

For the academic session 2022-23
DEPARTMENT OF MATHEMATICS
UNIVERSITY OF ALLAHABAD
ALLAHABAD

UNDERGRADUATE COURSE STRUCTURE

B.A./B.Sc. Part – I

(Effective from Session 2009-10)

There shall be three papers each consisting of 5 units.
Each unit will have 14 lectures schedule and hence 70
lectures per paper. Each paper will have 50 marks to its credit.
One question with an alternate will be asked from each Unit.
Students will have to attempt all questions.

PAPER I : GEOMETRY

Unit – 1

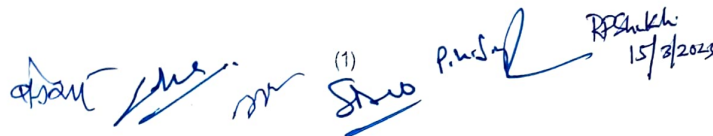
Polar Coordinates :

Polar equation of a parabola, ellipse and hyperbola
when focus is taken as pole, Polar equations of the chord
joining two points, tangent, normal, polar (chord of contact),
pair of tangents, asymptotes, director circle and auxiliary circle
of a conic.

Unit – 2

Straight Lines & Planes (Using Vector technique)

Normal form of equation, intercept form of equation
and general equation of a plane, plane passing through three
points, angle between two planes, two sides of a plane, Length
of perpendicular from a point to a plane, Bisectors of angles
between two planes, Planes passing through the line of
intersection of two planes.


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Symmetrical and non-symmetrical form of equations of a line, transformation of non-symmetrical form to symmetrical form, Planes passing through a line, coplanar lines, The shortest distance between two lines, Length of perpendicular from a point to a line, Orthogonal projection of a point and a line on a plane, Lines intersecting two lines, intersection of three planes, volume of a tetrahedron, pair of planes.

Unit — 3

SPHERES

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, centre of spheres, coaxial system of spheres, Orthogonal systems of spheres.

Unit— 4

(a) CONES & CYLINDERS

Cones and cylinders with given base, intersection of a cone and a plane passing through the vertex of the cone, tangent lines and planes, reciprocal cones, normal plane passing through a generator of the cone, right circular cones and cylinders.

(b) GENERATING LINES

Ruled surfaces, generating lines of a hyperboloid of one sheet, ~~and hyperbolic paraboloid and its properties,~~ generators through a point on the principal elliptic section of hyperboloid of one sheet, (θ, ϕ) point on hyperboloid of one sheet and equations of generators at (θ, ϕ) point.

Unit – 5

CENTRAL CONICOID & PARABOLOIDS:

Standard equations of central conicoids and paraboloids, tangent lines and planes, polar planes and polar lines, enveloping cones and cylinders, section with given centre, diametral planes of central conicoids and paraboloids, Locus of point of intersection of three mutually perpendicular tangent planes to central conicoids and paraboloids, Normals drawn from a point to a central conicoid and a paraboloid, Cone passing through the normals drawn from a point to central conicoid and paraboloid, Conjugate diameters of an ellipsoid and its properties.

Books recommended:

1. R. S. Gupta and R. D. Pathak : Conic Sections.
2. Mata Ambar Tiwari and R. S. Sengar : A course in Vector Analysis and its Applications.
3. N. Saran and R. S. Gupta : Analytical Geometry of Three Dimensions.

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15/3/2023

B.A./B.Sc. Part - I
(Effective from Session 2009-2010)

PAPER - II : ELEMENTARY ANALYSIS

Unit - 1

Statements, Connectives (Conjunction, Disjunction, Negation, Conditional and Biconditional Joins) Statement formulas, Tautologies, Implication and equivalences, Statement Functions, Quantifiers, Sets, Relations, Equivalence and Order relations, Partitions, Functions, Direct and Inverse images of subsets under maps.

Axiomatic introduction of IR as a complete ordered Field, Existence of square roots of positive real numbers.

Unit - 2

Properties of Integers and Sequences

Natural numbers, First Principle of induction, Well Ordering property of N, Second Principle of Induction, Integers and rational numbers, Archimedean Property, Rational and Irrational Density Theorems, Division and Euclidean Algorithm in Z, Primes, Fundamental Theorem of Arithmetic, Irrationality of surds.

Intervals in IR, Real sequences and their algebra, Limit of a sequence, Bounded, convergent, monotone and Cauchy sequences, Cauchy's general principle of convergence, Algebra of limits (passage to limits under addition, multiplication, inversions and inequality), Divergence of sequences.

Unit - 3

Limits and Continuity

Real valued Functions of one variable, their graphs and algebra, Neighbourhoods of a point and limit points of subsets of IR, Limit of a function at limit point of its domain, sequential characterization of limit of a function, Algebra of limits, One sided limits, Limit of a function as $x \rightarrow \pm\infty$, Infinite limits.

Continuity, Local Boundedness and local maintenance of sign, Boundedness and intermediate value properties of continuous functions over closed intervals, Image of a closed interval under continuous maps.

Unit - 4

Differentiability

Differentiability of a function at a point and its geometrical interpretation, algebra of differentiable functions, Chain rule of differentiation, sign of derivatives and monotonicity of functions, Interior Extremum Theorem, Rolle's Theorem, Lagrange's Mean value Theorem, Cauchy's Mean value Theorem.

Unit - 5

Applications of Derivatives

Higher derivatives, Leibnitz Theorem, Taylor's and Maclaurin's Theorem with Lagrange's and Cauchy's Forms of remainders, Maxima and minima, Local extremum points (necessary and sufficient conditions), Indeterminate Forms, L'Hospital's rule, Convexity and concavity, Points of Inflection, curvature of curves in explicit form $y = f(x)$, Darboux's Theorem on intermediate value property of derivatives.

P.K.Singh
R.P. Singh
15/3/2023

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Books Recommended

1. Sherbert & Bartle : Introduction to Real Analysis.
2. N.N. Bhattacharya : Elementary Analysis.
3. Thomas & Finney : Calculus & Analytic Geometry.
4. T.M. Apostol : Calculus Vol. 1.
5. Smith & Albrecht : Fundamental Concepts in Analysis.
6. S. C. Malik : Mathematical Analysis.
7. Arora & Bansilal : Real Analysis.

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B.A./B.Sc. Part – I

(Effective from Session 2009-2010)

PAPER III : DIFFERENTIAL EQUATIONS AND VECTOR CALCULUS

Unit 1

Origin, concept and formation of an ordinary differential equation and its solution, initial-value problems and statement of Existence and Uniqueness Theorems, order and degree of differential equation, First order equations, separable equations, equations reducible to separable form, exact equations.

Integrating factors, linear equations, Geometrical meaning of a differential equation and its solution, isoclines and direction field.

Unit – 2

Picard's iteration method, Curves under given geometrical conditions, orthogonal trajectories, mechanical applications (Newton's law of cooling, growth and decay problems, motion in a resisting medium, escape velocity). Equations solvable for p , x or y , Clairaut's equations, singular solutions.

Unit – 3

Homogeneous linear differential equations, linearly dependent and independent solutions, fundamental system of solutions, equations with constant coefficients, Methods of undetermined coefficients, variation of parameters and operators for determining particular integrals, Euler-Cauchy equations.

Unit - 4

(a) Applications to damped and forced oscillations, linear systems of differential equations with constant coefficients.

(b) Derivatives of a vector function of a single scalar variable, scalar and vector fields, gradient, divergence and curl, vector identities.

Unit - 5

Orthogonal curvilinear coordinates, spherical polar and cylindrical polar coordinates double integrals. Line, surface and volume integrals, Green's, Stokes' and Gauss' Theorems (statements only) and their simple applications.

Books Recommended

1. R.S. Sengar : Ordinary Differential Equations.
2. E. Kreyszig : Advanced Engineering Mathematics.
3. B. Rai & D. P. Choudhury : Ordinary Differential Equations : An Introduction.
4. Mata Ambar Tiwari & R.S. Sengar : A Course in Vector Analysis and its Applications.
5. G F Simmons : Differential Equations.

P. K. Singh

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For the academic session 2022-23

B.A./B.Sc. Part - II

(Effective from Session 2010-2011)

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Paper - I : LINEAR ALGEBRA

Unit - 1

Definition of a field, Examples \mathbb{R} , \mathbb{C} , \mathbb{Q} and \mathbb{Z}_p of fields. Vector Space : definition, examples and basic properties. Subspaces, subspace generated by a subset, Linear dependence and independence of a subset, Basis and Dimension of a vector space, Sum and direct sum of subspaces, Quotient spaces.

Unit - 2

Linear transformations and Isomorphism of vector spaces, Null space, range space, rank and nullity of linear transformations, Fundamental theorem of homomorphism, Rank nullity Theorem, $\text{Hom}(V, W)$ as a vector space, $\text{Dim Hom}(V, W) = \text{Dim } V \cdot \text{Dim } W$. Dual space V^* and transpose of a linear transformation, Annihilator of a subset of a vector space.

Unit - 3

Matrix representation of linear transformation. Algebra of matrices, Effect of change of basis on matrix representation. Equivalent and similar matrices, Rank and nullity of a matrix, System of linear equations, their

consistency and inconsistency [Reduction of a matrix to normal form and algorithms to find the inverse (if it exists), Definition of Determinant and statement of properties (without proof), Co-factor, Adjoint of a matrix and its properties.]

Unit – 4

Inner product space : Definition and Examples, Cauchy Schwarz inequality, Norm of a vector, Notion of angle, Orthogonality, Orthonormal set and basis, Gram Schmidt orthonormalization, Bessel's Inequality, Orthogonal complement, Adjoint of a linear transformation, inner product and distance preserving transformations (orthogonal and Unitary), Hermitian, skew Hermitian, Symmetric and Skew Symmetric matrices. Invariant Subspaces, Eigenvalues, Eigenvectors, Characteristic polynomials of a Linear transformation, Cayley-Hamilton Theorem.

Unit – 5

Diagonalization of a matrix with distinct Eigenvalues, Orthogonal (Unitary) reduction of real Symmetric (Hermitian) matrices.

Bilinear forms, Equivalence of bilinear forms, matrix representation of Bilinear forms, Quadratic forms, Classification of Symmetric, Skew Symmetric bilinear forms over \mathbb{R} and \mathbb{C} , Sylvester's law of inertia, Classification of curves and surfaces represented by equations of 2nd degree.

Books Recommended :

1. K. Hoffman and R. Kunze : Linear Algebra.
2. I.N. Herstein : Topics in Algebra, 2nd Edition.
3. Serge Lang : Introduction to Linear Algebra 2nd Edition.
4. Ramji Lal : Algebra Vol. II.
5. M. Artin : Algebra.

For the academic session 2022-23

B.Sc./B.Sc. Part – II

(Effective from Session 2010-2011)

PAPER – II : ANALYSIS

Unit – 1

Series of Positive Terms

Convergence of Infinite series, addition and removal of terms, nth term test, Cauchy's criterion, Series of positive terms, Comparison Theorem, Comparison Test. Ratio and Root Tests, Comparison of ratios, Raabe's test, Logarithmic ratio test, Cauchy's Condensation test, De Morgan & Bertrand's test, higher logarithmic ratio test.

Unit – 2

General Series

Convergence of arbitrary infinite series, Alternating Series, Absolute and conditional convergence, Abel's and Dirichlet's test, rearrangement of series, Dirichlet's and Riemann's Theorem on rearrangement of absolutely and conditionally convergent series, [Convolution (Cauchy) product of series, Mertens' Theorem.]

Unit – 3

Riemann's Theory of Integration

Step functions and their integrals, upper and lower integrals of a bounded function, Integrable functions, Riemann's condition of integrability, Properties of integrals, Mean Value Theorem for Integrals, Differentiations of functions defined by integrals, Fundamental Theorem of integral calculus, primitives, change of variables, Second Mean Value Theorem, Integral Test.

Unit – 4

Convergence of Improper Integrals

Integrals over infinite intervals with bounded integrands, Convergence of such integrals, Necessary and sufficient conditions, Case of positive integrands, comparison test, μ -test, absolute convergence, convergence of integrals of product of two functions, Abel's and Dirichlet's test. Convergence of integrals with unbounded integrands.

Unit – 5

Metric Spaces

Definition and examples of Metric spaces, Open balls, interior, boundary, closure and accumulation points, Open and closed sets, Interior and closure of sets, Limits of sequences in Metric spaces, Cauchy sequences, Completeness.

Books Recommended

1. S.C. Malik : Mathematical Analysis.
2. Smith & Albrecht : Fundamental Concepts of Analysis.
3. G.F. Simmons : Topology & Modern Analysis.
4. D. Widder : Advanced Calculus.
5. Arora & Bansilal : Real Analysis.
6. Shanti Narayan : Real Analysis.
7. T. M. Apostol : Mathematical Analysis.

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B.A./B.Sc. – II

PAPER III – MECHANICS

(Effective from Session 2010-2011)

Statics

Unit – 1

Common centenary, ~~virtual work and stability of equilibrium.~~

Dynamics of a Particle

Unit – 2

Rectilinear Motion : Simple Harmonic Motion including the cases of horizontal and vertical elastic strings, Motion under inverse square law, Motion in resisting media, ~~Motion of varying mass.~~

Unit – 3

Motion in plane : Kinematics and kinetics of motion, velocity and acceleration in Cartesian, polar and tangential & normal coordinates, determination of path under a given force.

Unit – 4

Constrained Motion : Motion in a vertical circle, ~~Cycloidal motion.~~

Unit – 5

Motion under Central Forces : Conservation of angular momentum, areal velocity, differential equation to the path of a particle moving under a central attractive force, (p, r) equation to the path, ~~energy equation, Kepler's laws of planetary motion.~~

Books recommended :

1. S.L. Loney : Statics.
2. P.L. Srivastava : Elementary Dynamics.