ALLAHABAD STATE UNIVERSITY
RECOMMENDED SYLLABUS OF MATHEMATICS
FOR B.A./B.Sc. CLASSES
(w.e.f. 2017-18 onwards)

B.A./B.Sc. I

Paper I : Algebra and Trigonometry M.M.: 50

Unit I : Properties of integers, Division algorithm, Euclidean Algorithm, Fundamental theorem of Arithmetic, Equivalence relations, Equivalence classes and Partition of sets, congruence relation modulo an integer m, Residue classes modulo *m*.

Unit II : Binary Operation on a set groups and its elementary properties, Permutation groups, Subgroups, Centre and Normalizer. Integral powers of an element of a group order of an element of a group, cyclic groups.

Unit III : Coset decomposition, Lagrange's theorem and its consequences, Normal subgroups, Homomorphism and Kernel of a homomorphism, Isomorphism, Cayley's theorem, Fundamental theorem of group homomorphism.

Unit IV : Rings, Subrings, Integral domains, Fields and their elementary properties, Ideals and quotient rings, Characteristic of a ring, Ring homomorphism, Ring isomorphism.

Unit V : Complex functions, Separation into real and imaginary parts, Exponential, general exponential and Logarithmic functions, Circular functions, Hyperbolic functions, Inverse circular functions and inverse hyperbolic functions, Gregory's series, Summation of series (C + iS method only).

Paper II: CALCULUS M.M. : 50

Unit 1: Limit of a function, Continuous functions and kinds of discontinuities, Differentiability, Chain rule of differentiability, Rolle's

theorem, First and second mean value theorems, Successive differentiation and Leibnitz's theorem, Taylor's theorem with Lagrange's and Cauchy's forms of remainders.

Unit 2: Expansion of functions (in Taylor's and Maclaurin's series), Indeterminate forms, Partial differentiation and Euler's theorem, Jacobians, Tangents and normals (polar form only).

Unit 3: Curvature, Envelopes and evolutes, Asymptotes, Tests for concavity and convexity. Points of inflexion, Multiple points, Tracing of curves in Cartesian and polar co-ordinates.

Unit 4: Definite Integral as the limit of a sum, Reduction formulae, Beta and Gamma functions.

Unit 5: Qudrature, Rectification, Volumes and Surfaces of solids of revolution, Double and triple integrals, Change of order of integration.

Paper III : ANALYTICAL GEOMETRY

M.M. : 50

Unit 1: Plane polar co-ordinates, Straight line, circle, conics, tangent, normal and asymptotes.

Unit 2: Three dimensional Cartesian co-ordinate System, direction cosines of a straight line, Plane, Straight line.

Unit 3: Sphere, cone and cylinder.

Unit 4: Central conicoids and paraboliods.

Unit 5: Generating lines, Reduction of general equation of second degree.

Paper IV : Assignment and viva-voce. M.M. : 50

B.Sc. II

Paper I: LINEAR ALGEBRA

M.M.: 50

Unit 1: Vector spaces and their elementary properties, Subspaces, Linear dependence and independence, Basis and dimension, Direct sum, Quotient space.

Unit 2: Linear transformations and their algebra, Range and null space, Rank and nullity, Matrix representation of linear transformations, Change of basis.

Unit 3: Linear functionals, Dual space. Bi-dual space, Natural isomorphism. Annihilators, Bilinear and quadratic forms, Inner product spaces, Cauchy-Schwarz's inequality. Bessel's inequality and orthogonality.

Unit 4: Symmetric and skew-symmetric matrices, Hermitian and skew-Hermitian matrices, Orthogonal and unitary matrices, Triangular and diagonal matrices, Rank of a matrix. Elementary transformations, Echelon and normal forms, Inverse of a matrix by elementary transformations.

Unit 5: Characteristic equation, Eigen values and eigen vectors of a matrix, Cayley Hamilton's theorem and its use in finding inverse of a matrix, Application of matrices to solve a system of linear (both homogeneous and non-homogeneous) equations, Consistency and general solution. Diagonalization of square matrices with distinct eigen values.

Paper II: DIFFERENTIAL EQUATIONS & VECTOR CALCULUS

M.M. : 50

Unit 1: Differential Equation, Formation of a differential equation, Order and degree, Methods of Solution of a differential equation of first order and first degree, Method of separation of

variables, solution of homogeneous equations, linear equations and exact equations.

Unit 2: Linear differential equations with constant, coefficients, Homogeneous linear differential equations. Differential equations of the first order but not of the first degree. Clairaut's equations and singular solutions, Orthogonal trajectories.

Unit 3: Simultaneous linear differential equations with constant coefficients, General Linear differential equations of the second order, Method of solution in terms of one unknown integral belonging to the complementary function, Method of solution by transformation of the equation to the normal form, Transformation of the equation by changing the independent variable, Method of operational factors, Method of variation of parameters.

Unit 4: Vector differentiation and integration, Gradient, divergence and curl, and their properties.

Unit 5: Line integrals, Surface and Volume integrals Gauss, Green and Stokes theorems and problems based on these.

Paper III : MECHANICS M.M. : 50

Unit 1: Velocity and acceleration along radial and transverse directions, and along tangential and normal directions.

Unit 2: Simple harmonic motion, Motion under other laws of forces, Earth attraction, Elastic strings, Motion in resisting medium.

Unit 3: Motion on smooth and rough plane curves, Constrained motion (circular and cycloidal only).

Unit 4: Central orbits and Kepler's law.

Unit 5: Common catenary, Virtual work, Stable and Unstable equillibrium.

Paper IV : Assignment and viva voce. M.M. : 50

B.Sc. III

Paper I: REAL ANALYSIS

M.M. : 60

Unit 1: Axiomatic study of real numbers, Completeness property in R, Archimedean property, Countable and uncountable sets, Neighbourhood, Interior points, Limit points, Open and closed sets, Derived sets, Dense sets, Perfect sets, Bolzano-Weierstrass theorem.

Unit 2: Sequences of real numbers, Subsequences. Bounded and monotonic sequences. Convergent sequences, Cauchy's theorems on limit, Cauchy sequence, Cauchy's general principle of convergence.

Unit 3: Convergence of infinite series, comparison test, Cauchy's root test, D' Alembert's ratio test, Raabe's test, Logarithmic ratio test, Cauchy's condensation test, De Morgan and Bertrand's test, Higher logarithmic ratio test, Alternating series, Leibnitz's test, Absolute and conditional convergence.

Unit 4: Sequential continuity, Boundeness and intermediate value properties of continuous functions, Uniform continuity, Meaning of sign of derivative, Darboux theorem.

Limit and continuity of functions of two variables, Taylor's theorem for functions of two variables, Maxima and minima of functions of three variables, Lagrange's method of undetermined multipliers.

Unit 5: Improper integrals and their convergence. Comparison test, μ-test, Abel's test Dirichlet's test. Integral as a function of a parameter and its differentiability and integrability.

Paper II: COMPLEX ANALYSIS

M.M. : 60

Unit 1: Functions of a complex variable, Concepts of limit, continuity and differentiability of complex functions, Analytic functions, Cauchy-Riemann equations (Cartesian and polar form), Harmonic functions, Orthogonal system. Power series as an analytic function.

Unit 2: Elementary functions, Mapping by elementary functions, Linear and bilinear transformations. Fixed points, Cross ratio, Inverse points and critical points, Conformal transformations.

Unit 3: Complex Integration, Line integral, Cauchy's fundamental theorem, Cauchy's integral formula, Morera's theorem, Liouville theorem, Maximum Modulus theorem, Taylor and Laurent series.

Unit 4: Singularities and zeros of an analytic function, Rouche's theorem, Fundamental theorem of algebra.

Unit 5: Residue theorem and its applications to the evaluation of definite integrals, Argument principle.

PAPER III :NUMERICAL ANALYSIS

M.M. : 60

Unit 1: Shift operator, Forward and backward difference operators and their relationships, Fundamental theorem of difference calculus, Different types of errors in numerical methods, Interpolation, Newton-Gregory's forward and backward interpolation formulae.

Unit 2: Divided differences, Newton's divided difference formula, Lagrange's interpolation formula, Central differences, Formulae based on central differences : Gauss, Striling's, Bessel's interpolation formulae.

Unit 3: Numerical differentiation, Numerical integration, General quadrature formula. Trapezoidal and Simpson's rules. Weddle's rule.

Unit 4: Numerical solution of first order differential equations Euler's method, Picard's method, Runge-Kutta method and Milne's method, Numerical solution of linear, homogeneous and simultaneous difference equations, Generating function method.

Unit 5: Solution of simultaneous linear algebraic equations by Gauss elimination method, Triangularization method, Jacobi's iterative method and Gauss seidel method, Solution of transcendental and polynomial equations by iteration, bisection, Regula-Falsi and Newton-Raphson methods, Algebraic eigen value problems, Power method. Jacobi's method and given's method Approximation, Different types of approximations, Least square polynomial approximation, Fitting of the curves by least square method (straight line, parabola and exponential curves), Chebyshev polynomials.

Paper IV : Anyone of the following papers M.M. : 60

Paper (a) : LINEAR PROGRAMMING

Unit 1: Linear programming problems, Statement and formation of general linear programming problems, Graphical method, Slack and surplus variables, Standard and matrix forms of linear programming problem, Basic feasible solution.

Unit 2: Convex sets, Fundamental theorem of linear programming, Simplex method, Artificial variables, Big-M method, Two phase method.

Unit 3: Resolution of degeneracy, Revised simplex method, Sensitivity Analysis.

Unit 4: Duality in linear programming problems, Dual simplex method, Primal-dual method, Integer programming.

Unit 5: Transportation problems, Assignment problems.

Paper (b) : DISCRETE MATHEMATICS

Unit 1: Propositional Logic - Proposition logic, basic logic, logical connectives, truth tables, tautologies, contradiction, normal forms (conjunctive and disjunctive), modus ponens and modus tollens, validity, predicate logic, universal and existential quantification.

Method of Proof - Mathematical induction, proof by implication, converse, inverse, contrapositive, negation, and contradiction, direct proof by using truth table, proof by counter example.

Unit 2: Relation - Definition, types of relation, composition of relations, domain and range of a relation, pictorial representation of relation, properties of relation, partial ordering relation.

Posets, Hasse Diagram and Lattices - Introduction, ordered set, Hasse diagram of partially ordered set, isomorphic ordered set, well ordered set, properties of lattices, and complemented lattices.

Boolean Algebra - Basic definitions, Sum of products and product of sums. Logic gates and Karnaugh maps.

Unit 3: Graphs : Simple graph, multi graph. graph terminology, representation of graphs, Bipartite, regular, planar and connected graphs, connected components in a graph, Euler graphs, Hamiltonian path and circuits, Graph colouring, chromatic number, isomorphism and homomorphism of graphs.

Tree - Definition, Rooted tree, properties of trees, binary search tree, tree traversal.

Unit 4: Combinatorics - Basics of counting, permutations, combinations, inclusion exclusion, recurrence relations (n^{th} order recurrence relation with constant coefficients, Homogeneous recurrence relations, Inhomogeneous recurrence relations), generating function (closed form expression, properties of G.F., solution of recurrence relation using, G.F, solution of combinatorial problem using G.F.).

Unit 5: Finite Automata - Basic concepts of automation theory, Deterministic finite automation (DFA), transition function, transition table, Non deterministic finite automata (NDFA), Mealy and Moore machine, Minimization of finite automation.

Paper (c) : MATHEMATICAL STATISTICS

Unit 1: Concept of probability, Dependent, independent and compound events.

Addition and multiplication theorems of probability, conditional probability, Bionomial and multinomial theorems of probability, Baye's theorem.

Unit 2: Mathematical expectation and its properties, Moment generating functions (n.g.f.) and cumulants, Binomial & Poisson distributions and their properties.

Distribution function, Probability density function (Pdf), Normal distributions and their properties.

Unit 3: Bivariate population, Meaning of correlation & regression, Coefficient of Correlation, rank correlation, lines of regression. Properties of regression coefficients, Partial and multiple correlation and their simple Properties.

Unit 4: Types of population, Parameters & Statistics, Null Hypothesis, Level of Significance, critical region. Procedure for testing Hypothesis, Type I & Type II error, χ^2- distribution and its properties.

Unit 5. Simple and random sampling. Test of significance for large samples. Sampling distribution of Mean. Standard error, Test of significance based on χ^2, Test of significance based on t, F & Z distribution.

Paper IV : Assignment and viva voce. M.M. : 60