trees and simple applications of graphs.

Number Theory:

Unit IV : Divisiblity Theory In the Integers: Division Algorithim, the Greatest Common Divisor. The Euclidean Algorithm, The Diophantine Equations $ax+by = c$, Fundamental Theoem of Arithmetic.

References:

1. Kolman, Bushi and Ross :- Discrete Mathematical Structure.
2. Pundir And Pundir:- Fuzzy Sets & their Application,
3. G.J.Klir & B. Yuan :- Fuzzy sets.
4. Graph Theory : F. Harare, Addison Wesley.
5. A.Baker, A concise introduction to the Theory of Numbers.

PAPER VI (MAT CC-06)

Complex Analysis

Complex Analysis:

Unit 1 : Algebra of complex numbers, the complex plane, polynomials, power series, transcendental functions such as exponential, trigonometric and hyperbolic functions. Analytic functions, Cauchy-Riemann equations.

Unit 2 : Contour integral, Cauchy's theorem, Cauchy's integral formula, Liouville's theorem.

Unit 3 : Taylor's theorem, Maximum modulus Principle, Schwarz's Lemma, Laurent Series, Isolated singularities, Meromorphic function, Mittag-Leffler's theorem The argument principle, Rouche's theorem, fundamental theorem of algebra, Power series.

Unit 4 : Residues, Cauchy's residue theorem, Evaluation of integral, Branches of any valued functions with special reference to argz, logz and Bilinear transformations, their properties and classifications, definition and examples of conformal mappings. Mobius Transformations.

References :

1. J.B. Conway :-Functions of one Complex Variables,
2. L.V. Ahlfors :- Complex Analysis

PAPER VII (MAT CC-07)

Differential and Integral Equation

Differential and Integral Equations

Unit 1: Initial Value problem and the equivalent integral equation, n order equation in d dimension as a first order system. Concepts of local existence, existence and uniqueness of solution with examples.

Unit 2: Integral Equations and their classifications. Eigen values and eigen functions. Fredholm Integral equations of Second Kind, Iterative Scheme and method of successive approximations.

Unit 3 : Ascoli- Arzela theorem, a theorem on convergence of solutions of a family of Initial value problems. Picard- Lindelof theorem, Peano's existance theorem Corollaries, Kamke's convergence theorem.

Unit 4 : Gronwall's inequality, maximal and minimal solution, Differential inequalities, Uniqueness theorem, Nagumo's and Osgood's criteria, successive approximations.

References :

1. P. Hartman :- Ordinary Differential Equation
4. S.G.Mikhlin :- Linear Integral Equations.
5. R.P.Kanwal :- Linear Integral Equations, Theory and Techniques

PAPER VIII (MAT CC-08)

Measure Theory

Measure theory:

Unit 1: Lebesgue outer measure, Measurable sets Measuribility, Measurable functions, Borel and Lebesque measurability, non- measurable sets.

Unit 2 : Integration of non-negative functions, the general integral, Integration of series, Riemann and Lebesgue integrals.

Unit 3 : The Four Derivatives, function of bounded variation, Lebesgue differentiation Theorems, Differentiation and Integration.

Unit 4 : Measure and outer measure, extension of measures,uniqueness of extension, Completion of a measure, measurable spaces, Integration with respect to a measure.

Unit 5 : The L^P-spaces, convex functions, Jensen inequality Holder's and Minkowski's Inequalities, completeness of -spaces, convergence in measure, Almost uniform Convergence.

References :

1. G.de Barra :- Measure Theory and Integration
2. P.K. Jain and V.P Gupta :- Lebesque Measure and Integration
3. I.K. Rana :- An Introduction to Measure and Integration
4. P.R. Halmos- Measure Theory

PAPER IX (MAT CC-09)

Topology

Unit 1 : Definition and examples of topological spaces, closed sets, dense subsets, Neighbourhood, interior, exterior, boundary and accumulation points. Derived Sets, Bases and subbases. Subspaces and Relative topology.

Unit 2 : Continuous functions and homeomorphism, characterisation of continuity in Terms of open sets, closed sets and closure. First and second countable topological spaces Lindelof's theorem, separable Spaces, second countability and separability.

Unit 3 : Separation axioms T_0, T_1 and T_2 spaces and their basic properties, compactness, Continuous function and compact sets, basic properties of compactness and Finite intersection property.

Unit 4: Connectedness, continuous function and connected sets characterization of Connectedness in terms of a discrete two point space, connectedness on real line.

Unit 5 : Regular and Normal spaces T_3 and T_4 spaces, characterisations and basic properties, Urysohn's lemma and Tietze extension Theorems.

References

1. G.F.Simmons:- Introduction to Topology and Modern Analysis
2. K.K.Jha :– Functional Analysis, Advanced General Topology
3. Futton:- Algebraic Topology First Course

PAPER X (MAT CC-10)

Number Theory

Number Theory:

Unit-1

Divisibility, G.C.D and L.C.M., Primes, Fermat numbers, congruences and residues, theorems of Euler, Fermat and Wilson, solutions of congruences, linear congruences, Chinese remainder theorem.

Unit-2

Arithmetical functions $\varphi(n)$, $\mu(n)$ and $d(n)$and $\sigma(n)$, Moebius inversion formula, congruences of higher degree, congruences of prime power modulli and prime modulus, power residue.

Unit-3

Quadratic residue, Legendre symbols, lemma of Guass and reciprocity law. Jacobi symbols, Farey series, rational approximation, Hurwitz theorem, irrational numbers, irrationality of e and π, Representation of the real numbers by decimals.

Unit-4

Finite continued fractions, simple continued fractions, infinite simple continued fractions, periodic continued fractions, approximation by convergence, best possible approximation, Pell's equations, Lagrange four sphere theorem.

Reference:

1. Theory of Numbers, G H Hardy and E M Wright, Oxford Science Publications, 2003.
2. Introduction to the Theory of Numbers, I Niven and H S Zuckerman, John Wiley & Sons,1960.
3. Elementary Number Theory, D M Burton, Tata McGraw Hill Publishing House, 2006.
4. Higher Arithmetic, H. Davenport, Cambridge University Press, 1999.
5. Introduction to Analytic Number Theory, T.M. Apostal, Narosa Publishing House.