

**NEHRU GRAM BHARATI UNIVERSITY**

Kotwa- Jamunipur- Dubawal

**ALLAHABAD**

**DEPT. OF MATHEMATICS**  
**SYLLABUS FOR B.SC. (MATHEMATICS)**

DEPARTMENT OF MATHEMATICS

FOR

UNDER GRADUATE CLASSES

### **B. Sc. Part-I : Mathematics (180. Hours)**

Paper	Units	Marks	Tot. Lectures	Load Per Week
1 <sup>st</sup>	5	50	60	3 Lectures/Week
2 <sup>nd</sup>	5	50	60	3 Lectures/Week
3 <sup>rd</sup>	5	50	60	3 Lectures/Week
Total		150	180	9 Lectures/Week

### **B. Sc. Part-II : Mathematics (180. Hours)**

Paper	Units	Marks	Tot. Lectures	Load Per Week
1 <sup>st</sup>	5	50	60	3 Lectures/Week
2 <sup>nd</sup>	5	50	60	3 Lectures/Week
3 <sup>rd</sup>	5	50	60	3 Lectures/Week
Total		150	180	9 Lectures/Week

### **B. Sc. Part-III : Mathematics (270. Hours)**

Paper	Units	Marks	Tot. Lectures	Load Per Week
1 <sup>st</sup>	5	50	65	3 Lectures/Week
2 <sup>nd</sup>	5	50	65	3 Lectures/Week
3 <sup>rd</sup>	5	50	65	3 Lectures/Week
4 <sup>th</sup>	5	50	65	3 Lectures/Week
Viva		25		
Total		225	260	12 Lectures/Per Week

#### **Syllabus-Mathematics**

B.A/B. Sc. Part I (Effective from Session 2017-2018)

**The examination shall consist of three theory Papers as follows:**

**Paper –I** Algebra

**Paper -II** Calculus

**Paper –III** Analytical Geometry

## **Paper I : Algebra and Trigonometry**

### **Unit –I**

Set and Relation, Order Relation, Maps, Equivalence Relation, Binary Operation on a set, Cardinal Numbers; Number system: Natural number, Integers, Division Process in  $\mathbb{Z}$ , Division Algorithm, Euclidean Algorithm, Fundamental theorem of arithmetic's, Fermat's and Wilson's Theorem's. Congruencies and residue Classes, Rational Numbers, Density Property, Archimedean Property; Real Numbers, Axioms of Real Numbers, Complex Numbers.

### **Unit- II**

Relations between the roots and Coefficients of General Polynomial equation in one variable. Transformation of Equations, Descarte's Rule of signs Solution of Cubic equations (Cardon's Method). Solution of biquadratic equations.

### **Unit – III**

Definition of a Group with examples and Simple Properties. Subgroups, Cyclic groups, Coset decomposition, Lagrange's Theorem, and its consequences Fermat's and Euler's theorems, Homomorphism and isomorphism.

### **Unit-I V**

Normal subgroups, quotient groups, the fundamental theorems of Homomorphism, permutation Groups, Even and odd permutations, the alternative group  $A_n$ . Cayley's theorem.

### **Unit V**

Rings, Subrings, Ideals and quotient rings, Ring homomorphism, Integral domains and fields, Fields of quotient of an Integral Comain, Polynomial Rings over a Field, Division and Euclidean algorithms for Polynomials, Remainder & Factor Theorems.

## **References: (Books Recommended)**

1. P.B. Bhattacharya, S.K. Jain and S.R. Nagpal, Basic Abstract Algebra, 3<sup>rd</sup> edition, Cambridge University Press, 2000.
2. Martin, Algebra, Prentice Hall of India
3. Ramjilal, Algebra (Vol.I), Shail Publication, Allahabad.
4. R.S. Mishra & N.N. Bhattacharya, Fundamental Structures in Modern Algebra, Pothishala Pvt Ltd. Allahabad.

## **B.Sc. Part – I**

### **Paper II : Calculus**

#### **Unit-I**

Functions of One Variable : Limit and Continuity and differentiability, Properties of Continuous Functions, Rolle's theorem, Lagrange's and Cauchy's mean-value theorems, Indeterminate forms.

#### **Unit – II**

Successive differentiation, Leibnitz theorem Maclaurin and Taylor series expansions. Tangents and normals, Asymptotes.

#### **Unit – III**

Curvature, tracing of curves in Cartesian and polar coordinates. Partial and total differentiation. Change of variables, Euler's theorem on homogeneous functions.

#### **Unit IV**

Integration of irrational algebraic functions and transcendental functions. Reduction formulae. Definite integrals. Beta and Gamma functions.

## **Unit- V**

Quadrature, Rectification, volumes and surfaces of solids of revolution, Double and triple integrals. Change of order of integration in double integrals.

### **Reference: (Books Recommended)**

1. N.N. Bhattacharya, A First course in Real Analysis, Ram Narain Lal & co. Allahabad
2. Gorakh prasad, Diffefential Calculus, Pothishala Private Ltd. Allahabad.
3. Gorakh Prasad, Integral Calculus, Pothishala Private Ltd., Allahabad
4. A. H. Smith & W. A. Albrecht, Fundamental Concepts of Analysis, Prentice Hall of India Pvt. Ltd., New Delhi.

## **B. Sc. Part – I**

### **PAPER III : Analytical Geometry**

#### **Unit – I**

Polar Coordinates, Distance between two given points, Polar equations of straight lines and circles. Polar equation of a Conic, directrix, tangents and normal. Polar of a point with respect to a conic, Asymptotes.

#### **Unit – II**

Orthogonal Cartesian coordinates of a point on space, Projections and direction cosines, Equation of plane in different forms, Plane bisecting angles between two given planes, Pairs of planes, Symmetrical and non-symmetrical forms of a straight line. Shortest distance between two skew lines, Coplaner lines.

#### **Unit- III**

**Sphere** : Equation of a sphere, plane section of a sphere and intersection of two spheres, spheres passing through a circle, tangent plane, plane of contact polar lines, angle of intersection of two spheres, power of a point, radical plane, line and center, co-axial system of spheres.

#### **Unit-IV**

**Cones & Cylinders**: Conics and cylinders with a given base, Intersection of a cone and a plane passing through the vertex of the cone. Tangent Lines and planes, reciprocal cones, right circular cones and cylinders.

#### **Unit-V**

**Central Conicoids**: Tangent Lines & planes, director sphere, polar planes and polar Lines, enveloping cones and cylinders of central conicoids, section with given centre, diametral planes, planes, normals, conjugate diameters of an ellipsoid.

#### **Books Recommended:**

1. R.S. Gupta and R.D. Pathak : Conic Section.
2. R.S. Sengar and M.Ambar : `Vector Analysis.
3. N. Saran and R.S. Gupta : Analytical Geometry of three Dimensions.
4. R.J.T. Bell : Coordinate Geometry of Three Dimensions.

### **B.A./B.Sc. Part II - Mathematics**

There shall be three compulsory papers each of 50 Marks.

**Paper I** : Linear Algebra

**Paper II** : Differential Equations

**Paper III** : Mechanics

### **B. Sc. Part – II**

#### **PAPER I : LINEAR ALGEBRA**

## **Unit – I**

Rings, subrings, ideals and quotient rings, Ring homomorphism, Integral domains and fields, Fields of quotient of an Integral Domain. Polynomial ring over a field. Division and Euclidean algorithms for Polynomials. remainder and factor theorems.

## **Unit – II**

Vector Spaces : Definition, Properties and examples, Linear combination of vectors, Linear sum and direct sum of subspaces, Linear span of subsets Bases and dimension, Quotient spaces.

## **Unit – III**

Linear Transformations : Definition, Properties and examples, Algebra of linear transformations. Non singular linear maps, Fundamental theorems of vector space homomorphism and its applications, dual space and dual basis, Transpose of a linear transformation.

## **Unit – IV**

Matrices : Matrix representation of a linear transformation. Change of base and its effect on matrix representation. Elementary operations on matrices, Equivalent and similar matrices, Trace of a square matrix and of a linear transformation, Definition and properties of a determinant of a square matrix. Rank of linear transformation and Matrices, Rank- Nullity Theorems, Row and Column rank. Determinantal rank.

## **Unit – V**

Applications of Matrices to a system of Linear (Both homogeneous and non-homogeneous) equations, theorems on consistency of a system of linear equations. The characteristic equation of a matrix. Eigen values and eigen vectors, Cayley-Hamilton theorem and its use in finding inverse of a matrix. Diagonalisation of square matrices.

## **B. Sc. Part – II**

### **PAPER II : DEFFERENTIAL EOUTIONS**

#### **Unit – I**

##### **Ordinary Differential Equations :**

Degree and order of a differential equation. Differential equations of first order and first degree. Differential equations in which the variables are separable, Homogeneous equations. Linear equations and equations reducible to the linear form. Exact differential equations.

#### **Unit – II**

First order higher degree equation solvable for  $x$ ,  $y$ ,  $p$ , Clairaut's form and Singular solutions, Orthogonal trajectories.

#### **Unit – III**

Linear differential equations with constant coefficients. Homogeneous linear differential equations and equations reducible to the homoheneous linear differential equations and equations reducible to the homogeneous linear form. Simultaneous differential equatios.

#### **Unit – IV**

Linear differential equations of second order with variable coefficients by changing the dependent variable/the dependent variable. Method of variation of parameters.

#### **Unit – V**

Linearity of Laplace transform, Existence theorem for Laplace transforms Laplace transforms of derivatives and Integrals. Shifting theorems. Defferentiation and integrations of transforms. Inverse Laplace transform solution of differential equations using the Laplace transform.

## **B. Sc. Part – II**



## **PAPER III : MECHANICS**

### **Unit – I**

Analytical conditions of equilibrium of coplanar forces, Virtual work.

### **Unit – II**

Catenary, Stable and Unstable equilibrium.

### **Unit – III**

Velocities and accelerations along radial and transverse directions and along tangential and normal directions, Simple Harmonic Motion, Elastic string.

### **Unit – IV**

Motion in a resisting medium, Motion on Smooth and rough plane curves

### **Unit – V**

Central orbits, Kepler's Laws, Inverse Square law, Motion of a particle in three directions, Accelerations in terms of different coordinate system.

## **B.A./B.Sc. Part III Mathematics**

There shall be three compulsory papers and one optional paper each of 50 marks and 3 hours duration and viva-voce test of 25 marks based on all the theory papers of B.A./B.Sc. Part III

**Paper I** : Analysis

**Paper II** : Numerical Methods

**Paper III** : Complex Analysis and Tensors

**Paper IV** : Any one of the following :

(A) Operations Research.

(B) Discrete Mathematics.

(C) Differential Geometry.

(D) Fluid Mechanics.

## **Paper I : ANALYSIS**

### **Unit – I**

Real sequences and their algebra, Limit of a sequence, Convergent, monotonic bounded and Cauchy's Sequences, Cauchy's general Principle of convergence. Convergence of Infinite series of positive terms. Cauchy's criterion. comparison test. Cauchy's nth root test, D' Alembert's ratio test, Raabe's test, Logarithmic test, Cauchy's condensation test, Higher ratio test, De Morgan and Bertrand test. Alternating series. Leibnitz test. Absolute and conditional convergence.

### **Unit – II**

Limit and continuity of functions of several variables. Taylor's theorem. Jacobians. Maxima, Minima and saddle points of functions of two and three variables. Lagrange's Multiplier method.

### **Unit – III**

Vector differentiation, Gradient, Divergence and curl, Vector integration, theorems of Gauss, Green and Stokes.

### **Unit – IV**

Riemann Integral, Integrability of continuous and monotonic functions, The fundamental theorem of Integral Calculus. Mean value theorems of Integral Calculus. Improper Integrals and their convergence, Comparison tests.

### **Unit – V**

Definition and examples of metric spaces, Open and closed spheres, Open and closed sets, Limit Points. Interior boundary and exterior points. Closure and interior of a set. Continuity of maps between metric spaces and their characterization.

## **PAPER II : NUMERICAL METHODS**

## **Unit – I**

**Introduction** : Need for numerical methods, floating point representation, rounding off rules.

## **Unit – II**

Solution of Arbitrary Equations : Fixed point iteration methods, Bisection method, Method of False position ( Regula Falsi). Newton- Raphson's method, order of convergence.

## **Unit – III**

Interpolation : Forward, Backward and Central differences, Calculus of finite differences, Gregory-Newton Forward and Backward interpolations formulas, Lagrange's and Newton's divided difference interpolation formula inverse interpolation, Formulas based on Central differences: Gauss; Stirlings, Bessel's and Evertt's interpolation formula, Cubic spline interpolation, Clamped and natural splines.

## **Unit – IV**

Numerical differentiation and Integration : Formulas for differentiation based on Lagrange's and on Gregory Newton's interpolation, quadrature formula Trapezoidal and Simpson's One- Third and three- eighth rules, Numerical Methods for O. D. E.'s First order equations, incremental methods, Euler's Taylor series and improved Euler methods, Runge Kutta method, multistep methods, Predictor corrector pair, Adam's- Bash forth, Adam's- Moulton and Milens Formulas. Second Order Equations : Taylor Series and Runge Kutta Nystrom Method.

## **Unit – V**

Numerical Linear Algebra : Gauss Elimination, Cholesky's Method, Gauss Jacobi and Gauss Seidel iteration formulas, Least square approximation, Estimation of Eigen values Determination of fo elgen values and eigen vectors by iteration.

## **PAPER III : COMPLEX ANALYSIS AND TENSORS**

## **Unit – I**

Continuity and differentiability of functions of a complex variable. Analytic functions, Cauchy-Riemann equations, Harmonic functions, Power series as an analytic function.

## **Unit – II**

Complex Integration, Cauchy's theorem, Cauchy's integral formula Derivation, Taylor's series. Laurent's series, Liouville's theorem, Morera's theorem Zeros and singularities, Rauche's theorem.

## **Unit – III**

Poles of analytic function, Residues, Cauchy's residue theorem, contour integration.

## **Unit – IV**

Transformation of coordinates, Contravariant and covariant vectors, Scalar invariants, Scalar product of two vectors. Tensors of any order, symmetric and skew- symmetric tensors, Addition and multiplication of tensors, contraction composition and quotient law.

## **Unit – V**

Fundamental tensor, Associated covariant and contravariant vectors. inclination of two vectors and orthogonal vectors. christoffel symbols, covarition and derivatives of covariant and contravariant vectors. Covariant differentiation of tensors. Curvature tensor, Ricci tensor and curvature tensor identities.

## **OPTIONAL PAPER IV (A) : OPERATION RESEARCH**

### **Unit – I**

Linear programming : Convex sets and functions, Linear programming problem (LPP), Two- variable LP. Procedure of solving two- variable LPP by Graphical method, Some Important Definitions related to General LPP, Canonical and

standard forms of LPP, Slack and surplus variables, Basic solutions of LPP, Solutions of General LPP, Simplex method, Big- M Method, Two Phase method, Exceptional cases, Degeneracy in simplex methods.

## **Unit – II**

Solutions of simultaneous Linear equations using Simplex method, Inverse of 'matrix using Simplex method. Duality concept in LPP, Formulation of Dual Problem, Duality Principle, Duality and Simplex Method. Important Results of Duality, Economic Interpretation of Duality and Duality theorems, Dual- Simplex Method,. Applications of Linear Programming, Advances of Linear Programming, Limitations of Linear Programming.

## **Unit- III**

Transportation and Assignment problems : Mathematical formulation of Transportation Problem , Balanced and unbalanced transportation problems, Solution of Transportation problem, Transportation table, Initial Basic Feasible solution, Methods of Finding Initial basic Feasible Solution, Optimality test, Modified Distribution (MOD) Method, Degeneracy of transportation problems, Maximization Transportation Problem, Trans- shipment Problem,

## **Unit – IV**

Game theory characteristics of Game theory, Basic Definitions, Competitive Games, Zero- Sum and Non- Zero Sum Games, Two person zerosum games, Minimax- Maximin Criterion, Saddle Point, Solution of rectangular Games with and without Saddle Points. Minimax-Maximin Principal Dominance Property, Graphical Method for  $2 \times n$  and  $m \times 2$  games : without Saddle point, Applications and Limitations of Game theory.

## **Unit – V**

Network analysis : Basic Concepts, Construction of Network diagram analysis of Network diagram. Critical path method, Object of CPM. Labeling method, Method based on time estimates, Slack and Float, pertcalculation requirements for the application of CPM and PERT.

## **OPTIONAL PAPER (B) : DISCRETE MATHEMATICS**

### **Unit – I**

Statements, Truth value of a statement, Truth tables, Conditional and Biconditional Statements, Propositional functions, Tautologies and contradictions, Law of duality, Quantifiers, arguments, Principle of Mathematical Induction, set, venn-diagrams, Operations on sets, Cartesian product of sets, Relations on a sets, Composition of Relations, Equivalence Relation, Equivalence Classes, Partitions of a set, Mappings, Types of Mappings, Domain and range of a function, Composition of maps.

### **Unit – II**

Partially ordered set, Hasse Diagrams, Minimal and Maximal element in a poset, least and greatest element, Upper bounds and least upper bound, Lower bounds and greatest lower bound, Isomorphic posets, Lattices, properties of lattices, Lattice as an Algebraic system, sub-lattices Isomorphic lattices, Bounded lattices, complete Lattices, complemented Lattices

### **Unit – III**

Discrete numeric functions Sum and Product of two discrete numeric functions, Generating functions, Recurrence relations, Linear Recurrence relations with constant coefficients, Homogeneous Solution, Particular solutions, Solutions by Method of Generating solutions.

### **Unit – IV**

Boolean Algebra, Principle of Duality, Switching Circuits, Logic Circuits OR Gate, AND gate, Logic Networks.

### **Unit – V**

Graphs, Directed Graphs, Indegree and Outdegree of a vertex, Even and Odd vertex, Adjacent vertices, Walk, Trail, Path, Length of a Path Circuits, Cycle, Sub Graph, Spanning sub Graph, Operations on Graph, Complement of a sub Graph,

Connected and disconnected circuit graph, Isomorphic Graph, Regular Graph, Bipartite Graph, Matrix representation of a Graph, Adjacency matrix, Euler Graph, Properties of Eulerian Graph (Without Proof), Hamiltonian Graph, Weighted Graph, Trees, Distance and centres in a tree, Eccentricity of a vertex, radius and diameter.

## **PAPER IV (C) : DIFFERENTIAL GEOMETRY**

### **Unit – I**

Curves in Space : Regular Curves, tangent, Principal normal and binormal curvature and Torsion, Serret – Frenet’s Formula.

### **Unit – II**

Contact between curves and surfaces, Osculating Plane, Normal Plane, Rectifying Plane, Osculating circle, osculating spheres, Spherical Indicatrices, Helices, Involutives and evolutes.

### **Unit – III**

Theory of Surfaces : Parametric Patches on surface, curves on a surface, First fundamental form and arc length, Orthogonal Trajectories, Second Fundamental form, Curvature of a curve on a surface, Normal Curvature, Meusnier’s theorem.

### **Unit – IV**

Principal curvature, Gaussian curvature, Mean curvature, lines of curvature, Euler’s theorem.

### **Unit – V**

Conjugate Directions, Asymptotic lines, null lines, Beltrami and Enneper’s theorem, Christoffel symbols, Gauss formulae, Weingarten’s formulae, Gauss characteristic equation, Mainardi Codazzi equation, Geodesics, Geodesic Curvature.

## **PAPER IV (D) : FLUID MECHANICS**

## **Unit – I**

Equation of Continuity in Fluid motion, Equation of Continuity in different Coordinate system (Cartesian , Cylindrical and Spherical), Stream Line, Path Line and their equations, Velocity potential, Vorticity vector, equation of Continuity in Lagrangian form.

## **Unit – II**

Boundary surfaces of fluid particles, Euler's Equations of motion for perfect fluids, Bernoulli's Equation, Impulsive motion and its Equation.

## **Unit – III**

Motions of Sphere in perfect Fluid and motion of Liquid past a sphere.

## **Unit – IV**

Two dimensional motion, Complex potential

## **Unit – V**

Navier-Stokes equations for viscous flows-some exact solutions.