Chakdaha College

Department of Mathematics

B.Sc. (Honors) with Mathematics	
PROGRAM OUTCOMES	Construct and elaborate various mathematical arguments in a logical manner. Further, when information is needed, the student will be able to identify, evaluate, locate and effectively use that knowledge for handling issues or solving problems at hand. Achieve good understanding and knowledge in advanced areas of mathematics and its applications. More specifically- a) Enabling students to develop a very positive attitude towards mathematics as a precious and attractive subject of study. b) A student should acquire a relational knowledge of mathematical concepts and concerned structures, and should be able to chase the patterns involved, mathematical reasoning. c) Having enough concepts to analyze a problem, identify and define the computing requirements, which may be adequate to its solution. d) Introduction to various courses like group theory, ring theory, field theory, Real Analysis, Complex Analysis, metric spaces and number theory. e) Enhancing students' overall development and to equip them with mathematical modeling abilities, problem solving skills, creative talent and power of communication necessary for various kinds of employment. f) Having enough knowledge to pursue advanced studies and research in pure and applied mathematical science.
PROGRAMME SPECIFIC OUTCOME	Students will be able to implement their knowledgeable thinking skills to analyze problems that can be modeled mathematically, to critically interpret numerical and graphical data, to understand and construct mathematical arguments and proofs, to use computer technology appropriately to solve problems and to promote understanding, to apply mathematical knowledge to a career related to mathematical sciences thus cultivating a proper attitude for higher learning in mathematics. Students will be able to a) Think in a critical manner. b) Know when the information is needed, to be able to identify, locate, evaluate, and effectively use that information for the issue or problem at hand. c) Formulate and develop mathematical arguments in a logical manner. d) Acquire good knowledge and understanding in advanced areas of mathematics and statistics, chosen by the student from the

		given courses. e) Understand, formulate and use quantitative models arising in social science, Business and other contexts.
Class/ Paper / Semester	Title	Course Outcome (CO)
Mathematics UG (CBCS) Semester-I		
Mathematics-UG Paper-MATH-H-CC-T-01 (Theory) Sem-I	Calculus & Analytical Geometry	**Upon completion of the course, students will be able to learn the concept of Calculus like as:** • Hyperbolic functions and its derivative, higher order derivatives, Leibnitz rule and its applications to problems of type $e^{ax+b}\sin x$, $e^{ax+b}\cos x$, $(ax+b)^n \sin x$, $(ax+b)^n \cos x$. • Pedal equations. Curvature, radius of curvature, centre of curvature, circle of curvature. Asymptotes. • Singular points, concavity and inflection points. Curve tracing in Cartesian coordinates, tracing in polar coordinates of standard curves. • L'Hospital's rule, applications in business, economics and life sciences. • Reduction formulae, derivations and illustrations of reduction formulae of the type $\int \sin^n x\,dx$, $\int \cos^n x\,dx$, $\int \tan^n x\,dx$, $\int \sec^n x\,dx$, $\int (\log x)^n\,dx$, $\int \sin^n x \cos^m x\,dx$. • Parametric equations, parameterizing a curve, arc length of a curve, arc length of parametric curves, area under a curve, area and volume of surface of revolution, techniques of sketching conics. **Upon completion of the course, students will be able to learn the concept of Analytical Geometry as like:** • Transformation of coordinate axes, pair of straight lines, reflection properties of conics, canonical form second degree equations, classification of conics using the discriminant, polar equations of conics. • Straight lines in 3D, sphere, cylindrical surfaces. central conicoids, paraboloids, plane sections of conicoids, generating lines, classification of quadrics, illustrations of graphing standard quadric surfaces like cone, ellipsoid.
Mathematics-UG Paper-MATH-H-CC-T-02	Algebra	**Upon completion of the course, students will be able to learn the concept of Algebra like as:** **<u>Classical Algebra</u>**

(Theory) Sem-I		• Polar representation of complex numbers, n-th roots of unity, De Moivre's theorem for rational indices and its applications. Direct and inverse circular form of trigonometric and hyperbolic functions. Exponential & Logarithm of a complex number. • Relation between roots and coefficients, transformation of equation, Descartes rule of signs, solution of cubic equation (Cardan's method). • Well-ordering property of positive integers, division algorithm, Euclidean algorithm. Congruence relation between integers. Principles of mathematical induction, statement of fundamental theorem of arithmetic. **Abstract Algebra** • Equivalence relations and partitions. Functions, cardinality of a set, Permutations. • Elementary group theory. Some important finite groups: S_3, V_3, $\mathbf{Z}_n$ and U_n etc. Order of an element, order of a group and its properties. **Linear Algebra** • Orthogonal matrix and its properties. Rank of a matrix, inverse of a matrix, characterizations of invertible matrices. Row reduced and echelon forms, Normal form and congruence operations. • Solutions of systems of linear equations of the form $Ax = b$ and their applications.
Mathematics-UG Paper-MATH-H-GE-T-01/ MATH-H-GE-T-03 (Theory) Sem-I/ Sem- III	Algebra& Analytical Geometry	**Upon completion of the course, students will be able to learn the concept of Algebra like as:** • Complex umbers De Moivre's theorem and its applications. Exponential, Sine, Cosine and Logarithm of a complex number. Inverse circular and hyperbolic functions. • Polynomials: Fundamental theorem of algebra (Statement only). Polynomials with real coefficients. Statement of Descartes rule of signs and its applications. Relation between roots and coefficients, transformations of equations. Cardan's method. • Rank of a matrix. System of linear equations with not more than 3 variables. • Equivalence relations and partitions. Functions and cardinality of a set • Elementary group Theory. Some important finite groups: S_3, V_3 and $\mathbf{Z}_n$. Order of an element, order of a group, Subgroups. **Upon completion of the course, students will be able to**

		learn the concept of Analytical Geometry as like: • Transformations of rectangular axes. Invariants. General equation of second degree, Canonical forms. Classification of conics. • Pair of straight lines. Equation of bisectors. Equation of two lines joining the origin to the points in which a line meets a conic. • Polar equation of straight lines, circles, a conic refers to a focus as a pole, chord joining two points, tangents and normals.
Mathematics UG (CBCS) Semester-II		
Mathematics-UG Paper-MATH-H-CC-T-03 (Theory) Sem-II	Real Analysis	**Upon completion of the course, students will be able to learn the concept of Real Analysis like as:** • The natural numbers Peano's axioms. Review of algebraic and order properties of $\mathbb{R}$. Bounded sets, unbounded sets. L.U.B. (supremum) and G.L.B. (infimum) of a set and its properties. L.U.B. axiom or order completeness of $\mathbb{R}$. Countable and uncountable sets, uncountability of $\mathbb{R}$ and Countability of $\mathbb{Q}$. The Archimedean property, density of rational (and irrational) numbers in $\mathbb{R}$. • Intervals, ε-neighbourhood of a point in $\mathbb{R}$, interior points and open sets, limit points and closed sets, isolated points, adherent point, derived set, closure of a set, interior of a set. Illustrations of Bolzano-Weierstrass theorem for sets. Upper and lower limits of a subset of R. • Compact set in $\mathbb{R}$. Lindelöf covering theorem (statement only). Heine-Borel theorem and its application. • Sequences, bounded sequence, convergent sequence, limit of a sequence, $\liminf x_n$, $\limsup x_n$. Limit theorems. Sandwich theorem. Nested interval theorem. Monotone sequences, monotone convergence theorem. Subsequences, divergence criteria. Monotone subsequence theorem (statement only). Bolzano Weierstrass theorem for sequences. Cauchy sequence, Cauchy's convergence criterion, Cauchy's 1stand 2nd limit theorems. • Infinite series, convergence and divergence of infinite series, Cauchy criterion. Tests for convergence: comparison test, limit comparison test, ratio test: D'Alembert's ratio test, Raabe's test, Cauchy's root test, Gauss test (Statement only), integral test, Cauchy's condensation test. Alternating series,

		Leibnitz test. Absolute and conditional convergence.
Mathematics-UG Paper-MATH-H-CC-T-04 (Theory) Sem-II	Differential Equations	**Upon completion of the course, students will be able to learn the concept of Differential Equations like as:** • Differential equations and mathematical models. General, particular, explicit, implicit and singular solutions of a differential equation. Separable equations. Exact differential equations and integrating factors. Linear equation and Bernoulli equations, special integrating factors and transformations. • First order and higher degree differential equations, solvable for x, y and p, Clairaut's Equations. Lipschitz condition and Picard's Theorem (Statement only). • General solution of homogeneous equation of second order, principle of superposition for homogeneous equation. Wronskian, linear homogeneous and non-homogeneous equations of higher order with constant coefficients. • Euler's equation, method of undetermined coefficients. Method of variation of parameters. Systems of linear differential equations. Types of linear systems. Differential operators. An operator method for linear systems with constant coefficients. Basic Theory of linear systems in normal form. • Homogeneous linear systems with constant coefficients, two Equations in two unknown functions. Equilibrium points. Interpretation of the phase plane. Power series solution of a differential equation about an ordinary point, solution about a regular singular point. • Partial differential equations – Basic concepts and definitions. Mathematical problems. First- order equations, Lagrange's method, Charpit's method. Method of characteristics. Canonical forms. Method of separation of variables.
Mathematics-UG Paper-MATH-H-GE-T-02/ MATH-H-GE-T-04 (Theory) Sem-II/ Sem- IV	Calculus & Differential Equations	**Upon completion of the course, students will be able to learn the concept of Calculus like as:** • Real-valued functions defined on an interval, limit and Continuity of a function (using $\varepsilon - \delta$). Algebra of limits. Differentiability of a function. Successive derivative Leibnitz's theorem and its applications. Partial derivatives. Euler's theorem. Indeterminate Forms L'Hospital's Rule (Statement and Problems only). • Statement 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 forms of remainders. Taylor's and Maclaurin's infinite series of functions. • Application of the principle of maxima and minima for a function of a single variable. • Reduction formulae, derivations and illustrations of reduction formulae. **Upon completion of the course, students will be able to learn the concept of Differential Equations like as:** • First order equations: (i) Exact equations and those reducible to such equations. (ii) Euler's and Bernoulli's equations (Linear). (iii) Clairaut's Equations General and Singular solutions. • Second order differential equation: (i) Method of variation of parameters, (ii) Method of undetermined coefficients.
Mathematics UG (CBCS) Semester-III		
Mathematics-UG Paper-MATH-H-CC-T-05 (Theory) Sem-III	Theory of Real & Vector Functions	**Upon completion of the course, students will be able to learn the concept of Theory of Real Functions like as:** • Limits of functions ($\varepsilon-\delta$ approach). Sequential criterion for limits. Divergence criteria. Limit theorems. Infinite limits and limits at infinity. • Continuous functions, neighbourhood property. Sequential criterion for continuity and discontinuity. Algebra of continuous functions. Continuous functions on an interval, Bolzano's Theorem, intermediate value theorem. Location of roots theorem, preservation of intervals theorem. • Uniform continuity. Differentiability of a function. Caratheodory's theorem. Algebra of differentiable functions. Darboux's theorem. • Rolle's theorem, Lagrange's and Cauchy's mean value theorems. Taylor's theorem with Lagrange's and Cauchy's forms of remainder and its application to convex functions. • Applications of mean value theorem to inequalities and approximation of polynomials. Relative extrema, interior extremum theorem. • Taylor's series and Maclaurin's series expansions of exponential and trigonometric functions $\log(1+x), \frac{1}{ax+b}, (1+x)^n$. Application of Taylor's theorem to inequalities. **Upon completion of the course, students will be able to**

		learn the concept of Theory of Vector Functions like as: • Vector products, Introduction to vector functions, operations with vector-valued functions. • Limits and continuity of vector functions, Differentiation and integration of vector functions of one variable $\left(\int_a^b \overrightarrow{f(t)}dt\right)$.. Gradient, divergence, curl of vector functions.
Mathematics-UG Paper-MATH-H-CC-T-06 (Theory) Sem-III	Group Theory-I	**Upon completion of the course, students will be able to learn the concept of Group Theory like as:** • Subgroups, Cyclic group. Cosets and their properties. Lagrange's theorem and consequences including Fermat's little theorem. External direct product of a finite number of groups. • Centre of a group, centralizer, normalizer. Normal subgroups. Factor groups. Cauchy's theorem for finite abelian groups. • Group homomorphisms, basic properties of homomorphisms. Cayley's theorem. Properties of isomorphisms. First, second and third isomorphism theorems.
Mathematics-UG Paper-MATH-H-CC-T-07 (Theory & Practical) Sem-III	Numerical Methods (Theory) & Numerical Methods Lab	**Upon completion of the course, students will be able to learn the concept of Numerical Methods (Theory) like as:** • Algorithms, convergence, errors, relative, absolute, round-off, truncation errors. • Interpolation, Lagrange and Newton's methods. Error bounds. Finite difference operators. Gregory forward and backward difference interpolation. Central difference interpolation formula: Stirling and Bessel interpolation • Numerical differentiation, methods based on interpolations, methods based on finite differences. Numerical integration, Newton Cotes formula, Trapezoidal rule, Simpson's 1/3rd rule, Simpson's 3/8th rule, Weddle's rule, Boole's rule. Midpoint rule, composite trapezoidal rule, composite Simpson's 1/3rd rule, Gauss quadrature formula. • Transcendental and polynomial equations, bisection method, Newton's method, secant method, Regula-Falsi method, fixed point iteration, Newton-Raphson method, rate of convergence of these methods. • System of linear algebraic equations, Gaussian elimination and Gauss Jordan methods, Gauss Jacobi method, Gauss Seidel method and their convergence analysis, LU decomposition

		• The algebraic eigenvalue problem, power method. Approximation, least square polynomial approximation. • Ordinary differential equations: The method of successive approximations, Euler's method, the modified Euler method, Runge-Kutta methods of orders two and four. **Upon completion of the course, students will be able to learn the following Programme under Numerical Methods (Lab):** • LIST OF PRACTICAL PROBLEMS (Using 'C' or Python programming) i. Calculate the sum of infinite convergent series. ii. Find the absolute value of an integer. iii. Enter 100 integers into an array and sort them in an ascending order. iv. Bisection Method. v. Newton Raphson Method. vi. Secant Method. vii. Regula-Falsi Method. viii. LU decomposition Method. ix. Gauss-Jacobi Method. x. SOR Method or Gauss-Seidel Method. xi. Lagrange's Interpolation xii. Trapezoidal Rule. xiii. Simpson's rule.
Mathematics-UG Paper-MATH-H-SEC-T-1A (Theory) Sem-III	Programming in 'C'	**Upon completion of the course, students will be able to learn the concept of Programming in 'C' like as:** • Brief historical development. Computer generation. Basic structure and elementary ideas of computer systems, operating systems, hardware and software. • Positional number systems: Binary, octal, decimal, hexadecimal systems. Binary arithmetic. • BIT, BYTE, WORD. Coding of data -ASCII, EBCDIC, etc. Algorithms and flow chart: Important features, ideas about complexities of algorithms. Application in simple problems. • Programming language and importance of 'C' programming. Constants, variables and data type of 'C'-Program: Character set. Constants and variables data types, expression, assignment statements, declaration. • Operation and expressions: Arithmetic operators, relational operators, logical operators. Decision

		making and branching: Decision making with if statement, if-else statement, nesting if statement, switch statement, break and continue statement. • Control statements: While statement, do-while statement, for statement. Arrays: One-dimension, two-dimensional and multidimensional arrays, declaration of arrays, initialization of one and multi-dimensional arrays. • User-defined Functions: Definition of functions, scope of variables, return values and their types, function declaration, function call by value, nesting of functions, passing of arrays to functions, recurrence of function.
Mathematics-UG Paper-MATH-H-SEC-T-1B (Theory) Sem-III	Programming in Python	**Upon completion of the course, students will be able to learn the concept of Programming in Python like as:** • Brief historical development. Computer generation. Basic structure and elementary ideas of computer systems, operating systems, hardware and software. Positional number systems: binary, octal, decimal, hexadecimal systems. Binary arithmetic. • BIT, BYTE, WORD. Coding of data -ASCII, EBCDIC, etc. Algorithms and flow chart: Important features, ideas about complexities of algorithms. Application in simple problems. Overview of programming: Structure of a Python Program, elements of Python. • Introduction to Python: Python Interpreter, Using Python as calculator, Python shell, Indentation. Atoms, identifiers and keywords, literals, strings, operators (Arithmetic operator, relational operator, logical or Boolean operator, assignment, operator, ternary operator, bit wise operator, increment or decrement operator). • Creating Python Programs: Input and Output statements, control statements (branching, looping, conditional statement, exit function, difference between break, continue and pass), defining functions, default arguments.
Mathematics UG (CBCS) Semester-IV		
Mathematics-UG Paper-MATH-H-CC-T-08 (Theory) Sem-IV	Ring Theory & Linear Algebra	**Upon completion of the course, students will be able to learn the concept of Ring Theory like as:** • Definition of Ring. Properties of rings. Subrings. Integral domains and fields. Characteristics of a ring. Ideal. Factor rings. Operations on ideals. Prime and maximal ideals.

		• Ring homomorphisms, properties of ring homomorphisms. Isomorphism theorems I, II and III. Field of quotients. **Upon completion of the course, students will be able to learn the concept of Linear Algebra like as:** • Concept of Vector space over a field: Examples, concepts of Linear combinations, linear dependence and independence of a finite number of vectors. Sub-space, concepts of generators and basis of a finite dimensional vector space. Replacement theorem. Extension theorem. Deletion theorem and their applications. Row space, column space. • Euclidean Spaces. Orthogonal and orthonormal vectors. Gram-Schmidt process of orthogonalization. • Linear transformations. Null space. Range, rank and nullity of a linear transformation, matrix representation of a linear transformation, algebra of linear transformations. • Eigenvalues, eigen vectors and characteristic equation of a matrix. Matric polynomials, Cayley-Hamilton theorem and its use in finding the inverse of a matrix. Diagonalization, Canonical forms.
Mathematics-UG Paper-MATH-H-CC-T-09 (Theory) Sem-IV	Multivariate Calculus & Tensor Analysis	**Upon completion of the course, students will be able to learn the concept of Multivariate Calculus like as:** • Functions of several variables, limit and continuity of functions of two or more variables. Differentiability and total differentiability. Partial differentiation. Sufficient condition for differentiability. Schwarz Theorems, Young's Theorems. Chain rule for one and two independent parameters. • Homogeneous function and Euler's theorem on homogeneous functions and its converse. Jacobians and functional dependence. Extrema of functions of two variables, method of Lagrange multipliers, constrained optimization problems. • Double integration over a rectangular region. Double integration over non-rectangular regions. Double integrals in polar coordinates. Triple integrals. Triple integral over parallelepiped and solid regions. Volume by triple integrals, cylindrical and spherical coordinates. Change of variables in double integrals and triple integrals. • Directional derivatives. The gradient, maximal and normal property of the gradient. Line integrals, applications of line integrals: Mass and work. Fundamental theorem for line integrals, conservative

		vector fields, independence of path. • Green's theorem, surface integrals, integrals over parametrically defined surfaces. Stoke's theorem, the divergence theorem. pplications of Green's, Stoke's and divergence theorems. **Upon completion of the course, students will be able to learn the concept of Tensor Analysis like as:** • A tensor as a generalized concept of a vector in E^2 and its generalization in E^n. Space of n–dimension. Transformation of coordinates. Summation convention. • Definition of scalar or invariant. Contravariant, covariant vectors and tensors, mixed tensors of arbitrary order. Kronecker delta. • Equality of tensors, addition, subtraction of two tensors. Outer product of tensors, contraction and inner product of tensors. Symmetric and skew symmetric tensors. • Quotient law, reciprocal tensor of a tensor. Metric tensor, Christoffel symbol, covariant derivative.
Mathematics-UG Paper-MATH-H-CC-T-10 (Theory) Sem-IV	Linear Programming Problems & Game Theory	**Upon completion of the course, students will be able to learn the concept of Linear Programming Problems like as:** • Introduction to linear programming problems. Mathematical formulation of LPP. Graphical solution. Convex sets. Basic solutions (B.S.) and non-basic solutions. Reduction of B.F.S from B.S. • Theory of simplex method. Optimality and unboundedness, the simplex algorithm, simplex method in tableau format, introduction to artificial variables, two-phase method. Big-M method and their comparison. • Duality, formulation of the dual problem, primal-dual relationships, economic interpretation of the dual. • Transportation problem and its mathematical formulation, northwest-corner method, least cost method and Vogel approximation method for determination of initial basic solution. Algorithms for solving transportation problems. • Assignment problem and its mathematical formulation, Hungarian method for solving assignment problems. Travelling Salesman Problems. **Upon completion of the course, students will be able to learn the concept of Game Theory like as:** • Game theory: Formulation of two-person zero sum

		games. Solving two persons zero sum games. Games with mixed strategies. Graphical solution procedure. Solving game using simplex algorithm.
Mathematics-UG Paper-MATH-H-SEC-T-2A (Theory) Sem-IV	Logic & Boolean Algebra	**Upon completion of the course, students will be able to learn the concept of Logic like as:** • Introduction, propositions, truth table, negation, conjunction and disjunction. Implications, biconditional propositions, converse, contrapositive and inverse propositions and precedence of logical operators. Propositional equivalence, Logical equivalences. Predicates and quantifiers: Introduction, quantifiers, binding variables and negations. • Definition, examples and basic properties of ordered sets, maps between ordered sets, duality principle. Lattices as ordered sets, lattices as algebraic structures, sublattices, products and homomorphisms. **Upon completion of the course, students will be able to learn the concept of Boolean Algebra like as:** • Definition, examples and properties of modular and distributive lattices, Boolean algebras, Boolean polynomials, minimal and maximal forms of Boolean polynomials. • Quinn-McCluskey method, Karnaugh diagrams, logic gates, switching circuits and applications of switching circuits.
Mathematics-UG Paper-MATH-H-SEC-T-2B (Theory) Sem-IV	Graph Theory	**Upon completion of the course, students will be able to learn the concept of Graph Theory like as:** • Definition, examples and basic properties of graphs, pseudo graphs, complete graphs, bi-partite graphs isomorphism of graphs. • Eulerian circuits, Eulerian graphs, semi-Eulerian graphs, Hamiltonian cycles. Representation of a graph by matrix, the adjacency matrix, incidence matrix, weighted graph. • Travelling salesman's problem, shortest path, tree and their properties, spanning tree, Dijkstra's algorithm, Warshall algorithm.
Mathematics UG (CBCS) Semester-V		
Mathematics-UG Paper-MATH-H-CC-T-11 (Theory) Sem-V	Riemann Integration and Series of Functions	**Upon completion of the course, students will be able to learn the concept of Riemann Integration like as:** • Riemann integration: inequalities of upper and lower sums, Darbaux theorem, Riemann conditions of integrability, Riemann sum and definition, Riemann integral through Riemann sums. • Equivalence of two definitions. Riemann integrability

		of monotone and continuous functions, properties of the Riemann integral; definition and integrability of piecewise continuous and monotone functions. • Fundamental theorem of integral calculus. 1st and 2nd mean value theorems for integral calculus. Improper integration: Type1, Type2. Necessary and sufficient condition for convergence of improper integral in both cases. Cauchy's Criterion. Cauchy's principal value. • Tests of convergence: Comparison and μ-test. Absolute and non-absolute convergence and. Abel's and Dirichlet's test for convergence on the integral of a product. • Convergence of Beta and Gamma functions. Relation between Beta and Gamma functions and related problems. **Upon completion of the course, students will be able to learn the concept of Series of Functions like as:** • Pointwise and uniform convergence of sequence of functions. Theorems on continuity, derivability and integrability of the limit function of a sequence of functions. • Series of functions. Theorems on the continuity and derivability of the sum function of a series of functions; Cauchy criterion for uniform convergence and Weierstrass M-Test. • Power series, radius of convergence, Cauchy Hadamard theorem. Differentiation and integration of power series; Abel's theorem; Weierstrass approximation theorem. • Fourier series: Definition of Fourier coefficients and series, examples of Fourier expansions and summation results for series.
Mathematics-UG Paper-MATH-H-CC-T-12 (Theory) Sem-V	Mechanics-I	**Upon completion of the course, students will be able to learn the concept of Mechanics like as:** • Motion in a straight line, under attractive and repulsive forces, under acceleration due to gravity. Simple harmonic motion. • Motion in a resisting medium: Vertical and curvilinear motion in a resisting medium. Motion of varying mass. Work, Power and Energy. Conservative forces. Conservation of energy. • Impulse and impulsive forces: Impulse of a force. Impulsive forces. Conservation of linear momentum. Collision of elastic bodies: Elasticity. Impact of smooth bodies. Impact on a fixed plane. Direct and

		oblique impact of two smooth spheres. Loss of kinetic energy. Angle of deflection. • Motion in a Plane. Motion of a particle moving on a plane refers to a set of rotating rectangular axes. Angular velocity and acceleration. Circular motion. Tangential and normal accelerations. • Central orbit. Areal velocity. Law of force for elliptic, parabolic and hyperbolic orbits. Velocity under central forces. Orbit under radial and transverse accelerations. Stability of nearly circular orbits. • Planetary motion Newtonian law. Orbit under inverse square law. Kepler's laws of planetary motion. Time of description of an arc of an elliptic, parabolic and hyperbolic orbit. Effect of disturbing forces on the orbit. Artificial satellites. • Degrees of freedom. Moments and products of inertia: Moment of inertia (M.I.) and product of inertia (P.I.) of some simple cases. M.I. about a perpendicular axis. Routh's rule. M.I. about parallel axes. M.I. about any straight line. M.I. of a lamina about a straight line in its plane. Momental ellipsoid. Equi-momental systems. • General equations of motion D'Alembert's principle and its application to deduce general equations of motion of a rigid body. Motion of the centre of inertia (C.I.) of a rigid body. Motion relative to C.I. • Motion about an axis. Equation of motion. K.E. of the body rotating about an axis. Compound pendulum and its minimum time of oscillation. • Motion in two dimensions under finite forces. Two – dimensional of a solid of revolution down a rough inclined plane. Necessary and sufficient conditions for pure rolling.
Mathematics-UG Paper-MATH-H-DSE-T-1A (Theory) Sem-V	Group Theory-II	**Upon completion of the course, students will be able to learn the concept of Group Theory like as:** • Automorphism, inner automorphism, automorphism groups, automorphism groups of finite and infinite cyclic groups, applications of factor groups to automorphism groups. • Characteristic subgroups, Commutator subgroups and its basic properties, relationship with solvability of groups. • Properties of external direct products, the group of units modulo n as an external direct product, internal direct products. Fundamental theorem of finite abelian groups.

		• Group actions, stabilizers and kernels, permutation representation associated with a given group action. Applications of group actions: Generalized Cayley's theorem, Index theorem. • Groups acting on themselves by conjugation, class equation and consequences, conjugacy in S_n, p-groups, • Sylow's theorems and consequences. Cauchy's theorem, Simplicity of A_n for $n \geq 5$, non-simplicity tests.
Mathematics-UG Paper-MATH-H-DSE-T-1B (Theory) Sem-V	Partial Differential Equations & Laplace Transforms	**Upon completion of the course, students will be able to learn the concept of Partial Differential Equations like as:** • Derivation of heat equation, wave equation and Laplace equation. Classification of second order linear equations. Reduction of second order linear equations to canonical forms. • The Cauchy problem, Cauchy-Kovalevskaya theorem (Statement only), Cauchy problem of an infinite string. • Initial boundary value problems. Semi-infinite string with a fixed end, semi-infinite string with a free end. Method of separation of variables, solving the vibrating string problem. Solving the heat conduction problem. • One dimensional diffusion equation and parabolic differential equations. Method of separation of variables. Solving the vibrating string problem and the heat conduction problem. Wave equation. **Upon completion of the course, students will be able to learn the concept of Laplace Transforms like as:** • Laplace Transform (LT) of Elementary functions. Properties of LTs: change of scale theorem, shifting theorem. LTs of derivatives and integrals of functions, derivatives and integrals of LTs. LT of Dirac Delta function, periodic functions. • Convolution Theorem. Inverse LT. Application of Laplace transforms to solve ordinary and partial differential equations.
Mathematics-UG Paper-MATH-H-DSE-T-2A (Theory) Sem-V	Number Theory	**Upon completion of the course, students will be able to learn the concept of Number Theory like as:** • Linear diophantine equation, prime counting function, statement of prime number theorem. Goldbach conjecture, linear congruences, complete set of residues. • Chinese remainder theorem, Fermat's little theorem,

		Wilson's theorem, Statement of Fermat's Last theorem and their applications. • Number theoretic functions, sum and number of divisors, totally multiplicative functions, definition and properties of the Dirichlet product, the Mobius Inversion formula, the greatest integer function. Euler's phi-function, Euler's theorem, reduced set of residues, some properties of Euler's phi-function. • Order of an integer modulo n, primitive roots for primes, composite numbers having primitive roots. Euler's criterion, the Legendre symbol and its properties, quadratic reciprocity, quadratic congruences with composite moduli. • Prime number and its properties. The arithmetic of $\mathbb{Z}_p$, p a prime, pseudo prime and Carmichael Numbers, Fermat Numbers, perfect numbers, Mersenne numbers. Public key encryption, RSA encryption and decryption, the equation $y^2 + x^2 = z^2$.
Mathematics-UG Paper-MATH-H-DSE-T-2B (Theory) Sem-V	Differential Geometry	**Upon completion of the course, students will be able to learn the concept of Differential Geometry like as:** • Space curves. Parametrised curves, arc length, regular curves, reparametrisation of space curves, curvature and torsion, planer curves, signed curvature of planer curves, curvature, torsion and Serret-Frenet formula. • Osculating circles, osculating circles and spheres. Existence of space curves. Evolutes and involutes of curves. Simple closed curves, isoperimetric inequality, four vertex theorem. • Theory of surfaces: Definition of smooth surfaces, tangents normal and orientability, parametric curves on surfaces. Lengths of curves on surfaces, direction coefficients. First fundamental forms on surfaces. • Curvature of surfaces: Second fundamental forms. Curvature of curves on surfaces, Principal and Gaussian curvatures. Normal curvature, lines of curvature, Meusnier's theorem, Euler's theorem. • Developable surfaces: Developable surfaces, surfaces of constant mean curvature, minimal surfaces. • Geodesics, equation of geodesics. Nature of geodesics on a surface of revolution. Clairaut's theorem. Normal property of geodesics. Torsion of a geodesic. Geodesic curvature. Gauss-Bonnet theorem.
Mathematics UG (CBCS) Semester-VI		
Mathematics-UG Paper-MATH-H-	Metric Spaces and	**Upon completion of the course, students will be able to learn the concept of Metric Spaces like as:**

CC-T-13 (Theory) Sem-VI	Complex Analysis	• Metric spaces: Definition and examples. Open and closed balls, neighbourhood, open set, interior of a set. Limit point of a set, closed set, diameter of a set. • Sequences in metric spaces, Cauchy sequences. Complete metric spaces, Cantor's intersection theorem. Subspaces, dense sets, separable spaces. • Continuous mappings, sequential criterion and other characterizations of continuity. Uniform continuity. Connectedness in metric space and its basic properties, connected subsets of $\mathbb{R}$. • Compactness, sequential compactness, Heine-Borel property, countable compactness, totally bounded spaces, finite intersection property, continuous functions on compact sets. **Upon completion of the course, students will be able to learn the concept of Complex Analysis like as:** • Regions in the complex plane, stereographic projection, functions of complex variables, Limits, limits involving the point at infinity, continuity. • Derivatives of functions, analytic functions, examples of analytic functions, differentiation formulas, Cauchy-Riemann equations, sufficient conditions for differentiability. • Complex integration: Curves in the complex plane, properties of complex line integrals, definite integrals of functions. Contours, Contour integrals and its examples, upper bounds for moduli of contour integrals. • Cauchy-Goursat theorem (statement only), Cauchy integral formula, problems relating to Cauchy's integral formula and its applications. • Absolute and uniform convergence of power series, Taylor series and its examples. Laurent series and its examples.
Mathematics-UG Paper-MATH-H-CC-T-14 (Theory) Sem-VI	Probability & Statistics	**Upon completion of the course, students will be able to learn the concept of Probability & Statistics like as:** • Sample space, probability axioms, real random variables (discrete and continuous). • Probability distribution function, probability mass/density functions. Discrete distributions: uniform, binomial, Poisson, geometric, negative binomial. Continuous distributions: uniform, normal, exponential, Beta, Gamma. • Mathematical expectation, moments, moment generating function, characteristic function. • Joint cumulative distribution function and its

		properties, joint probability density functions, marginal and conditional distributions. • Expectation of function of two random variables, conditional expectations, independent random variables, bivariate normal distribution, correlation coefficient. Linear regression for two variables. • Chebyshev's inequality, statement and interpretation of (weak) law of large numbers and strong law of large numbers. • Central limit theorem for independent and identically distributed random variables with finite variance. • Random samples, sampling distributions. Estimation of parameters and estimate – consistent and biased. Maximum likelihood estimation. Applications to binomial, Poisson and normal populations. • Confidence interval. Interval estimation for parameters of normal population. Confidence intervals for mean and standard deviation of a normal population. Approximate confidence limits for the parameter of a binomial population. Testing of hypotheses.
Mathematics-UG Paper-MATH-H-DSE-T-3A (Theory) Sem-VI	Fuzzy Set Theory	**Upon completion of the course, students will be able to learn the concept of Fuzzy Set Theory like as:** • Interval numbers, arithmetic operations on interval numbers, distance between intervals, two level interval numbers. • Fuzzy versus crisp sets, different types of fuzzy sets, -cuts and its properties. Representations of fuzzy sets, decomposition theorems. Support, convexity, normality, cardinality of fuzzy sets. Standard set-theoretic operations on fuzzy sets. Zadeh's extension principle. • Types of fuzzy operations. Fuzzy complements, fuzzy intersections, fuzzy unions and their properties. Combinations of fuzzy operations. • Crisp versus fuzzy relations. Fuzzy matrices and fuzzy graphs. Composition of fuzzy relations, relational joins. Fuzzy binary relations. • Fuzzy numbers. Arithmetic operations on fuzzy numbers (multiplication and division on only). Fuzzy equations.
Mathematics-UG Paper-MATH-H-DSE-T-3B (Theory) Sem-VI	Bio-Mathematics	**Upon completion of the course, students will be able to learn the concept of Bio-Mathematics like as:** • Mathematical biology and the modeling process: an overview. Continuous models: Malthus model, logistic growth, Allee effect, Gompertz growth,

		Michaelis-Menten Kinetics, Holling type growth. Bacterial growth in a chemostat, harvesting a single natural population. Prey-predator systems and Lotka-Volterra equations, populations in competitions, epidemic models (SI, SIR, SIRS). Activator-inhibitor system, Insect outbreak model. • Qualitative analysis of continuous models: Linearization, equilibrium points, hyperbolic and non-hyperbolic equilibrium, Routh-Hurwitz criteria for stability. Interpretation of the phase plane. Phase plane methods and qualitative solutions, bifurcations and limit cycles with examples in the context of biological scenarios. Spatial models: One species model with one-dimensional diffusion. Two species model with one-dimensional diffusion. Conditions for diffusive instability, spreading colonies of microorganisms. • Introduction to discrete models, Overview of difference equations, steady state solution and linear stability analysis. Linear models, growth models, decay models, drug delivery problem, discrete prey-predator models, density dependent growth models with harvesting, host-parasitoid systems (Nicholson-Bailey model). Optimal exploitation models, models in genetics, stage-structure models, age-structure models.
Mathematics-UG Paper-MATH-H-DSE-T-4A (Theory) Sem-VI	Point Set Topology	**Upon completion of the course, students will be able to learn the concept of Point Set Topology like as:** • Topological spaces, discrete and indiscrete topology, co-finite topology, co-countable topology. Basis and sub-basis for a topology, topology on a set generated by a family of subsets, metric topology, lower limit topology in $\mathbb{R}$. • Neighbourhood of a point, interior points, limit points, derived set, boundary of a set, closed sets, closure and interior of set, dense subsets. • Subspace topology, finite product topology. Continuous functions, open maps, closed maps, homeomorphisms. Net in a topological space and its convergence. • First, second countable and separable spaces with examples and basic properties. Separation axioms, T_0, T_1 and T_2 spaces, regular topological spaces with examples, basic characterizations. • Connected spaces, basic properties and

		characterizations, components, connected sets in. Compact spaces, finite intersection property (FIP), compact sets in a topological space, characterization of compactness via net and FIP, preservation of compactness under continuity and finite product. Properties of real valued continuous function on connected and compact spaces.
Mathematics-UG Paper-MATH-H-DSE-T-4B (Theory) Sem-VI	Mechanics-II	**Upon completion of the course, students will be able to learn the concept of Mechanics like as:** • Coplanar forces: Reduction of a system of coplanar forces. Moment about any point as base. Equation of the line of resultant. Necessary and sufficient conditions of equilibrium. Astatic equilibrium .Principle of virtual work and its converse. • Forces in three dimensions: Moment of a force about a line. Reduction of a system of forces in space. Poinsot's central axis. Equations of the central axis. Wrench and screw. Condition for a single resultant force. • Centre of gravity: Centre of gravity of areas, surfaces and volumes (variation of gravity included). Pappus theorem (statement only). Stable and unstable equilibrium. Stability of equilibrium of two bodies other than spherical bodies. Energy test of stability. Condition of stability of equilibrium of a perfectly rough heavy body lying on a fixed body. • Real and ideal fluids. Pressure of fluid. Transmission of fluid pressure. Elasticity. Specific gravity Pressure of heavy fluids: Magnitude of pressure at a point in a liquid. Pressure at all points at the same horizontal level in a liquid at rest under gravity. For a liquid in equilibrium under gravity, the difference of pressure between any two points is proportional to their depths. Free surface of a homogeneous in equilibrium under gravity is horizontal. Horizontal planes in a liquid in equilibrium under gravity are surfaces of equal density. Pressure at any point in the lower of two immiscible liquids in equilibrium under gravity; Surface of separation is a horizontal plane. Thrust of homogeneous liquids on the plane surface. • Condition of equilibrium of fluids: Pressure derivative in terms of force. Pressure equation and the conditions of equilibrium. Surfaces of equal pressure. Fluid of equilibrium under gravity. Fluid in relative equilibrium. Rotating fluid. • Centre of pressure: Definition, position of the centre

		of pressure (C.P.) of a plane area. C.P. of a plane area immersed in a heavy liquid under gravity. Positions of centres of pressure of some simple areas, e.g., triangular area, parallelogram, circular area, composite plane area. C.P. of a plane area immersed in a number of liquids with different densities. Locus of the C.P. C.P. of a plane area referred to the axes through its centroid. • Thrusts on curved surfaces: Resultant thrust on a curved surface of a heavy homogeneous fluid at rest. Resultant thrust on a solid body wholly or partially immersed in a heavy fluid at rest. Resultant vertical thrust on a surface exposed to the pressure of a heavy fluid at rest. Resultant horizontal thrust in a given direction on a given surface. Resultant thrust on any surface of a liquid at rest under given forces. Resultant thrust on the curved surface of a solid bounded by a plane curve. • Equilibrium of floating bodies: Conditions of equilibrium. Bodies floating under constraint. Potential energy of a liquid. Stability of floating bodies: Plane and surface of floatation. Buoyancy. Metacentre and metacentric height. Conditions of stability of equilibrium. Properties of surface of buoyancy. Equilibrium of a vessel containing liquid. Some elementary curves of buoyancy, e.g., triangle, rectangle. Oscillation of floating bodies.
B.Sc. (General) with Mathematics		
Class/ Paper / Semester	Title	Course Outcome (CO)
Mathematics UG (CBCS) Semester-I		
Mathematics-UG Paper-MATH-G-CC-T-01 (Theory) Sem-I	Algebra& Analytical Geometry	**Upon completion of the course, students will be able to learn the concept of Algebra like as:** • Complex umbers De Moivre's theorem and its applications. Exponential, Sine, Cosine and Logarithm of a complex number. Inverse circular and hyperbolic functions. • Polynomials: Fundamental theorem of algebra (Statement only). Polynomials with real coefficients. Statement of Descartes rule of signs and its applications. Relation between roots and coefficients, transformations of equations. Cardan's method. • Rank of a matrix. System of linear equations with not

		more than 3 variables. • Equivalence relations and partitions. Functions and cardinality of a set • Elementary group Theory. Some important finite groups: S_3, V_3 and $\mathbf{Z}_n$. Order of an element, order of a group, Subgroups. **Upon completion of the course, students will be able to learn the concept of Analytical Geometry as like:** • Transformations of rectangular axes. Invariants. General equation of second degree, Canonical forms. Classification of conics. • Pair of straight lines. Equation of bisectors. Equation of two lines joining the origin to the points in which a line meets a conic. • Polar equation of straight lines, circles, a conic refers to a focus as a pole, chord joining two points, tangents and normals.
Mathematics UG (CBCS) Semester-II		
Mathematics-UG Paper- MATH-G-CC-T-02 (Theory) Sem-II	Calculus & Differential Equations	**Upon completion of the course, students will be able to learn the concept of Calculus like as:** • Real-valued functions defined on an interval, limit and Continuity of a function (using $\varepsilon - \delta$). Algebra of limits. Differentiability of a function. Successive derivative Leibnitz's theorem and its applications. Partial derivatives. Euler's theorem. Indeterminate Forms L'Hospital's Rule (Statement and Problems only). • Statement 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 forms of remainders. Taylor's and Maclaurin's infinite series of functions. • Application of the principle of maxima and minima for a function of a single variable. • Reduction formulae, derivations and illustrations of reduction formulae. **Upon completion of the course, students will be able to learn the concept of Differential Equations like as:** • First order equations: (i) Exact equations and those reducible to such equations. (ii) Euler's and Bernoulli's equations (Linear). (iii) Clairaut's Equations General and Singular solutions.

		Second order differential equation: (i) Method of variation of parameters, (ii) Method of undetermined coefficients.
Mathematics UG (CBCS) Semester-III		
Mathematics-UG Paper- MATH-G-CC-T-03 (Theory) Sem-III	Real Analysis	**Upon completion of the course, students will be able to learn the concept of Real Analysis like as:** • Review of algebraic and order properties of $\mathbb{R}$. Idea of countable sets, uncountable sets and uncountability of $\mathbb{R}$. Countability of $\mathbb{Q}$. Bounded sets, unbounded sets. Suprema and infima. Completeness property of $\mathbb{R}$ and its equivalent properties. The Archimedean property, density of rational (and Irrational) numbers in $\mathbb{R}$, intervals. • Intervals, ε-neighborhood of a point in $\mathbb{R}$, Interior points, Limit points of a set, isolated points, open set, closed set, union and intersection of open and closed sets. derived set, Closure of a set, Interior of a set. Bolzano-Weierstrass theorem for sets (statement only). • Sequences, bounded sequence, convergent sequence, Sandwich theorem. Cauchy's convergence criterion for sequences. Cauchy's theorem on limits. Monotone sequences, monotone convergence theorem (without proof). • Infinite series, Convergence and divergence of infinite series, Cauchy's criterion. Series of positive terms, Geometric Series, p-Series. Tests for convergence: comparison test, limit comparison test, ratio test: D'Alembert's ratio test, Raabe's test, Cauchy's root test. • Alternating series, Leibnitz test (without proof), definition and examples of Absolute and conditional convergence. Power series and radius of convergence (problems only).
Mathematics-UG Paper-MATH-G-SEC-T-1A (Theory) Sem-III	Logic & Sets	**Upon completion of the course, students will be able to learn the concept of Logic like as:** • Introduction, propositions, truth table, negation, conjunction and disjunction. Implications, biconditional propositions, converse, contrapositive and inverse proportions and precedence of logical operators. Propositional equivalence: Logical equivalences. Predicates and quantifiers: Introduction, quantifiers, binding variables and negations. **Upon completion of the course, students will be able to learn the concept of Sets like as:** • Sets, subsets, set operations and the laws of set theory

		and Venn diagrams. Examples of finite and infinite sets. Finite sets and counting principle. Empty set, properties of empty set. Standard set operations. Classes of sets. Power set of a set. • Difference and Symmetric difference of two sets. Set identities, generalized union and intersections. Relation: Product set. Composition of relations, types of relations, partitions, equivalence Relations with example of congruence modulo relation. Partial ordering relations, n-ary relations.
Mathematics-UG Paper-MATH-G-SEC-T-1B (Theory) Sem-III	Vector Calculus	**Upon completion of the course, students will be able to learn the concept of Vector Calculus like as:** • Differentiation and partial differentiation of a vector function. Derivative of sum, dot product and cross product of two vectors. Gradient, divergence and curl with applications. • Vector integration: Line, surface and volume integrals. Green's theorem (statement only), surface integrals, integrals over parametrically defined surfaces. Stoke's theorem (statement only), divergence theorem (statement only). Applications of Green's, Stoke's and divergence theorems.
Mathematics UG (CBCS) Semester-IV		
Mathematics-UG Paper- MATH-G-CC-T-04 (Theory) Sem-IV	Linear Programming Problems & Game Theory	**Upon completion of the course, students will be able to learn the concept of Vector Calculus like as:** • Introduction to linear programming problems, Graphical solution of LPP. Convex sets. Basic solutions and non-basic solutions. Reduction of B.F.S from B.S. • Simplex method, two-phase method, Big-M- method and their comparison. Duality, formulation of the dual problem, primal-dual relationships, economic interpretation of the dual. • Transportation problem and its mathematical formulation, northwest-corner method, least cost method and Vogel's approximation method for determination of initial basic solution. Algorithms for solving transportation problems. Assignment problem and its mathematical formulation, Hungarian method for solving assignment problem. **Upon completion of the course, students will be able to learn the concept of Game Theory like as:** • Game theory: formulation of two-person zero sum games. Solving two-person zero sum games. Games with mixed strategies. Graphical solution procedure. Solving game Using Simplex Algorithm.

Mathematics-UG Paper-MATH-G-SEC-T-2A (Theory) Sem-IV	Graph Theory	**Upon completion of the course, students will be able to learn the concept of Game Theory like as:** • Definition, examples and basic properties of graphs, pseudo graphs, complete graphs, bi-partite graphs isomorphism of graphs. • Eulerian circuits, Eulerian graphs, semi-Eulerian graphs, Hamiltonian cycles. Representation of a graph by matrix, the adjacency matrix, incidence matrix, weighted graph. • Travelling salesman's problem, shortest path, Tree and their properties, spanning tree, Dijkstra's algorithm, Warshall algorithm.
Mathematics-UG Paper-MATH-G-SEC-T-2B (Theory) Sem-IV	Operating System (Linux)	**Upon completion of the course, students will be able to learn the concept of Operating System (Linux) like as:** • Linux – The operating system: Linux history, Linux features, Linux distributions, Linux's relationship to Unix, overview of Linux architecture, installation, startup scripts, system processes (an overview), Linux security. • The Ext2 and Ext3 file systems: General characteristics of the Ext3 file system, file permissions. User management: types of users, the powers of root, managing users (adding and deleting): using the command line and GUI tools. • Resource management in Linux: file and directory management, system calls for files process Management, signals, IPC: Pipes, FIFOs, System V IPC, message queues, system calls for processes, memory management, library and system calls for memory.
Mathematics UG (CBCS) Semester-V		
Mathematics-UG Paper- MATH-G-DSE-T-1A (Theory) Sem-V	Group Theory & Linear Algebra	**Upon completion of the course, students will be able to learn the concept of Group Theory like as:** • Definition and examples of groups, cyclic subgroups, the concept of a subgroup generated by a subset and the commutator subgroup of a group, examples of subgroups including the center of a group. Cosets, Index of subgroups, Lagrange's theorem, order of an element. Normal subgroups, their definition, examples, and characterizations, Quotient groups. **Upon completion of the course, students will be able to learn the concept of Linear Algebra like as:** • Vector spaces, subspaces, algebra of subspaces, quotient spaces, linear combination of vectors, linear

		span, linear independence, basis and dimension, dimension of subspaces. • Characteristic Polynomial, Eigenvalues and Eigenvectors. Linear transformations, null space, range, rank and nullity of a linear transformation, matrix representation of a linear transformation, algebra of linear transformations. Dual Space, Dual Basis, Change of basis. Matrices in diagonal form. Reduction to diagonal form upto matrices of order 3.
Mathematics-UG Paper- MATH-G-DSE-T-1B (Theory) Sem-V	Complex Analysis	**Upon completion of the course, students will be able to learn the concept of Complex Analysis like as:** • Regions in the complex plane, functions of complex variables, limits, limits involving the point at infinity, continuity. • Derivatives of functions, analytic functions, examples of analytic functions, differentiation formulas, Cauchy-Riemann equations, sufficient conditions for differentiability. • Definite integrals of functions. Contours, Contour integrals and its examples, upper bounds for moduli of contour integrals. Cauchy-Goursat theorem (Statement only), Cauchy integral formula and applications. • Liouville's theorem and the fundamental theorem of algebra. • Convergence of sequences and series. Absolute and uniform convergence of power series. Taylor series and its examples.
Mathematics-UG Paper-MATH-G-SEC-T-3A (Theory) Sem-V	Theory of Probability	**Upon completion of the course, students will be able to learn the concept of Theory of Probability like as:** • Sample space, probability axioms, real random variables (discrete and continuous). Cumulative distribution function, probability mass/density functions. Mathematical expectation, moments, moment generating function, characteristic function, discrete distributions: uniform, binomial, Poisson, continuous distributions: uniform, normal, exponential. • Joint cumulative distribution function and its properties, joint probability density functions, marginal and conditional distributions. Expectation of function of two random variables, conditional expectations, independent random variables.
Mathematics-UG Paper-MATH-G-SEC-T-3B	Boolean Algebra	**Upon completion of the course, students will be able to learn the concept of Boolean Algebra like as:** • Definition, examples and basic properties of ordered

(Theory) Sem-V		sets, maps between ordered sets, duality principle, maximal and minimal elements. Lattices as ordered sets, complete lattices, lattices as algebraic structures, sublattices, products and homomorphisms. • Definition, examples and properties of modular and distributive lattices, Boolean algebras, Boolean polynomials, minimal forms of Boolean polynomials. Quinn-McCluskey method, Karnaugh diagrams, switching circuits and applications of switching circuits.
Mathematics UG (CBCS) Semester-VI		
Mathematics-UG Paper- MATH-G-DSE-T-2A (Theory) Sem-VI	Dynamics of a Particle	**Upon completion of the course, students will be able to learn the concept of Dynamics of a Particle like as:** • Motion in a straight line, motion under attractive and repulsive forces, motion under acceleration due to gravity. • Simple Harmonic Motion, Horizontal Oscillation, Composition of two S.H.M.'s, damped harmonic motion, forced oscillation, damped forced oscillation. • Motion in a resisting medium: Vertical and curvilinear motion in a resisting medium. Motion of varying mass: Equations of motion. • Work, Power and Energy: Definitions. Work done in stretching an elastic string. Conservative forces. Conservation of energy. Impulse and impulsive forces: Impulse of a force. Impulsive forces. Conservation of linear momentum. • Collision of elastic bodies: Elasticity. Impact of smooth bodies. Impact on a fixed plane. Direct and oblique impact of two smooth spheres. Loss of kinetic energy. Angle of deflection. • Motion in a Plane: Velocity and acceleration of a particle moving on a plane in Cartesian and polar coordinates. Motion of a particle moving on a plane refers to a set of rotating rectangular axes. Angular velocity and acceleration. Circular motion. Tangential and normal accelerations. • Central orbit: Characteristics of central orbits. Areal velocity. Law of force for elliptic, parabolic and hyperbolic orbits. Velocity under central forces. Orbit under radial and transverse accelerations. Stability of nearly circular orbits. • Planetary motion: Newtonian law. Orbit under inverse square law. Kepler's laws of planetary motion. Time of description of an arc of an elliptic, Parabolic and hyperbolic orbit. Effect of disturbing forces on the

		orbit. Artificial satellites: Orbit round the earth. Parking orbits. Escape velocity.
Mathematics-UG Paper- MATH-G-DSE-T-2B (Theory) Sem-VI	Numerical Methods	**Upon completion of the course, students will be able to learn the concept of Numerical Methods like as:** • Errors, relative, absolute, round-off, truncation errors. Interpolation, Lagrange and Newton's methods. Finite difference operators. Gregory forward and backward difference interpolation. Numerical differentiation, Methods based on interpolations, methods based on finite differences. • Numerical Integration, Newton Cotes formula, Trapezoidal rule, Simpson's 1/3rd rule, composite trapezoidal rule, composite Simpson's 1/3rd rule. • Transcendental and polynomial equations, Bisection method, Regula-Falsi method, Fixed point iteration, Newton-Raphson method, Rate of convergence of these methods. System of linear algebraic equations, Gaussian elimination and Gauss Jordan methods, Gauss Jacobi method, Gauss Seidel method. • The method of successive approximations, Euler's method, the modified Euler method, Runge-Kutta method of order two.
Mathematics-UG Paper-MATH-G-SEC-T-4A (Theory) Sem-VI	Programming in 'C'	**Upon completion of the course, students will be able to learn the concept of Programming in 'C' like as:** • Brief historical development. Computer generation. Basic structure and elementary ideas of computer systems, operating systems, hardware and software. Positional number systems: binary, octal, decimal, hexadecimal systems. Binary arithmetic. BIT, BYTE, WORD. Coding of data -ASCII, EBCDIC, etc. • Algorithms and Flow chart: Important features, Ideas about complexities of algorithms. Application in simple problems. • Programming language and importance of C programming. Constants, Variables and Datatype of C-Program: Character set. Constants and variables data types, expression, assignment statements, declaration. • Operation and Expressions: Arithmetic operators, relational operators, logical operators. Decision Making and Branching: decision making with if statement, if-else statement, Nesting if statement, switch statement, break and continue statement. • Control Statements: While statement, do-while statement, for statement. Arrays: One-dimension,

		two-dimensional and multidimensional arrays, declaration of arrays, initialization of one and multi-dimensional arrays. • User-defined Functions: Definition of functions, Scope of variables, return values and their types, function declaration, function call by value, Nesting of functions, passing of arrays to functions, Recurrence of function. • Programming in 'C' i. Calculate the area of a triangle. ii. Solution of quadratic equation. iii. Sum of n numbers. iv. A.M. and G.M. of n numbers. v. Find the magnitude of a Vector. vi. Arrange the numbers in ascending and descending orders. vii. Addition and Subtraction of two matrices. viii. Multiplication of two matrices.
Mathematics-UG Paper-MATH-G-SEC-T-4A (Theory) Sem-VI	Programming in Python	**Upon completion of the course, students will be able to learn the concept of Programming in Python like as:** • Brief historical development. Computer generation. Basic structure and elementary ideas of computer systems, operating systems, hardware and software. Positional number systems: binary, octal, decimal, hexadecimal systems. Binary arithmetic • BIT, BYTE, WORD. Coding of data -ASCII, EBCDIC, etc. Algorithms and Flow chart: Important features, Ideas about complexities of algorithms. Application in simple problems. • Overview of Programming: Structure of a Python Program, Elements of Python. Introduction to Python: Python Interpreter, Using Python as calculator, Python shell, Indentation. Atoms, Identifiers and keywords, Literals, Strings, Operators (Arithmetic operator, Relational operator, Logical or Boolean operator, Assignment, Operator, Ternary operator, Bit wise operator, Increment or Decrement operator). • Creating Python Programs: Input and Output Statements, Control statements (Branching, Looping, Conditional Statement, Exit function, Difference between break, continue and pass.), Defining Functions, default arguments.