# RAIGANJ UNIVERSITY
# DEPARTMENT OF MATHEMATICS

## SYLLABUS FOR MATHEMATICS
## B. Sc. (Honours)

## CBCS FORMAT
**w.e.f. the academic session 2017 - 2018**

**RAIGANJ UNIVERSITY**
**Raiganj, Uttar Dinajpur**
**West Bengal, India**

# Contents

# SEMESTER 1

# Chapter 1

# SEMESTER 1

## 1.1 BSCHMATH101 [Credit 6]

**CLASSICAL ALGEBRA [CORE]**

### 1.1.1 CLASSICAL ALGEBRA [CORE]

1. **Integers :** First and Second principles of mathematical induction, equivalence of these two principles (statement only). Proof of some simple mathematical results by induction. The division theorem(or algorithm). The greatest common divisor (*g.c.d.*) of two integers $a$ and $b$. [This number is denoted by the symbol $(a, b)$]. Existence and uniqueness of $(a, b)$. Relatively prime integers. The equation $ax + by = c$ has integral solution iff $(a, b)$ divides $c$ ($a, b, c$ are integers). Prime integers. Euclid's first theorem: If some prime $p$ divides $ab$, then $p$ divides either $a$ or $b$. Euclid's second theorem: There are infinitely many prime integers. Unique factorization theorem. The greatest integer function.

2. **Congruences:** Definition and properties. Euler's $\phi$ function. Multiplicative property of Euler's $\phi$ function. Fermat's theorem, Euler's theorem, Wilson's theorem. Solutions of Linear Congruence equations. Statement of Chinese Remainder theorem and simple problems. Primitive Roots. Divisibility tests. Checkdigits in ISBN, UPC and Credit cards. Theorem regarding error detecting capability.

3. **Complex Numbers :** De-Moivre's theorem and its applications. Exponential, Sine, Cosine and Logarithm of a complex number. Definition of $a^z$, $(a \neq 0)$. Gregory's series. Inverse circular and Hyperbolic functions.

4. **Theory of Equations (polynomials with real coefficients):** Fundamental theorem of Classical Algebra (statement only). The $n$-th degree polynomial equation has exactly $n$ roots. Nature of roots of an equation (surds or complex roots occur in pairs). Statements of Rolle's theorem, Descartes' rule of signs, Sturm's theorem and their applications. Multiple roots. Relation between roots and coefficients. Symmetric functions of the

roots. Transformation of equations. Reciprocal equations. Cardan's method of solving a cubic equation. Ferrari's method of solving a biquadratic equation. Binomial equations. Special roots.

5. **Inequalities:** A.M. = G.M. = H.M. and their generalizations: the theorem of weighted means and $m$-th power theorem (statements and applications only). Cauchy's inequality (statement only) and its direct applications.

## 1.2 BSCHMATH102 [Credit 6]

**Analytical Geometry of Two and Three Dimensions [CORE]**

### 1.2.1 [Analytical Geometry of Two Dimensions]

1. (a) **Transformations of Rectangular axes:** Translation, Rotation and their combinations. Theory of Invariants.

   (b) **General equation of second degree in two variables:** Reduction into canonical form. Classification of conics. Lengths and position of the axes.

2. **Pair of straight lines:** Condition that the general equation of second degree in two variables may represent two straight lines. Point of intersection of two intersecting straight lines. Angle between two lines given by $ax^2 + 2hxy + by^2 = 0$. Equation of angle bisectors. Equation of pair of straight lines joining the origin to the points in which a line meets a conic.

3. **Conic sections :** Circle, Parabola, Ellipse and Hyperbola. Equations of pair of tangents from an external point, chord of contact, poles and polars, conjugate points and conjugate lines.

4. **Polar equations :** Polar equations of straight lines and circles. Polar equation of a conic referred to a focus as pole. Equations of tangent, normal, chord of contact.

### 1.2.2 [Analytical Geometry of Three Dimensions]

1. Rectangular Cartesian co-ordinate in a space. Halves and octants. Projection of a line segment on a co-ordinate axis. Inclination of a line segment with co-ordinate axes. Direction cosines and direction ratios. Distance between two points. Division of a line segment in a given ratio.

2. Equation of a plane. General form, intercept and normal forms. Signed distance of a point from a plane. Equation of a plane passing through the intersection of two planes. Angle between two intersecting planes. Bisectors of angles between two intersecting planes. Parallelism and perpendicularity of two planes.

3. Straight lines in a space. Equations in symmetric and parametric forms. Direction ratios and direction cosines. Canonical equation of the line of intersection of two intersecting planes. Angle between two lines. Distance of a point from a line. Condition for coplanarity of two lines. Skew lines and shortest distance between skew lines.

4. Sphere: General equation. Circle. Sphere through the intersection of two spheres. Radical plane.

5. Cone: Right circular cone. General homogeneous second-degree equation. Section of a cone by a plane as a conic and as a pair of lines. Condition for three perpendicular generators. Cylinder. Right circular cylinder.

6. Transformation of rectangular axes by translation, rotation and their combinations.

7. Canonical equations and shapes of Ellipsoid, Hyperboloid, Paraboloid.

8. Tangent and Normal. Enveloping cone and Reciprocal cone.

9. Knowledge of Cylindrical and Spherical polar co-ordinates (no reduction required).

## 1.3 MATHGE101 [Credit 6]

**Analytical Geometry of Two and Three Dimensions and Vector Algebra [GE 1]**

### 1.3.1 Analytical Geometry of Two Dimensions

1. Transformations of Rectangular axes: translation, rotation and their combinations.

2. General equation of second degree in $x$ and $y$: Reduction to canonical forms. Classification of conics.

3. Pair of straight lines: condition that the general equation of second degree in $x$ and $y$ may represent two straight lines. Point of intersection of two intersecting straight lines. Angle between two lines given by $ax^2 + 2hxy + by^2 = 0$. Equation of bisectors. Equation of pair of straight lines joining the origin to the points in which a line meets a conic.

4. Equations of pair of tangents from an external point, chord of contact, poles and polars in case of general conic, in particular for Circle, Parabola, Ellipse, Hyperbola.

5. Polar equation of straight lines and circles. Polar equation of a conic referred to a focus as pole. Equation of chord joining two points. Equations of tangent and normal.

### 1.3.2 Analytical Geometry of Three Dimensions:

1. Rectangular Cartesian co-ordinates. Distance between two points. Division of a line segment in a given ratio. Direction cosines and direction ratios of a straight line.
2. Equation of plane: General equation of a plane. Intercept and normal forms. Angle between two planes. Distance of a point from a plane and distance between two parallel planes. Bisectors of angles between two intersecting planes.
3. Equation of a straight line: General and symmetric form. Angle between two straight lines. Distance of a point from a line. Coplanarity of two straight lines. Shortest distance between two skew lines.
4. Sphere and its tangent plane.

### 1.3.3 Vector Algebra

Collinear and coplanar vectors. Scalar and vector products of three vectors. Simple applications to problems of Geometry. Vector equations of plane and straight line. Volume of a tetrahedron. Applications to problems of Mechanics (Work done and Moment).

## 1.4 AECC101 [Credit 4]

**ENVIRONMENTAL STUDIES [AECC]**

# SEMESTER 2

# Chapter 2

# SEMESTER 2

## 2.1 BSCHMATH201 [Credit 6]

**Modern Algebra [CORE]**

1. **Set, Mapping and Algebraic structure:** Basic properties and operations on sets. Equivalence relation and partition. Congruence of integers, Congruence Classes. Different kinds and compositions of mappings. Concept of cardinally equivalent sets. Concept of binary operation and algebraic structure.

2. **Group Theory:** Groupoid, Semigroup, Quasi-group, Monoid, Group, Abelian Group. Examples of groups from number system, roots of unity, matrices, etc. Groups of congruence classes. Klein's 4-group.
   Properties deducible from definition of group including solvability of equations like $ax = b$, $ya = b$. Any finite semigroup having both cancellation laws is a group. Integral power of elements and laws of indices in a group. Order of an element of a group. Order of a group.
   Subgroups: Necessary and sufficient conditions for a subset of a group to be a subgroup. Intersection and union of two subgroups. Necessary and sufficient condition for union of two subgroups to be a subgroup.

3. Cosets and Lagrange's theorem.

4. **Cyclic Groups:** Definition and examples. Generator. Subgroups of cyclic groups. Necessary and sufficient condition for a finite group to be cyclic.

5. **Permutation:** Cycle, transposition, statement of the result that every permutation can be expressed as a product of disjoint cycles. Even and odd permutations. Permutation Group. Symmetric group. Alternating Group. Order of an alternating group.

6. **Normal subgroups of a Group:** Definition and examples. Intersection, union of normal subgroups. Product of a normal subgroup and a subgroup. Quotient group of a group by a normal subgroup.

7. **Homomorphism and Isomorphism of Groups:** Kernel of a Homomorphism. First Isomorphism theorem. Properties deducible from the definition of Isomorphism. An infinite cyclic group is isomorphic to $(\mathbb{Z}, +)$ and a finite cyclic group of order n is isomorphic to the group of residue classes modulo n.

8. **Rings and Fields:** Properties of Rings directly following from the definition. Unitary and commutative rings. Divisors of zero. Integral domain. Field. Every field is an integral domain, every finite integral domain is a field. Definitions of subring and subfield. Statement of necessary and sufficient conditions for a subset of a ring (field) to be a subring (subfield). Characteristic of a ring and of an integral domain.

## 2.2 BSCHMATH202 [Credit 6]

**Integral Calculus [CORE]**

### 2.2.1 Integral Methods:

Simple problems on definite integral as the limit of sum. Working knowledge of Beta and Gamma functions (convergence to be assumed) and their interrelation (without proof). Use of the result:

$$\Gamma(m)\Gamma(1-m) = \frac{\pi}{\sin m\pi}, \quad \textit{where} \;\; 0 < m < 1.$$

Computation of the following integrals using Beta and Gamma functions (when they exist):

$$\int_0^{\frac{\pi}{2}} \sin^n x \,\mathrm{dx}, \quad \int_0^{\frac{\pi}{2}} \cos^n x \,\mathrm{dx}, \quad \int_0^{\frac{\pi}{2}} \tan^n x \,\mathrm{dx} \;\; \textit{etc.}$$

Working knowledge of double and triple integrals.

### 2.2.2 Riemann Integration:

1. Partition and refinement of partition of a closed and bounded interval. Upper Darboux sum $U(P, f)$ and lower Darboux sum $L(P, f)$ and associated results. Upper Riemann (Darboux) integral and lower Riemann (Darboux) integral. Darboux's theorem. Necessary and sufficient condition for Riemann integrability (R-integrability).

2. Classes of Riemann-integrable (R-integrable) functions: Monotone functions, continuous functions, piecewise continuous functions with

   (i) finite number of points of discontinuities,

   (ii) infinite number of points of discontinuities having finite number of accumulation points.

3. Riemann Sum: Alternative definition of integrability. Equivalence of two definitions (statement only). Integrability of sum, product, quotient, modulus of R-integrable functions. Sufficient condition for integrability of compositions of R-integrable functions. Properties of Riemann integrable functions arising from the above results.

4. Function defined by definite integral $\int_a^x f(t)$ dt and its properties. Primitive of indefinite integral. Properties of definite integral. Definition of $\log x$ $(x > 0)$ as an integral and deduction of simple properties including its range. Definition of $e$ and its simple properties. Fundamental theorem of Integral Calculus. Statements and applications of First(with proof) and Second(Both Bonnet's form and Weierstrass's form) Mean Value theorems of Integal Calculus. Theorem on method of substitution for continuous functions.

### 2.2.3 Improper Integral:

(a) Range of integration, finite or infinite. Necessary and sufficient condition for convergence of improper integral in both the cases.

(b) Tests of convergence: Comparison and $\mu$-test. Absolute and non-absolute convergence and corresponding tests. Abel's and Dirichlet's tests for convergence of the integral of a product (statements only).

(c) Uniform convergence of Improper Integral by $M$-test.

(d) Convergence of Beta and Gamma functions and their interrelations (assuming $\Gamma(m)\Gamma(1-m) = \frac{\pi}{\sin m\pi}$, $0 < m < 1$).

### 2.2.4 Definite Integral as a function of a parameter:

Differentiation and Integration with respect to the parameter under integral sign. Statements (only) of some relevant theorems and problems.

### 2.2.5 Fourier Series:

Trigonometric series. A periodic function of bounded variation can be expressed as a Fourier Series (statement only). Fourier coefficients. Statement of Dirichlet's conditions for convergence. Statement of theorem of sum of Fourier Series. Half range series, sine and cosine series.

### 2.2.6 Multiple Integral:

Concepts of upper sum, lower sum, upper integral, lower integral and double integral (no rigorous treatment is needed). Statement of existence theorem for continuous functions. Change of order of integration. Triple integral. Transformation of double and triple integrals (Problems only). Determination of volume and surface area by multiple integrals (Problems only).

## 2.3 MATHGE201 [Credit 6]

**Algebra [GE 2]**

### 2.3.1 Classical Algebra

1. **Complex Numbers:** De-Moivre's theorem and its applications. Exponential, sine, cosine and logarithm of a complex number. Inverse circular and hyperbolic functions.

2. **Theory of Equations (polynomials with real coefficients):** Fundamental theorem of Classical Algebra(statement only). Polynomials with real coefficients. The $n$-th degree polynomial equation has exactly $n$ roots. Nature of roots of an equation (surds or complex roots occur in pairs). If the polynomial $f(x)$ has opposite signs for two real values of $x$, then the equations $f(x) = 0$ has an odd number of real roots between $a$ and $b$. If $f(a)$ and $f(b)$ are of same sign, either no root or an even number of roots lie between $a$ and $b$. Rolle's theorem ,Descartes' rule of signs and their direct applications. Relation between roots and co-efficients. Symmetric functions of the roots, transformations of equations, Cardan's method of solving a cubic equation.

3. Determinants: Basic properties and operations. Symmetric and skew symmetric determinants. Solutions of a system of linear equations with not more than three variables.

4. Matrices: Basic properties and operations of Matrices. Orthogonal matrix. Rank of a matrix. Determination of rank of a matrix. Solutions of a system of linear equations with three variables by matrix method.

### 2.3.2 Modern and Linear Algebra

1. Basic concepts and properties of sets, operations on sets. Different kinds and compositions of mappings. Binary operations. Identity element. Inverse element.

2. Definitions and examples of Groups. Elementary properties using definition of Group, its identity and inverse. Definition and examples of Subgroups. Statement of necessary and sufficient conditions for a subset of a Group to be a Subgroup and its applications.

3. Definitions and examples of Rings, Fields, Subrings and Subfields. Basic theorems and simple problems.

4. Definitions and examples of Vector Space over a Field. Linear combinations, linear dependence and independence of a finite set of vectors. Subspace. Generators and basis of a finite-dimensional Vector Space. Problems on formation of basis of a Vector Space (proof is not required).

5. Real Quadratic Form involving not more than three variables (problems only).

## 2.4 AECC201 [Credit 2]

**ENGLISH/MIL COMMUNICATIONS [AECC]**

# SEMESTER 3

# Chapter 3

# SEMESTER 3

## 3.1 BSCHMATH301 [Credit 6]

**Real Analysis I and Applications of calculus [CORE]**

### 3.1.1 Real Analysis I

1. **Real Numbers:** Field axioms. Concept of ordered field. Bounded set, $L.U.B.$(supremum) and $G.L.B.$(infimum) of a set. Least upper bound axiom or Completeness axiom. Characterization of $\mathbb{R}$ as a complete ordered field. Definition of an Archimedean ordered field. Archimedean property of $\mathbb{R}$. $\mathbb{Q}$ is Archimedean ordered field but not ordered complete. Arithmetic continuum. Linear continuum.

2. **Countable Sets of Real Numbers:** Denumerable, at most denumerable and non denumerable sets. A subset of a denumerable set is either finite or denumerable. Union of

   (i) a finite set and a denumerable set,

   (ii) two denumerable sets and

   (iii) denumerable number of denumerable sets. Denumerability of rational numbers. Non-denumerability of points in a finite interval of the set of real numbers.

3. **Point Sets in one dimension:** Neighbourhood of a point. Interior point. Open set. Union, intersection of open sets. Every open set can be expressed as disjoint union of open intervals (statement only). Limit point and isolated point of a set. Criteria for $L.U.B.$ and $G.L.B.$ of a bounded set to be limit point of the set. Bolzano-Weierstrass theorem on limit point. Derived set. Derived set of a bounded set $A$ is contained in the closed interval $[\inf A,\ \sup A]$. Closure of a set. Closed set. Complement of open set and closed set. Union and intersection of closed sets as a consequence. No nonempty proper subset of $\mathbb{R}$ is both open and closed. Dense set in $\mathbb{R}$ as a set having non-empty intersection with every open interval $\mathbb{Q}$ and $\mathbb{R}$ are dense in $\mathbb{R}$.

4. **Sequence of points in one dimension:**

   (a) Definition of a sequence as function from $\mathbb{N}$ to $\mathbb{R}$. Bounded sequence. Limit, Convergence and nonconvergence. Every convergent sequence is bounded and limit is unique. Algebra of limits.

   (b) Relation between the limit point of a set and the limit of a convergent sequence of distinct elements. Monotone sequences and their convergence. Sandwich theorem. Nested interval theorem. Limit of some important sequences with special reference to $\{(1+\frac{1}{n})^n\}$, $\{1+\frac{1}{1!}+\frac{1}{2!}+\ldots+\frac{1}{n!}\}$, $\{r^n\}$ $(if\ -1 < r \leq 1)$, $\{r^{\frac{1}{n}}\}$ $(if\ r > 0)$. Cauchy's general principle of convergence, Cauchy Sequence.

   (c) **Subsequence:** Basic theorems. Subsequential limits. Limit supremum (upper limit) and limit infimum (lower limit) of a sequence using inequalities. Alternative definitions of $\limsup$ and $\liminf$ of a sequence $\{x_n\}_n$ using $L.U.B.$ and $G.L.B.$ of the set containing all the subsequential limits (equivalence of two definitions is assumed, proof is not required).

   (d) Statement and application of the following theorems/results:

      ( i) Cauchy's first and second limit theorems.

      (ii) A sequence $\{x_n\}$ is convergent iff $\limsup x_n = \liminf x_n$.

      (iii) Bolzano-Weierstrass theorem for sequences.

5. **Infinite series of real numbers:** Definition of series. Convergence and divergence. Geometric series, $p$-series. Cauchy's convergence criteria applied to infinite series. Statements of (without proof )

   (i) Comparison test,

   (ii) D' Alembert's ratio test,

   (iii) Cauchy's root test for convergence of infinite series of positive real numbers.

### 3.1.2 Applications of Calculus

1. **Applications of Differential Calculus:**

   (a) Concept of Plane curve, Closed curve, Simple curve.

   (b) Tangents and Normals, Sub-tangents and Sub-normals. Angle of intersection of curves. Pedal equation of a curve, Pedal of a curve.

   (c) Curvature, Radius of curvature, Centre of curvature, Chord of curvature, Evolute of a curve.

   (d) Rectilinear asymptotes of a curve (Cartesian, Parametric and Polar forms).

   (e) Envelopes of families of straight lines and curves (Cartesian and Parametric equations only). Evolutes and Involutes.

(f) Concavity, Convexity, Singular points, Nodes, Cusps, Points of inflexion.

2. **Applications of Integral Calculus:**

   (a) Area enclosed by a curve, area enclosed between a curve and a secant, area between two curves, area between a curve and its asymptote (if there be any)

   (b) Problems on volume and surface areas of solids of revolution. Statement of Pappus theorem and its direct application for well known curves.

   (c) Determination of Centre of Gravity, Moments and Products of Inertia (simple problems).

   (d) Reduction Formulae.

## 3.2 BSCHMATH302 [Credit 6]

**Differential Equations I [CORE]**

1. **Basics of ordinary differential equations:** Significance of ordinary differential equation. Geometrical and physical considerations. Formation of differential equation by elimination of arbitrary constants. Meaning of the solution of ordinary differential equation. Concepts of linear and non-linear differential equations.

2. **Equations of first order and first degree:** Existence theorem (statement only). Exact equation. Condition for exactness, Integrating factor. Rules of finding integrating factors (statements of relevant results only). Equations reducible to first order linear equations.

3. **Equations of first order but not of first degree:** Clairaut's equation. Singular solution.

4. **Applications:** Geometric applications, Orthogonal trajectories.

5. **Higher order linear equations with constant coefficients:** Complementary function. Particular Integral. Method of undetermined coefficients. Symbolic operator $D$. Method of variation of parameters. Euler's homogeneous equation and reduction to an equation of constant coefficients.

6. **Laplace Transform:** Concept of Laplace Transform and Inverse Laplace Transform. Statement of Existence theorem. Elementary properties of Laplace Transform and its inverse. Laplace Transform of derivatives. Laplace transform of integrals. Convolution theorem (statement only) and applications.

## 3.3 BSCHMATH303 [Credit 6]

**Mathematical Logic, Linear Algebra-I and II [CORE]**

### 3.3.1 Mathematical Logic

1. Simple and compound statements/propositions.
2. Logical connectives: negation, conjunction, disjunction, implication, equivalence.
3. Truth tables, tautology, logical equivalence, contradiction.
4. The algebra of propositions.

### 3.3.2 Linear Algebra-I

1. **Determinants, Matrices and Quadratic forms:** Basic properties and different types of determinants, finding values with or without expansion including Laplace method, Vandermonde's determinant (no proof of related theorems). Basic properties and operations of different types of matrices. Invertible matrix. Elementary operations and elementary matrices, echelon matrix. Determination of rank of a matrix and applications of relevant results/theorems (no proof). Normal forms, equivalency and congruency of matrices. Real quadratic form involving three variables. Reduction to normal form.
2. **Vector Space:** Definition and examples, subspaces, union, intersection, sum and direct sum of subspaces, linear combination, linear span, linear independence and dependence. Basis and dimension. Finite dimensional spaces: existence theorem for basis, invariance of number of vectors in a basis, extension and replacement theorems.
3. **Row space and Column space of a matrix:** Definitions. Row rank, column rank and their equality with rank of a matrix. Statements of relevant theorems.
4. **System of linear equations:** Consistency. System of linear equations as matrix equations and the invariance of its solution sets under row equivalence. Number of solutions. Solution by matrix method (when possible). Dimension of the solution space of a system of homogeneous linear equations and applications of relevant results/theorems.
5. **Characteristic equations:** Characteristic equations of a square matrix. Definition and simple properties of Eigen values and Eigen vectors, Cayley-Hamilton theorem and its use in finding the inverse of a matrix. Diagonalisation of matrices.

### 3.3.3 Linear Algebra II

1. Inner Product Spaces: Definition and examples, Norm, triangle inequality, Cauchy-Schwartz inequality. Orthogonal vectors and orthogonal complements. Orthonormal sets and bases. Bessel's inequality. Gram-Schmidt orthogonalization method.

2. Linear Transformation (L.T.) on Vector Spaces: Definition of L.T., Null space, Range space of an L.T., Rank and Nullity, Sylvester's Law of Nullity. Determination of rank (T), Nullity (T) of a Linear Transformation $T : \mathbb{R}^n \longrightarrow \mathbb{R}^m$. Inverse of Linear Transformation. Non-singular Linear Transformation. Change of basis by L.T., vector space of L.T.

3. Linear Transformation and Matrices: Matrix of a linear transformation relative to ordered bases of finite-dimensional vector spaces. Correspondence between Linear Transformations and Matrices. Linear Transformation is non-singular if its representative matrix be non-singular. Rank of L.T. = Rank of the corresponding matrix.

## 3.4 MATHGE301 [Credit 6]

**Differential Calculus and Integral Calculus [GE 3]**

### 3.4.1 Differential Calculus

1. Rational numbers. Geometrical representations. Irrational numbers. Real number represented as point on a line. Linear continuum. Basic properties of real numbers ( no deduction or proof)

2. Sequence: Definition of bounds of a sequence and monotone sequence. Limit of a sequence. Statements of limit theorems. Concepts of convergence and divergence of monotone sequences, relevant theorems and their applications. Statements of Sandwich theorem and Cauchy's general principle of convergence and their applications.

3. Infinite series of constant terms. Concepts of convergence and divergence . Cauchy's principle as applied to infinite series (application only). Series of positive terms. Statements of Comparison test, D' Alembert's ratio test and Cauchy's root test and their applications. Alternating series. Statement of Leibnitz's test and its applications.

4. Acquaintance with the important properties of continuous functions on closed intervals (no proof). Statement of existence of inverse function of a strictly monotone function and its continuity.

5. Differentiation-its geometrical and physical interpretations. Relation between continuity and derivability. Differential- application in finding approximation.

6. Successive differentiation. Leibnitz's theorem and its applications.

7. Statement and proof of Rolle's theorem and its geometrical interpretation. Mean value theorems of Lagrange and Cauchy. Statements of Taylor's and Maclaurin's theorems with Lagrange's and Cauchy's form of reminders. Taylor's and Maclaurin's infinite series for functions like $e^x$, $\sin x$, $\cos x$, $(1+x)^n$, $\log(1+x)$ (with restrictions whenever necessary).

8. Indeterminate forms. L' Hospital's rule: statement and problems only.

9. Functions of two variables: Their geometrical representations. Limit and continuity (definitions only) for functions of two variables. Partial derivatives: knowledge and use of chain rule. Exact differentials (emphasis on solving of problems only). Successive partial derivatives: Statements of Schwartz's and Young's theorems on commutativity of mixed partial derivatives. Euler's theorem on homogeneous function of two variables. Maxima and minima of functions of two variables. Rectilinear Asymptotes (Cartesian only), Curvature of a plane curve, Envelope of family of straight lines and of curves (problems only).

### 3.4.2 Integral Calculus

1. Evaluation of Definite Integrals.

2. Integration as the limit of a sum (with equally spaced as well as unequal intervals)

3. Reduction formulae and associated problems.

4. Definition of Improper integrals: Statements of

   (i) $\mu$-test,

   (ii) comparison test (limit form excluded) simple problems only. Use of Beta and Gamma functions(convergence and important relations being assumed).

5. Working knowledge of Double integral.

6. Applications: rectification, quadrature, volume and surface areas of solids formed by revolution of plane curve and areas (problems only).

## 3.5 SEC301 [Credit 2]

### 3.5.1 Numerical Analysis [SEC-1]

1. **Errors, Numbers and Operators:** Inherent error. Round-off error. Truncation error. Approximate numbers. Significant figures. Absolute, relative and percentage errors. Operators: $\Delta$, $\nabla$, $\mu$, $E$, $\delta$(definitions and simple relations among them).

2. **Interpolation:** Problems of interpolation. Weierstrass approximation theorem (statement only). Polynomial interpolation. Equispaced arguments. Difference table. Deduction of Newton's forward and backward interpolation formulae with error term. Statements of Stirling's and Bessel's interpolation formulae. Error terms. General interpolation formulae. Deduction of Lagrange's interpolation formula. Divided difference. Newton's General interpolation formula (only statement). Inverse interpolation. Hermite interpolation formula (only basic concepts).

3. **Numerical Differentiation:** Differentiation process based on Newton's forward, backward and Lagrange's formulae.

4. **Numerical Integration:** Integration of Newton's interpolating polynomial. Newton-Cotes formula. Trapezoidal and Simpson's $\frac{1}{3}$ formulae. Their composite forms and geometrical significance. Weddle's rule (only statement). Statement of the error terms associated with these formulae. Degree of precision (definition only).

5. **Numerical solutions of non-linear equations:** Location of a real root by tabular method. Bisection method, Secant method, Newton-Raphson method, Regula-Falsi method and their geometrical significance and convergence. Fixed point iteration method.

6. **Numerical solutions of a system of linear equations:** Gauss eliminations method. Gauss-Seidel Method. Their convergence. Matrix inversion by Gauss elimination method (up to $3 \times 3$ order).

7. **Eigen value problems:** Power method for numerically extreme eigen values.

8. **Numerical solution of ordinary differential equations:** Basic ideas, nature of the problems. Picard, Euler, Runge-Kutta (2 nd order, no proof for 4th order) methods (emphasis on problems only).

# SEMESTER 4

# Chapter 4

# SEMESTER 4

## 4.1 BSCHMATH401 [Credit 6]

**Real Analysis II and III [CORE]**

### 4.1.1 Real Analysis II

1. **Infinite series of real numbers:**
   (a) Series of non-negative real numbers: Abel-Pringsheim's test. Proofs of
      (i) Comparison test,
      (ii) D' Alembert's ratio test,
      (iii) Cauchy's root test and statements(only) of $(i)$ Raabe's test, $(ii)$ Logarithmic test and their applications.
   (b) Series of arbitrary real numbers: Absolutely convergent, conditionally convergent and alternating series. Statements (only) of
      (i) Ratio test,
      (ii) Root test,
      (iii) Leibnitz's test and their applications. Rearrangement of series through examples.

2. Limit of functions: Sandwich theorem. Cauchy criterion for the existence of finite limit. Important limits of functions like $\frac{\sin x}{x}$, $\frac{\log(1+x)}{x}$, $\frac{a^x-1}{x}$ as $x \longrightarrow 0(a > 0)$. Upper and Lower limits of function at a point.

3. Continuity of functions: Piecewise continuous function. Discontinuity. various types. Neighbourhood properties of continuous functions. Continuous function on $[a, b]$ is bounded and attains its bounds there. Bolzano's theorem. Intermediate value theorem and allied results. Boundedness property of continuous functions. Uniform continuity property. Continuity of inverse functions. Continuity and Monotonicity.

4. **Derivative of functions:** Lipschitz's condition and its equivalence with boundedness of the derivative. Darboux's theorem. Derivative as a rate measurer.

5. **Maxima and Minima of functions:** Points of local extremum (maximum, minimum and saddle point) of a function of real variable defined on an interval. Sufficient condition for the existence of local maximum/minimum of a function at a point. Applications of the principle of maximum/minimum in geometrical and physical problems.

### 4.1.2 Real Analysis III

1. **Linear Point Set:** Covering by open intervals. Sub-covering. Cantor intersection theorem. Lindelof covering theorem (statement only). Compact sets. Heine-Borel theorem and its converse.

2. **Functions defined on point sets in one dimension:** Limit and continuity. Continuity on compact set. Uniform continuity on compact set. Inverse function. Continuous image of compact set is compact.

3. **Sequence of functions defined on a subset of $\mathbb{R}$:**
   (a) Pointwise and uniform convergence. Cauchy criterion of uniform convergence. Dini's theorem on uniform convergence. Weierstrass M-test.
   (b) Limit function: Boundedness, Repeated limits, Continuity, Integrability and Differentiability of the limit function of a sequence of functions in case of uniform convergence.

4. **Series of functions defined on a subset of $\mathbb{R}$:**
   (a) Pointwise and uniform convergence. Cauchy criterion of uniform convergence. Statement (only) of Dini's theorem on uniform convergence.
   (b) Tests of uniform convergence: Weierstrass M-test. Statements (only) of Abel's and Dirichlet's tests and their applications. Passage to the limit term by term.
   (c) Sum function: Boundedness, continuity, integrability, differentiability of a series of functions in case of uniform convergence.

5. **Power Series:** Fundamental theorem of Power series. Statement (only) of Cauchy- Hadamard theorem. Determination of radius of convergence. Uniform and absolute convergence of Power Series. Properties of sum function of Power Series. Statement (only) of Abel's limit theorem. Uniqueness of power series having same sum function.

6. **Functions of Two Variables $f : \mathbb{R}^2 \longrightarrow \mathbb{R}$**
   (a) Mean value theorem and Taylor's theorem.
   (b) Extremum of functions of two and three variables: Lagrange's Method of undetermined multipliers.

## 4.2 BSCHMATH402 [Credit 6]

### 4.2.1 Differential Equations II

1. Second order linear equations with variable coefficients

$$\frac{\mathrm{d^2y}}{\mathrm{dx^2}} + P(x)\frac{\mathrm{dy}}{\mathrm{dx}} + Q(x)y = F(x).$$

   Reduction of order when one solution of the homogeneous part is known. Complete solution. Method of variation of parameters. Reduction to Normal form. Change of dependent and independent variables. Operational Factors.

2. Simple eigen value problems.

3. Simultaneous linear differential equations. Total differential equation, conditions for integrability.

4. Partial Differential Equation (PDE): Introduction. Formation and classification of PDE. Types of solutions. Solution of PDE by Lagrange's method and Charpit's method.

5. Application of Laplace Transform to the solutions of ordinary differential equations of second order with constant coefficients.

6. Power series solutions of ordinary differential equations: simple problems of series solutions about ordinary points and regular singular points.

## 4.3 BSCHMATH403 [Credit 6]

**Calculus of Single and Several Variables I and II [CORE]**

### 4.3.1 Calculus of Single Variable

1. Some basic elementary functions. Definitions (in different ways) of Limit, Continuity, Differentiability of a real valued function of single variable. Examples and algebra of limits, continuous and differentiable functions.

2. Leibnitz's theorem on successive derivatives and its applications.

3. Rolle's theorem, Mean value theorems of Lagrange and Cauchy. Statements and applications of Taylor's theorem with Schlomilch-Rouche's, Lagrange's, Cauchy's form of remainder and Young's form of Taylor's theorem. Maclaurin's series. Expansion of $e^x$, $a^x$ $(a > 0)$, $\log(1 + x)$, $(1 + x)^m$, $\sin x$ , $\cos x$, etc. with their ranges of validity.

4. Indeterminate forms, Statement of L' Hospital's rule and its consequences.

### 4.3.2 Calculus of Several Variables I

1. Point set in two and three dimensions. Concepts (only) of neighbourhood of a point, interior point, open set, closed set in $\mathbb{R}^2$ . Bolzano-Weierstrass theorem (statement only) in $\mathbb{R}^2$.

2. Concept (only) of $\mathbb{R}^n$ and examples of functions on $\mathbb{R}^n$.

3. **Functions of two and three variables:** limit and continuity, partial derivatives. Sufficient condition for continuity. Relevant results regarding repeated limits and double limits.

4. Differentiability of functions of two and three variables. Sufficient condition for differentiability. Differential of a function, Chain rule. Homogeneous function. Statements of Euler's theorem and its converse. Commutativity of order of partial derivatives. Statements (without proof) of Young's and Schwartz's theorems.

### 4.3.3 Calculus of Several Variables II

1. Young's theorem, Schwartz's theorem on commutativity of order of mixed partial derivatives.

2. Jacobian for functions of two and three variables and simple properties including functional dependence. Concept of Implicit function. Statement (only) and simple applications of Implicit function theorem for two variables. Differentiation of Implicit functions. Jacobian of Implicit functions. Partial derivative as ratio of two Jacobians in case of function of two variables.

## 4.4 MATHGE401 [Credit 6]

**Analytical Dynamics and Numerical Analysis [GE 4]**

### 4.4.1 Analytical Dynamics

1. Motion in straight line under variable acceleration. Simple Harmonic Motion.

2. Expressions for velocity and acceleration of a particle moving on a plane in Cartesian and Polar coordinates. Motion of a particle moving on a plane with reference to a set of rotating axes.

3. Central force and central orbit.

4. Tangential and normal accelerations. Circular motion.

5. Motion of a particle in a plane under different laws of resistance. Motion of a projectile in a resisting medium. Trajectories in a resisting medium where resistance varies as some integral power of velocity. Terminal velocity.

### 4.4.2 Numerical Analysis

1. Approximate numbers. Significant figures. Rounding off numbers. Errors-Absolute, Relative and Percentage.
2. Operators- $\Delta$, $\nabla$ and $E$ (definitions and some relations among them).
3. Interpolation: The problem of interpolation. Equispaced arguments. Difference tables. Deduction of Newton's Forward and Backward Interpolation formulae with remainder term. Lagrange's Interpolation formula(statement only). Simple numerical problems on Interpolation with both equally and unequally spaced arguments.
4. Numerical Integration: Deduction of Trapezoidal and Simpson's $\frac{1}{3}$ formulae. Geometrical interpretations. Simple problems on Numerical Integration.
5. Solution of Numerical Equation: Location of root(tabular method), Bisection method, Newton-Raphson method with geometrical significance. Simple problems.

## 4.5 SEC401 [Credit 2]

### 4.5.1 Computer Science and Programming [SEC-2]

**Computer fundamentals:**

1. **Basics:** Historical evolution, computer generations, functional description, operating systems, hardware and software.
2. **Positional number systems:** Binary, Octal, Decimal, Hexadecimal system. Conversion of a number from one system to another. Binary arithmetic.
3. **Storing of data in a computer:** BIT, BYTE, NIBBLE, WORD, coding of data- ASCII, EBCDIC, etc.
4. **Algorithm and Flow chart:** Important features, ideas about the complexities of algorithm. Application in simple problems.
5. **Programming Languages:** Machine language, Assembly language, High level languages. Compiler and Interpreter. Object and Source Program. Ideas about some major High level languages.

**Introduction to ANSI C:**

1. Character set in ANSI C.
2. Key words: if, while, do, for, int, char, float ,etc.
3. Data Type: character, integer, floating point, etc. Variables, operators: $=, ==, !!, <, >$, etc. (arithmetic, assignment, relational, logical, increment, etc.)

4. Expressions: eg. $(a = b)!!(b = c)$.
5. Statements: eg. if $(a < b)$ $small = a$; else $small = b$;
6. Standard input / output.
7. Use of while, if else, for, do while, switch, continue, etc.
8. Arrays, strings, library function and user defined function. Header file.
9. **Construction of simple C programs:** Solution of quadratic equations, Approximate sum of convergent infinite series, LCM, GCD, Factorial , Fibonacci series, etc.

# SEMESTER 5

# Chapter 5

# SEMESTER 5

## 5.1 BSCHMATH501 [Credit 6]

**Vector Algebra and Vector Analysis [CORE]**

### 5.1.1 Vector Algebra

1. Conditions for collinearity of three points and coplanarity of four points. Rectangular components of a Vector in two and three dimensions. Scalar and Vector products and triple products. Product of four vectors. Direct applications of Vector Algebra in
   (i) Geometrical and Trigonometrical Problems,
   (ii) Problems of Mechanics (Work done by a force, Moment of a force about a point).
2. Vector equations of straight lines and planes. Volume of a tetrahedron. Shortest distance between two skew lines.

### 5.1.2 Vector Analysis

1. Vector differentiation with respect to a scalar variable: Vector functions of one scalar variable. Derivative of a vector. Second derivative of a vector. Derivatives of sums and products. Velocity and Acceleration as derivatives.
2. Elements of Differential Geometry: Curves in space. Tangent to a curve at a point, Normal plane, Serret-Frenet formulae, Principal Normal and Binormal, Osculating plane, Rectifying plane, Darboux vector, Twisted cubic.
3. Differential Operators: Concept of scalar and vector fields. Directional derivative. Gradient, Divergence, Curl and Laplacian.
4. Vector Integration: Line integrals as integrals of vectors, circulation, irrotational vector, work done by a vector. Conservative force, potential orientation. Statements (only) and verification of Green's theorem, Stoke's theorem and Divergence theorem.

## 5.2 BSCHMATH502 [Credit 6]

**Dynamics of a Particle [CORE]**

### 5.2.1 Dynamics of a Particle

1. Motion in straight line under variable acceleration. Simple Harmonic Motion. Hooke's law. Problems on elastic string.

2. Expressions for velocity and acceleration of a particle moving on a plane in Cartesian and Polar coordinates. Motion of a particle moving on a plane with reference to a set of rotating axes.

3. Central force and central orbit.

4. Tangential and normal accelerations. Circular motion. Simple cases of constrained motion of a particle.

5. Motion of a particle in a plane under different laws of resistance. Motion of a projectile in a resisting medium. Trajectories in a resisting medium where resistance varies as some integral power of velocity. Terminal velocity.

6. Motion under the inverse square law in a plane. Kepler's law and planetary motion. Escape velocity, time of describing an arc of an orbit, motion of artificial satellites.

7. Equation of motion of a particle of varying mass. Problems of motion of varying mass such as those of falling raindrops and projected rockets.

## 5.3 MATHDSE501 [Credit 6]

**Linear Programming and Game Theory [DSE-1]**

### 5.3.1 Linear Programming

1. The Linear Programming Problem (L. P. P.). Problem formulation. Types of solutions: Basic Solution (B. S.), Feasible Solution (F. S.), Basic Feasible Solution (B. F. S.), degenerate and non-degenerate B. F. S., Linear programming in matrix notation. Graphical solution of linear programming problems.

2. Some basic properties of convex sets, hyperplane, extreme point, convex hull, convex polyhedron and simplex.

3. The collection of all feasible solutions of an L. P. P. constitutes a convex set. The extreme points of the convex set of feasible solutions correspond to its B. F. S. and conversely. The objective function has its optimal value at an extreme point of the convex polyhedron generated by the set of all feasible solutions (the convex polyhedron may also be unbounded). In the absence

of degeneracy, if the L. P. P. admits of an optimal solution then at least one B. F. S. must be optimal. Reduction of a F. S. to a B. F. S.

4. Theory and applications of the Simplex method of solutions of a linear programming problem, Charnes's M-technique (Big-M Method), the Two-phase method.

5. Duality, formulation of the dual problem, primal-dual relationships, fundamental duality theorem, complementary slackness. Duality and Simplex method and their applications.

6. Transportation and Assignment problems. Mathematical formulation, solution, optimality criterion. Algorithm for solving Transportation problem. Hungarian method for solving Assignment problems. Travelling Salesman Problem.

### 5.3.2 Game Theory

Introduction, Game, Strategy, Two-person Zero sum(or Rectangular) Game,pay-off Matrix, Minimax and Maximin Principle, Saddle point and value of the game ,Algorithm for determining a Saddle point, Theorems, Illustrative Examples, Game without a Saddle point- Mixed strategy, technique for mixed strategy , Theorems, Saddle point of functions , Theorems solutions of $2 \times 2$ -Rectanguler Games without a Saddle point,Illustrative Examples, Dominancy property-General Rules, Theorems, Illustrative Examples, Algebraic Method for Solving $m \times n$ Games, Theorems, Illustrative Examples, Symmetric Games,Theorems, Illustrative Examples, Graphical Method of solution of $2 \times n$ or $m \times 2$ Games, Illustrative Examples, Reduction of a Game problem to a Linear Programming Problem, Fundamental Theorem on Rectangular Game,Illustrative Examples, Solution of a Game problem by Matrix method.

## 5.4 MATHDSE502 [Credit 6]

**Thoery of Probability and Thoery of Statistics [DSE-2]**

### 5.4.1 Thoery of Probability

1. Random experiments. Simple and compound events. Event space. Classical and frequency definitions of probability and their drawbacks. Axioms of Probability. Statistical regularity. Multiplication rule of probabilities. Baye's theorem.

2. Independent events. Independent random experiments. Independent trials. Bernoulli trials and binomial law. Poisson trials. Random variables. Probability distribution. Distribution function. Discrete and continuous distributions: Binomial, Poisson, Gamma, Uniform and Normal distributions. Poisson Process(definition only).

3. Transformation of random variables. Two dimensional probability distributions. Discrete and continuous distributions in two dimensions. Uniform distribution and two dimensional normal distribution. Conditional distributions. Transformation of random variables in two dimensions.

4. Mathematical expectation. Mean, variance, moments and central moments. Measures of location, dispersion, skewness and kurtosis. Median, mode, quartiles. Moment generating function. Characteristic function. Two dimensional expectation. Covariance. Correlation co-efficient. Joint characteristic function. Multiplication rule for mathematical expectations. Conditional expectation. Regression curves. Least square regression lines and parabolas.

5. Chi-square and t-distributions and their properties (statements only). Tchebycheff's inequality. Convergence in probability. Statement of Bernoulli's limit theorem. Law of large numbers. Poisson's approximation to binomial distribution and normal approximation to binomial distribution. Concept of asymptotically normal distribution. Statement of central limit theorem in the case of equal components and of limit theorem for characteristic functions.

### 5.4.2 Thoery of Statistics

1. Random sample. Concept of sampling and various types of sampling. Sample and population. Collection, tabulation and graphical representation. Grouping of data, sample characteristics and their computations.

2. Sampling distribution of a statistic. Estimates of a population characteristic or parameter. Unbiased and consistent estimates. Sample characteristics as estimates of the corresponding population characteristics. Sampling distributions of the sample mean and variance. Exact sampling distributions for the normal populations.

3. Bivariate samples. Scatter diagram. Sample correlation coefficient. Least square regression lines and parabolas.

4. Estimation of parameters. Method of maximum likelihood. Application to binomial, Poisson and normal populations. Interval estimation for parameters of normal population.

5. Statistical hypothesis. Simple and composite hypothesis. Best critical region of a test. Neyman-Pearson theorem(statement only) and its application to normal population. Likelihood ratio testing and its application to normal population. Simple application of hypothesis testing.

# SEMESTER 6

# Chapter 6

# SEMESTER 6

## 6.1 BSCHMATH601 [Credit 6]

**Tensor Algebra and Analysis, Metric Space and Complex Analysis [CORE]**

### 6.1.1 Tensor Algebra and Analysis

1. A tensor as a generalized concept of a vector in an Euclidean space $E^3$. To generalize the idea in an $n$-dimensional space. Transformation of co-ordinates in $E^n$ $(n = 2, 3)$. Summation convention.

2. Contravariant and covariant vectors. Invariants. Contravariant, covariant and mixed tensors. The Kronecker delta. Algebra of tensors. Symmetric and skewsymmetric tensors. Addition and scalar multiplication. Contraction. Outer and Inner products of tensors. Quotient law. Reciprocal Tensor. Line element and metric tensor. Reciprocal metric tensor. Raising and lowering of indices with the help of metric tensor. Associated tensor. Magnitude of a vector. Angle between two vectors. Orthogonal vectors.

3. Christoffel symbols and their laws of transformations. Covariant differentiation of vectors and tensors. Riemann-Christoffel tensor. Ricci tensor. Geodesic coordinates and Bianchi identity. Parallel vector field. Intrinsic derivatives of vectors.

### 6.1.2 Metric Space

1. Definition and examples of Metric Spaces. Neighbourhoods. Limit points. Interior points. Open and Closed sets. Closure and Interior. Boundary points. Subspace of Metric Space.

2. Cauchy Sequence. Completeness. Cantor Intersection Theorem. Construction of $\mathbb{R}$ as the completion of incomplete Metric Space $\mathbb{Q}$ (Deduction of no other completion process is required). Real number as a complete ordered field (No proof of the theorem).

### 6.1.3 Complex Analysis

1. Complex numbers as ordered pairs. Geometric representation of complex numbers. Stereographic projection.

2. Complex functions. Continuity and differentiability of complex functions. Analytic functions, Cauchy-Riemann equations. Harmonic functions. Milne's method (statement only).

3. Conformal mappings, Bilinear transformation (simple problems only).

## 6.2 BSCHMATH602 [Credit 6]

**Analytical Statics and Rigid Dynamics[CORE]**

### 6.2.1 Analytical Statics

1. Definition of Center of Gravity (C. G.). General formula for the determination of C.G. Determination of C. G. of any arc, area of solid of known shape by method of integration.

2. Astatic equilibrium, astatic center, positions of equilibrium of a particle lying on a smooth plane curve under the action of given forces. Action at a joint in a frame work.

3. Virtual Work: Principle of virtual work for a single particle. Deduction of the conditions for equilibrium of a particle under coplanar forces from the principle of virtual work. The principle of virtual work for a rigid body. Forces which do not appear in the equation of virtual work. Forces which appear in the equation of virtual work. The principle of virtual work for any system of coplanar forces acting on a rigid body. Converse of the principle of virtual work.

4. Stable and unstable equilibrium. Co-ordinates of a body and of a system of bodies. Degree of freedom. Field of forces. Conservative field. Potential energy of a system. The energy test of stability. Condition for stability of equilibrium of a perfectly rough heavy body lying on fixed body.

5. Forces in three dimensions. Moment of a force about a line. Axis of a couple. Resultant of any two couples acting on a body. Resultant of any number of couples acting on a rigid body. Reduction of a system of forces acting on a rigid body. Resultant force is an invariant of the system but the resultant couple is not an invariant. Conditions for equilibrium of a system of forces acting on a body. Deductions of the conditions for equilibrium of a system of forces acting on a rigid body from the principle of virtual work. Poinsot's central axis. A given system of forces can have only one central axis. Condition that a given system of forces may have a single resultant. Invariants of a given system of forces. Equation of the central axis of a given system of forces.

### 6.2.2 Rigid Dynamics

1. Momental ellipsoid. Equimomental system. Principal axis. D' Alembert's principle. D' Alembert's equations of motion. Principles of moments. Principles of conservations of linear and angular momentum. Independence of the motion of centre of inertia and the motion relative to the centre of inertia. Principle of energy. Principle of conservation of energy.

2. Equation of motion of a rigid body about a fixed axis. Expression for kinetic energy and moment of momentum of a rigid body moving about a fixed axis. Compound pendulum. Interchangeability of the point of suspension and centre of oscillation. Minimum time of oscillation. Reaction of axis of rotation.

## 6.3 MATHDSE601 [Credit 6]

**Discrete Mathematics, Boolean Algebra and Graph Theory [DSE-3]**

### 6.3.1 Discrete Mathematics and Boolean Algebra

1. Principle of inclusion and exclusion. Pigeon-hole principle. Finite combinatorics. Generating functions. Partitions. Recurrence relations. Linear difference equations with constant coefficients.

2. Partial and linear orderings. Chains and antichains. Lattices. Distributive lattices. Complementation.

3. **Boolean Algebra:** Huntington postulates for Boolean Algebra. Algebra of sets and Switching Algebra as examples of Boolean Algebra. Duality. Boolean functions. Normal forms. Karnaugh maps. Design of simple switching circuits.

### 6.3.2 Graph Theory

1. **Graphs:** Undirected graphs. Directed graphs. Basic properties. Walk, Path, Cycle, Trail. Connected graphs. Components of a graph. Complete graph. Complement of a graph. Bipartite graphs. Necessary and sufficient condition for a Bipartite graph.

2. **Euler graphs:** Necessary and sufficient condition for a graph to be Euler graph. Konigsberg Bridge Problem.

3. **Planar graphs:** Face-size equation, Euler's formula for a planar graph. To show: the graphs $K_5$ and $K_{3,3}$ are non-planar.

4. **Tree:** Basic properties. Spanning tree. Minimal Spanning tree. Kruskal's algorithm. Prim's Algorithm. Rooted tree. Binary tree.

## 6.4 MATHDSE602 [Credit 6]

### 6.4.1 Numerical Methods: Practical [DSE-4]

1. **Numerical Methods Practical using Scientific Calculator:**
   a) Bisection method.
   b) Fixed-point iteration method.
   c) Newton-Raphson method.
   d) Regula- Falsi method.
   e) Newton's forward and backward interpolations.
   f) Stirling and Bessel interpolations.
   g) Lagrange interpolation.
   h) Newton's Divided Difference Interpolation.
   i) Trapezoidal, Simpson's $\frac{1}{3}$ and Weddle's rules.
   j) Gauss elimination method.
   k) Gauss-Seidelmethod.
   l) Euler's method.
   m) Runge-Kutta method (4-th order).

2. **NumericalMethods Practical using C programming:**
   a) Bisection method.
   b) Fixed-point iteration method.
   c) Secant method.
   d) Newton-Raphson method.
   e) Regula- Falsi method.
   f) Simpson's $\frac{1}{3}$ rule.
   g) Euler's method.
   h) Runge-Kutta method (4-th order).

# Books for reference in Mathematics (Honours)

# Chapter 7

# Books for reference in Mathematics (Honours)

**Algebra(Classical, Linear, Modern, Boolean), Number Theory:**

1. University Algebra: Gopala Krishnan, N. S. (New Age International)
2. Topics in Algebra: Herstein , I. N. (Wiley Eastern Ltd.)
3. Advanced Higher Algebra: Das, A. N. (Books and Allied)
4. Advanced Higher Algebra: Chakravorty, J. G. and Ghosh, P. R. (U. N. Dhur and Sons)
5. Algebra: R. M. Khan (New Central Book Agency)
6. Higher Algebra- Classical: S. K. Mapa (Sarat Book House)
7. Higher Algebra- Abstract and Linear: S. K. Mapa (Sarat Book House)
8. A First Course in Abstract Algebra: John B. Fraleigh (Pearson Education)
9. Topics in Abstract Algebra: M. K. Sen, S. Ghosh, P. Mukhopadhyay (Universities Press)
10. Abstract Algebra: N. P. Chaudhuri (Tata McGraw Hill)

**Analysis(Real and Complex), Calculus(Differential and Integral), Metric Space, Differential Equations :**

11. Mathematical Analysis: S. C. Malik, S. Arora (New Age International)
12. Mathematical Analysis, Vol-I: Das , A. N. (Books and Allied)
13. Advanced Mathematical Analysis: Utpal Chatterjee (Academic Publishers)
14. Mathematical Analysis-Problems and Solutions: Sitansu Bandyopadhyay (Academic Publishers)
15. Mathematical Analysis: S. N. Mukhopadhyay and A. K. Layek (U. N. Dhur and Sons)

16. A Course of Mathematical Analysis: Shanti Narayan (S. Chand and Co.)
17. Problems in Mathematical Analysis: B. P. Demidovich (Mir Publication )
18. Introduction to Real Analysis: D. R. Sherbert and R. G. Bartle (Wiley)
19. Topics In Real Analysis: Mukherjee, S (Academic Publishers)
20. Real Analysis: Ravi Prakash and Siri K.Wasan (Tata McGraw Hill)
21. Elements of Real Analysis: S. Narayan, M. D. Raisinghania (S. Chand and Co.)
22. An Introduction to Analysis- Differential Calculus, Part I and II: R. K. Ghosh and K. C. Maity (New Central Book Agency)
23. Differential Calculus: B. C. Das and B. N. Mukherjee (U. N. Dhur and Sons)
24. Differential Calculus: Shanti Narayan (S. Chand and Co.)
25. Application of Calculus: Sunil Kr. Maity and Sitansu Bandyopadhyay (Academic Publishers)
26. Application of Calculus: Debasish Sengupta (Books and Allied)
27. Calculus and its Applications: Goldstein, Lay, Schneider, Asmar (Pearson Education)
28. Integral Calculus: Shanti Narayan (S. Chand and Co.)
29. Integral Calculus - Differential Equationns: B. C. Das and B. N. Mukherjee (U. N. Dhur and Sons)
30. An Introduction to Analysis- Integral Calculus: R. K. Ghosh and K. C. Maity (New Central Book Agency)
31. Integral Calculus and Differential Equations: Dipak Chatterjee (Tata McGraw Hill)
32. Differential Equations: Chakravorty, J. G. and Ghosh, P. R. (U. N. Dhur and Sons)
33. An Introduction to Differential Equations: R. K. Ghosh and K. C. Maity (New Central Book Agency)
34. Differential Equation and Laplace Transform: Das, A. N. (New Central Book Agency)
35. Differential Equations: G. F. Simmons (Tata McGraw Hill)
36. Complex Analysis: Ganguly, S. (Academic Publishers)
37. Theory of Functions of a Complex Variable: Shanti Narayan and P.K. Mittal ( S. Chand and Co.)

38. Complex Variables: M. R. Spiegel (McGraw Hill)

39. Complex Analysis: U. C. Dey (U. N. Dhur and Sons)

40. Complex Analysis and Metric Spaces: U. C. Dey and Joydeep Sengupta (U. N. Dhur and Sons)

41. Metric space: Joydeep Sengupta (U. N. Dhur and Sons)

42. Elements of Metric Spaces: M. N. Mukherjee (Academic Publishers)


**Analytical Geometry (Two and Three Dimensions), Vector and Tensor Analysis:**


43. Advanced Analytical Geometry: Chakravorty, J. G. and Ghosh, P. R. (U. N. Dhur and Sons)

44. Analytical Geometry and Vector Algebra: N. Datta and R. N. Jana (Shreedhar Prakashani)

45. Analytical Geometry of two and three Dimensions: Das, A. N. (New Central Book Agency)

46. Analytical Geometry of two and three Dimensions and Vector Analysis: R. M. Khan (New Central Book Agency)

47. Vector Analysis: Chakravorty, J. G. and Ghosh, P. R. (U. N. Dhur and Sons)

48. Vector Analysis. Introduction to Tensor Analysis: Das, A. N. (U. N. Dhur and Sons)

49. Vector Analysis and An Introduction to Tensor Analysis: M. R. Spiegel (McGraw Hill)

50. Vector Analysis: R. K. Ghosh and K. C. Maity (New Central Book Agency)


**Analytical Dynamics(Particle and Rigid) :**


51. Dynamics of a Particle and of Rigid Bodies: Loney, S. L. (Cambridge University Press, Indian Edition. Radha Publishing House)

52. Advanced Analytical Dynamics: Chakravorty, J. G. and Ghosh, P. R. (U. N. Dhur and Sons)

53. Dynamics of Rigid Bodies: Mollah, S. (Books and Allied)

54. Rigid Dynamics: Rahaman, M. M. (New Central Book Agency)

55. Dynamics of a Particle: N. Datta and R. N. Jana (Shreedhar Prakashani)

56. Analytical Dynamics of a Particle: S. Ganguly and S. Saha (New Central Book Agency)

**Analytical Statics:**

57. Analytical Statics: Ghosh, M. C. (Shreedhar Prakashani)
58. Analytical Statics: Mollah, S. A. (Books and Allied)
59. Statics: B. C. Das and B. N. Mukherjee (U. N. Dhur and Sons)
60. Statics: S. L. Loney (Cambridge University Press, Indian Edition. Radha Publishing House)
61. Advanced Analytical Statics: Sukumar Mondal (U. N. Dhur and Sons)

**Classical Mechanics:**

62. Classical Mechanics: S. L. Gupta, V. Kumar, H. V. Sharma (Pragati Prakashan, Meerut)
63. Theoretical Mechanics: M. R. Spiegel (McGraw Hill)
64. Classical Mechanics: Tiwari, R. N. and Thakur, B. S. (Prentice Hall of India)
65. Classical Mechanics: H. Goldstein (Narosa Publishing House)

**Linear Programming:**

66. Linear Programming and Game Theory: Chakraborty, J. G. and Ghosh, P. R. (Moulik Library)
67. Linear Programming and Game Theory: D. C. Sanyal and K. Das (U. N. Dhur and Sons)
68. Linear Programming: P. M. Karak (New Central Book Agency)
69. Linear Programming: G. Hadley (Narosa Publishing House)

**Probability and Statistics:**

70. Groundwork of Mathematical Probability and Statistics: A. Gupta (Academic Publishers)
71. Mathematical Probability: A. Banerjee, S. K. De, S. Sen (U. N. Dhur and Sons)
72. Probability and Statistics-volume I and II: D. Biswas (New Central Book Agency)
73. Statistical Methods-part I and II: N. G. Das (M. Das and Co.)
74. Fundamentals of Mathematical Statistics: S. C. Gupta and V. K. Kapoor (Sultan Chand and Sons)
75. Mathematical Statistics: S. K. De, S. Sen (U. N. Dhur and Sons)

### Numerical Analysis, Computer Science and Programming:


76. A Textbook of Numerical Analysis: D. C. Sanyal and K. Das (U. N. Dhur and sons)
77. Numerical Analysis: Das, A. N. (U. N. Dhur and Sons)
78. Numerical Analysis: N. Datta and R. N. Jana (Shreedhar Prakashani)
79. Numerical Analysis: S. A. Mollah (Books and Allied)
80. Fundamentals of Computers: E. Balagurusamy ( Tata McGraw Hill)
81. Programming in ANSI C: E. Balagurusamy ( Tata McGraw-Hill)
82. Let us C : Yashwant Kanetkar ( BPB Publications )
83. Programming in C: V. Krishnamoorthy and K. R. Radhakrishnan (Tata McGraw Hill)


### Discrete Mathematics, Graph Theory, Mathematical Logic, Number Theory, Boolean Algebra:


84. Introduction to Graph Theory: Douglas B. West (Prentice Hall of India)
85. Discrete Mathematics ( with Graph Theory ): E. G. Goodaire and M. M. Permenter (Prentice Hall of India)
86. Discrete Mathematics: J. K. Sharma (Macmillan)
87. Selected Topics on Discrete Mathematics: S. Kar (U. N. Dhur and Sons)
88. Introduction to Analytic Number theory: T. M. Apostol (Springer)


### General Reading:


89. Mathematics for Science: S. M. Uppal and H. M. Humphreys (New Age International)
90. Objective Mathematics: Das, A. N. (Books And Allied)
91. Objective Mathematics: J. K. Goyal ( A. S. Prakashan, Meerut )
92. What is Mathematics: R. Courant and H. Robbins (Oxford University Press)


**THE END OF MATHS (HONS.) SYLLABUS**