

KUMAUN UNIVERSITY, NAINITAL
Department of Mathematics
B.A./B. Sc. Mathematics

SEMESTERWISE COURSE STRUCTURE AND DETAILED SYLLABUS:

1. There shall be six semesters in the three- years B.A./B.Sc. Programme.
2. There will be two papers in mathematics in each semester. The code numbers of the papers will be in accordance with the rules framed by the university for the B. A./B. Sc. Programme.
3. The Maximum Marks for each paper in the semester-end examination and for mid-semester/internal assessment will be in accordance with the rules framed by the university for the B. A./B. Sc. Programme.
4. The duration and the structure of the question papers for the semester-end examination will be in accordance with the rules framed by the university for the B. A./B. Sc. Programme.

B.A./B. Sc. Mathematics
Course Structure (Semester System)

I Semester	II Semester	III Semester	IV Semester	V Semester	VI Semester
Elementary Algebra, Matrices and Trigonometry	Geometry and Vector Analysis	Analytical Geometry	Differential Equations	Real Analysis	Complex Analysis
Differential Calculus	Integral Calculus	Group Theory	Ring Theory	Functions of several variables and Partial Differential Equations	Linear Algebra

B. Sc. I Semester I

PAPER I: Elementary Algebra, Matrices and Trigonometry

Matrices: Symmetric, skew-symmetric, Hermitian and skew-Hermitian matrices; idempotent, nilpotent, involutory, orthogonal and unitary matrices, singular and nonsingular matrices, Elementary operations on matrices, adjoint and inverse of a matrix, singular and nonsingular matrices, negative integral powers of a nonsingular matrix; Trace of a matrix, Rank of a matrix, elementary transformations of a matrix and invariance of rank through elementary transformations, normal form of a matrix, elementary matrices, rank of the sum and product of two matrices, inverse of a non-singular matrix through elementary row transformations; equivalence of matrices; Solutions of a system of linear homogeneous equations, condition of consistency and nature of the general solution of a system of linear non-homogeneous equations.

Trigonometry: Exponential, Logarithmic, Circular and hyperbolic functions together with their inverses, Gregory's series, Summation of Trigonometric series.

Roots of equations: Fundamental Theorem of Algebra, Relations between Roots and Coefficients, transformation of equations, Descartes rule of signs, Algebraic Solution of a Cubic equations (Cardan method), Bi-quadratic Equation.

Books Recommended:

1. Leonard E. Dickson: First Course in the Theory of Equations.
2. Burnside, William Snow, Panton and Arthur William: The Theory of Equations Vol I (1924).
3. John Bird: Engineering Mathematics, Fifth edition.
4. Rajendra Kumar Sharma, Sudesh Kumari Shah and Asha Gauri Shankar: Complex Numbers and the Theory of Equations, Anthon Press India

PAPER II: DIFFERENTIAL CALCULUS

Limit, Continuity and Differentiability: Functions of one variable, Limit of a function (ϵ - δ Definition), Continuity of a function, Properties of continuous functions, Intermediate value theorem, Classification of Discontinuities, Differentiability of a function, Rolle's Theorem, Mean value theorems and their geometrical interpretations, Applications of mean value theorems.

Successive Differentiation and Expansions of functions : Successive Differentiation, n^{th} Differential coefficient of functions, Leibnitz Theorem; Taylor's Theorem, Maclaurin's Theorem, Taylor's and Maclaurin's series expansions.

Tangents and Normals: Geometrical meaning of $\frac{dy}{dx}$, Definition and equation of Tangent, Tangent at origin, Angle of intersection of two curves, Definition and equation of Normal, Cartesian subtangent and subnormal, Tangents and Normals of polar curves, Angle between radius vector and tangent, Perpendicular from pole to tangent, Pedal equation of curve, Polar subtangent and polar subnormal, Derivatives of arc (Cartesian and polar formula).

Curvature and Asymptotes: Curvature, Radius of curvature; Cartesian, Polar and pedal formula for radius of curvature, Tangential polar form, Centre of curvature, Asymptotes of algebraic curves, Methods of finding asymptotes, Parallel asymptotes.

Singular Points and Curve Tracing: Regular points and Singular Points of a curve, Point of inflection, Double Points, Cusp, Node and conjugate points, Curve tracing.

Books Recommended:

1. M. Ray: Differential Calculus, Shiva Lal Agarwal and Co., Agra
2. H. S. Dhama: Differential Calculus, New Age International, New Delhi
3. T. M. Apostol: Calculus, John Willey and Sons, New York
4. S. Lang: A First Course in Calculus, Addison Wesley Publishing Co., Philippines
5. Gorakh Prasad: Differential Calculus, Pothishala publication, Allahabad.

B. Sc. I Semester II

PAPER I: GEOMETRY AND VECTOR ANALYSIS

Polar Equation of conics: Polar coordinate system, Distance between two points, Polar equation of a Straight line, Polar equation of a circle, Polar equation of a conic, Chords, Tangent and Normal to a conic, Chord of contact, Polar of a point.

Vector Algebra and its Applications to geometry (Plane and Straight Line):

Triple product, Reciprocal vectors, Product of four vectors. General equation of a Plane, Normal and Intercept forms, Two sides of a plane, Length of perpendicular from a point to a plane, Angle between two planes, System of planes.

Direction Cosines and Direction ratios of a line, Projection on a straight line, Equation of a line, Symmetrical and unsymmetrical forms, Angle between a line and a plane, Coplanar lines, Lines of shortest distance, Length of perpendicular from a point to a line, Intersection of three planes, Transformation of coordinates.

Vector Differentiation: Ordinary differentiation of vectors, Applications to mechanics, Velocity and Acceleration, Differential operator-Del, Gradient, Divergence and Curl,

Vector Integration: Line, Surface and volume integrals, Simple applications of Gauss divergence theorem, Green's theorem and Stokes theorem (without proof).

Books Recommended:

1. Murray R. Spiegel: Vector Analysis, Schaum's Outline Series, McGraw Hill.
2. N. Saran and S. N. Nigam: Introduction to vector analysis Pothishala Pvt. Ltd. Allahabad.
3. Shanti Narayan: A text book of vector calculus, S. Chand & co. New Delhi.
4. P. N. Pandey: Polar Coordinate Geometry, Sharda Academic Publishing House, Allahabad.
5. P. K. Jain and Khalil Ahmed: A textbook of Analytical Geometry, Wiley Eastern pub, New Age.

PAPER II: INTEGRAL CALCULUS

Definite Integrals: Integral as a limit of sum, Properties of Definite integrals, Fundamental theorem of integral calculus, Summation of series by integration, Infinite integrals, Differentiation and integration under the integral sign.

Functions Defined by Infinite Integrals: Beta function, Properties and various forms, Gamma function, Recurrence formula and other relations, Relation between Beta and Gamma function, Evaluation of integrals using Beta and Gamma functions.

Multiple Integrals: Double integrals, Repeated integrals, Evaluation of Double integrals, Double integral in polar coordinates, Change of variables and Introduction to Jacobians, Change of order of integration in Double integrals, Triple integrals, Evaluation of Triple integrals, Dirichlet's theorem and its Liouville's extension.

Geometrical Applications of Definite Integrals: Area bounded by curves (quadrature), Rectification (length of curves), Volumes and Surfaces of Solids of revolution.

Books Recommended:

1. M. Ray: Integral Calculus, Shiva Lal Agarwal and Co., Agra
2. H. S. Dhama: Integral Calculus, New Age International, New Delhi
3. T. M. Apostol: Calculus, John Willey and Sons, New York
4. S. Lang: A First Course in Calculus, Addison Wesley Publishing Co., Philippines
5. Gorakh Prasad: Integral Calculus, Pothishala Publication, Allahabad

B. Sc. I Semester III

PAPER I: ANALYTICAL GEOMETRY

System of co-ordinates: Curvilinear coordinates, Spherical and Cylindrical coordinates.

The Sphere: Definition and equation of a sphere, Plane section of a sphere, Intersection of two spheres, Intersection of a sphere and a line, Power of a point, tangent plane, Plane of contact, Polar plane, Pole, Angle of Intersection of two spheres, Radical plane, Co-axial system of spheres.

Cone and Cylinder: Definition and equation of a cone, Vertex, Guiding curve, Generators, Three mutually perpendicular generators, Intersection of a line with a cone, Tangent line and tangent plane, Reciprocal cone, Right circular cone, Definition and equation of a cylinder, Right circular cylinder, Enveloping cylinder.

Conicoids: General equation of second degree, Central conicoids, Tangent plane, Director sphere, Normal, Plane of contact, Polar plane, Conjugate plane and conjugate points.

Books Recommended:

1. Shanti Narayan: A Text book of Analytical Geometry, S. Chand, & company, New Delhi.
2. H. Burchard Fine and E. D. Thompson: Coordinate Geometry, The Macmillan company.
3. P. K. Jain and Khalil Ahmed: A textbook of Analytical Geometry, New Age, Delhi.

PAPER I: GROUP THEORY

Basic concepts: Sets, Subsets, Operations on sets, Index set and family of sets, Relations, Equivalence relations and partitions, Mappings.

Basic concepts Contd.: Infinite sets and cardinality, Congruence modulo-n., Laws of composition.

Groups: Binary operation and Algebraic structure, Groups, Subgroups, Generators of a group, Permutation groups, Cyclic groups, Coset decomposition, Lagrange theorem and its consequences, Homomorphism and Isomorphism, Normal subgroups, Quotient group, Cayley's theorem.

Groups Contd.: Fundamental theorems on homomorphism and isomorphism, Automorphism and inner automorphism, Automorphism groups and their computation, Normaliser and center of group, Group actions, Stabilizers and orbits, Finite groups, Commutator subgroups.

Books Recommended:

1. I. N. Herstein: Topics in Algebra, Wiley Eastern Ltd, New Delhi.
2. S. Singh: Modern Algebra, Vikas Publishing House, India.

B. Sc. I Semester IV

PAPER I: DIFFERENTIAL EQUATIONS

Differential equations: Introduction of Differential equations, Order and Degree of Differential Equations, Complete primitive (general solution, particular solution and singular solutions), Existence and uniqueness of the solution $dy/dx = f(x,y)$.

First Order Differential Equations: Differential equations of first order and first degree, Separation of variables, Homogeneous Equations, Exact Equations, Integrating Factor, Linear Equation, Equation of First order but not of first degree, Various methods of solution, Clairaut's form, Singular solutions, Trajectory, Orthogonal Trajectory, Self-Orthogonal family of Curves.

Linear Differential Equations: Linear equations with constant coefficients, Complementary function, Particular integral, Working rule for finding solution, Homogeneous linear equations.

Miscellaneous Equations: Simultaneous differential equations, Differential equations of the form $dx/P = dy/Q = dz/R$ where P, Q, R are functions of x, y, z. Exact differential equations, Total differential equations, Series solutions of differential equations, Linear differential equations of second order with variable coefficients.

Applications: Initial and boundary value problems, Simple applications of differential equations of first order.

Books Recommended:

1. Earl A. Coddington and Norman Levinson: Theory of Ordinary Differential Equations, Tata McGraw-Hill Publishing Company (1998).
2. Shepley L. Ross: Differential Equations, Wiley (1984).
3. Ravi P. Agarwal: Ordinary and Partial Differential Equations.
4. L. Elsgolts: Differential Equations and Calculus of Variations, Mir Publishers, 1970.
5. M D Raisinghania: Ordinary & Partial Differential Equation.

PAPER II: RING THEORY

Rings: Rings, Various types of rings, Rings with unity, Rings without zero divisors, Properties of rings, Sub rings.

Ideals: Ideals, Quotient rings, Principal ideals, Maximal ideals, Prime ideals, Principal ideal domains, Characteristic of a ring.

Integral domains and Fields: Integral domain, Field, Skew field etc., Field of quotients of an integral domain, Embedding of an integral domain in a field, Factorization in an integral domain, Divisibility, Units, Associates, Prime and irreducible elements, Unique Factorisation Domain, Euclidean rings.

Polynomial rings: Polynomials over a ring, Degree of a polynomial, Zero, Constant and monic polynomials, Equality of polynomials, Addition and multiplication of polynomials, Polynomial rings, Embedding of a ring R into $R[x]$, Division algorithm, Euclidean algorithm, Units and associates in polynomials, Irreducible polynomials.

Books recommended

1. I. N. Herstein: Topics in Algebra. Wiley Eastern Ltd.
2. N. Jacobson: Basic Algebra Vol I & II . Hindustan Publishing Co.
3. Joseph A. Gallian: Contemporary Abstract Algebra. Narosa Publishing House.
4. Shanti Narayan: Textbook of Modern Abstract Algebra . S Chand & Co.
5. R.S. Aggarwal: A Textbook on Modern Algebra. S Chand & Co.

B. Sc. I Semester V

PAPER I: REAL ANALYSIS

Continuity and Differentiability of functions: Continuity of functions, Uniform continuity, Differentiability, Taylor's theorem with various forms of remainders.

Integration: Riemann integral-definition and properties, integrability of continuous and monotonic functions, Fundamental theorem of integral calculus, Mean value theorems of integral calculus.

Improper Integrals: Improper integrals and their convergence, Comparison test, Ditchlet's test, Absolute and uniform convergence, Weierstrass M-Test, Infinite integral depending on a parameter.

Sequence and Series: Sequences, theorems on limit of sequences, Cauchy's convergence criterion, infinite series, series of non-negative terms, Absolute convergence, tests for convergence, comparison test, Cauchy's root Test, ratio Test, Rabbe's, Logarithmic test, De Morgan's Test, Alternating series, Leibnitz's theorem.

Uniform Convergence: Point wise convergence, Uniform convergence, Test of uniform convergence, Weierstrass M-Test, Abel's and Ditchlet's test, Convergence and uniform convergence of sequences and series of functions.

Books Recommended:

1. Walter Rudin: Principle of Mathematical Analysis (3rd edition) McGraw-Hill Kogakusha, 1976, International Student Edition.
2. K. Knopp: Theory and Application of Infinite Series.
3. T. M. Apostol: Mathematical Analysis, Narosa Publishing House, New Delhi, 1985.

PAPER II: FUNCTIONS OF SEVERAL VARIABLES AND PARTIAL DIFFERENTIAL EQUATIONS

Functions of several variables: Limit, continuity and differentiability of functions of several variables.

Partial Derivatives: Partial derivatives and their geometrical interpretation, differentials, derivatives of composite and implicit functions, Jacobians, Chain rule, Euler's theorem on homogeneous functions, harmonic functions, Taylor's expansion of functions of several variables.

Maxima and Minima: Maxima and minima of functions of several variables – Lagrange's method of multipliers.

Partial differential equations: Partial differential equations of first order, Charpit's method, Linear partial differential equations with constant coefficients. First-order linear, quasi-linear and non-linear PDE's using the method of characteristics: know how to obtain explicit solutions.

Partial differential equations of 2nd-order: Classification of 2nd-order linear equations in two independent variables: hyperbolic, parabolic and elliptic types (with examples).

Books Recommended:

1. W. Fleming: Functions of several variables, Springer
2. R P Agrawal: Ordinary and Partial Differential Equations, Springer
3. K Sankar Rao: Partial Diffrential Equations, PHI

B. Sc. I Semester VI

PAPER I: COMPLEX ANALYSIS

Complex Variables: Functions of a complex variable; Limit, continuity and differentiability.

Analytic functions: Analytic functions, Cauchy and Riemann equations, Harmonic functions.

Complex Integration: Complex integrals, Cauchy's theorem, Cauchy's integral formula, Morera's Theorem, Liouville's Theorem, Taylor's series, Laurent's series, Poles and singularities.

Residues: Residues, the Residue theorem, the principle part of a function, Evaluation of Improper real integrals.

Books Recommended:

1. J. B. Conway: Functions of One Complex Variable, Narosa Publishing House, 1980.
2. E. T. Copson: Complex Variables, Oxford University Press.
3. L. V. Ahlfors: Complex Analysis, McGraw-Hill, 1977.
4. D. Sarason: Complex Function Theory, Hindustan Book Agency, Delhi, 1994..
5. P. R. Halmos: Naive Set Theory, Van Nostrand, 1960.

PAPER II: LINEAR ALGEBRA

Vector space, subspaces, Linear combinations, linear spans, Sums and direct sums, Linear dependence and independence, Bases and dimensions, Dimensions and subspaces, Coordinates and change of bases, Linear transformations, rank and nullity, Linear operators, Algebra of linear transformations, Invertible linear transformations, isomorphism; Matrix of a linear transformation, Matrix of the sum and product of linear transformations, Change of basis, similarity of matrices, Linear functional, Dual space and dual basis, Double dual space, Annihilators, hyperspace; Transpose of a linear transformation, Eigen vectors and Eigen values of a matrix, product of characteristic roots of a matrix and basic results on characteristic roots, nature of the characteristic roots of Hermitian, skew-Hermitian, unitary and orthogonal matrices, characteristic equation of a matrix, Cayley-Hamilton theorem and its use in finding inverse of a matrix.

Books Recommended:

1. Hadley: Linear Algebra.
2. Hoffman and Kunze: Linear Algebra, Prentice Hall of India, New Delhi, 1972.
3. H. Helson: Linear Algebra, Hindustan Book Agency, New Delhi, 1994.
4. K. B. Dutta: Matrix and Linear Algebra, Prentice Hall of India.
5. S. Lang: Linear Algebra, Springer