GOUR MAHAVIDYALAYA

DEPARTMENT OF MATHEMATICS

COURSE & PROGRAM OUTCOMES

OF

MATHEMATICS (B.SC.) CBCS

Session: 2022-23

PROGRAMME OUTCOME	Formulate and develop mathematical arguments in a logical manner. Also when there is a need for information, the student will be able to identify, locate, evaluate, and effectively use than information for handling issues or solving problems at hand. Acquire good knowledge and understanding in advanced areas of mathematics and its applications. More specifically- • Enabling students to develop a positive attitude towards mathematics as an interesting and valuable subject of study. • A student should get a relational understanding of mathematical concepts and concerned structures, and should be able to follow the patterns involved, mathematical reasoning. • aAbility to analyse a problem, identify and define the computing requirements, which may beappropriate to its solution. • Introduction to various courses like group theory, ring theory, field theory, metric spaces, number theory. • Enhancing students' overall development and to equip them with mathematical modelling abilities, problem solving skills, creative talent and power of communication necessary for various kinds of employment. Ability to pursue advanced studies and research in pure and applied mathematical science.
PROGRAMME SPECIFICOUTCOME	Students will be able to apply critical thinking skills to solve problems that can be modelled mathematically, to critically interpret numerical and graphical data, to read and construct mathematical arguments and proofs, to use computer technology appropriately to solve problemsand 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 • Think in a critical manner. • Know when there is a need for information, to be able to identify, locate, evaluate, and effectively use that information for the issue or problem at hand. Formulate and develop mathematical arguments in a logical manner. • Acquire good knowledge and understanding in advanced areas of mathematics and statistics, chosen by the student from the given courses. • Understand, formulate and use quantitative models arising in social science, Business and other contexts.
LEARNING OUTCOME	Students will be well equipped to critically analyse a given problem, understand and build a mathematical model to represent the problem, solve the resulting equations and interpret the resulting solution. Students are well prepared for higher studies in their chosen field.

COURSES	**OUTCOMES** (On completion of the courses, the students will be able to understand-)
MATH-H-DC01 **Course title: Calculus & Geometry** After the completion of this course the students will be able to conceptualize the basic concepts about calculus and 2D, 3D Geometry.	• Real-valued functions defined on an interval. • limit of a function and algebra of limits. • Continuity of a function at a point and in an interval. • Acquaintance with the important properties of continuous functions no closed intervals • Hyperbolic functions and its derivative, higher order derivatives, • Leibnitz rule of successive differentiation and its applications. • Envelopes, Asymptotes. • 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 different type. 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.
MATH-H-DC02 **Algebra** After completion of this course the students will understand the concept of	• Polar representation of complex numbers, n-th roots of unity, De Moivre's theorem. • Inequality: The inequality involving AM≥GM≥HM, mth power theorem, Cauchy-Schwartz inequality. • General properties of equations, Fundamental theorem of classical algebra(statement only) and its application,

complex numbers, Inequality, theory of equations, system of linear equations,eigen values.	Transformation of equation, Location of roots. Relation between the roots and the coefficients of equations. Symmetric functions.Solutions of reciprocal and binomial equations. Algebraic solutions of the cubic .and biquadratic. • Equivalence relations,partitions and functions.Division algorithm, Divisibility and Euclidean algorithm. Congruence.Principles of Mathematical Induction.• Systems of linear equations, row reduction and echelon forms, vector equations, the matrix equation. solution sets of linear systems, linear independence. Real Quadratic Form. Characteristic equations.Eigen Values and Eigen Vectors.Cayley-Hamilton Theorem.
MATH-H-DC03 **Course title:** Real Analysis I After completing the course students are expected to be able to: Describe the basic difference between the rational and real numbers. Give the difination of concepts related to metric spaces such as continuity , compactness, convergent etc. Give the essence ofthe proofof Bolzano-weistrass theorem the contraction theorem as well as existence of convergent subsequence using equicontinuity. Evaluate the limits of wide class of real sequences. Determine whether or not real series are convergent by comparision with standard series or using the ratio test. Understand and perform simple proofs. Students will be able to demonstrate basic knowledge of key topics in classical real analysis. The course pervious the basic for further studies with in function analysis, topology & function Theory. They will also know about sequence and series and their convergence.	• Development of real numbers. The algebraic properties of R,rational and irrational numbers, the order properties of R. • Absolute value and the real line, bounded and unbounded setsin R, supremum and infimum, neighbourhood of a point. • The completeness property of R, the Archimedean property,density of rational numbers in R. • Nested intervals property, binary representation of real numbers. • Uncountabili ty of R. Closed set, open set. • Closure & interior of a subset of the real line. Sequences, the limit of a sequence and the notion ofconvergence. • Bounded sequences, limit theorems, squeeze theorem, monotone sequences, monotone convergence theorem. Subsequences, monotone subsequence theorem • The Bolzano-Weierstrass theorem, the divergence criterionLimit superior and limit inferior of a sequence. • Cauchy sequences, Cauchy's convergence criterion. • Infinite series, convergence and divergence of infinite series.Tests for Convergence: Comparison test. • Root test, ratio test, integral test. • Alternating series, absolute and conditional convergence. Sequential criterion for limits. • Divergence criteria. • Limit theorems, infinite limits and limits at infinity. Continuous function. • Sequential criterion for continuity and discontinuity.Algebra of continuous functions. • Continuous functions on an interval. • Intermediate value theorem, location of roots theorem.

	Preservation of intervals theorem. • Uniform continuity. • Non-uniform continuity criteria.Uniform continuity theorems. • Differentiability of a function at a point and in an interval.

	• Caratheodory's theorem, chain rule. • Derivative of inverse functions, algebra of differentiablefunctions. • Mean value theorems. • Rolle's Theorem, Lagrange's mean value theorem. • Applications of mean value theorem to inequalities. Relative extremum and approximation of polynomials.The intermediate value property of derivatives. • Darboux's theorem. L'Hospital's rule. Taylor's theorem and its application. Expansion of functions.
MATH-H-DC04 **Coursetitle:Abstract Algebra** After the completion of this course the students will be able to conceptualize the basic concepts about Group theory, ring and field.	• Definition and examples of groups, elementary properties of groups. • Subgroups and examples of subgroups, centralizer. • normalizer, center of a group. Properties of cyclic groups. • classification of subgroups of cyclic groups. • Permutation group, cycle notation for permutations. • properties of permutations, even and odd permutations. • Alternating group. Cosets, properties of cosets. • Lagrange's theorem and consequences including Fermat's Little theorem. • Normal subgroup and quotient group. • Group homomorphisms, properties of homomorphisms, properties of isomorphisms. • First, Second and Third isomorphism theorems. • External direct product of a finite number of groups. • Cauchy's theorem for finite abelian groups. Cayley's theorem. • Definition and examples of rings, elementary properties of rings. • subrings, integral domains and fields, characteristic of a ring. • Ring homomorphisms, properties of ring homomorphisms. • First Isomorphism theorem. Isomorphism theorems II and III(statement only), field of quotients. • Elementary properties of field. Introduction to polynomialring. • Ideal, ideal generated by a subset of a ring. • factor rings, operations on ideals. • prime and maximal ideals.
MATH-H-DC05 **Course title: Real Analysis II**	• Properties of monotone functions. • Functions of bounded variation. • Total variation. • Continuous functions of bounded variation.

On successful completion of the course students will be able to develop conceptual understanding of metric spaces and complex analysis. The students will be able to demonstrate understanding of the basic concepts and fundamental definitions underlying complex analysis. They can prove and explain concepts of series and integration of complex functions and clearly understand problem-solving using complex analysis, techniques.	● Curves and paths. ● Rectifiable paths and arc length. ● Riemann integration: upper and lower sums, upper and lower integral. ● Definition and conditions of integrability. ● Riemann integrability of monotone and continuous functions. ● Elementary properties of the Riemann integral. Intermediate Valuetheorems for Integrals. ● Fundamental theorem of Integral Calculus, change of variables. ● Periodic function. ● Fourier coefficient & Fourier series, example of Fourier series. ● Convergence. ● Bessel's inequality, Dirichlet's condition. ● Improper integrals. ● Range of integration, finite or infinite. ● Necessary and sufficient condition for convergence of improperintegral. ● Tests of convergence: Comparison and M-test. ● Absolute and non-absolute convergence and inter-relations. ● Statement of Abel's and Dirichlet's test for convergence on theintegral of a product. ● Convergence and working knowledge of Beta and Gamma functionand their interrelation. ● Pointwise and uniform convergence of sequence of functions. ● Theorems on continuity. ● Differentiability and integrability of the limit function of a sequence offunctions. ● Series of functions. ● Theorems on the continuity and differentiability of the sum functionof a series of functions. ● Cauchy criterion for uniform convergence and Weierstrass M-Test. ● Transformation of coordinate axes. ● Reflection properties of conics, canonical form second degree equations, classification of conics using the discriminant, polarequations ofconics. ● Pair of straight lines, Point of intersection of two inter-secting straight lines. Angle between two lines, Equation of bisectors. Equation of two lines joining the origin to the points in which aline meets a conic. ● Equations of pair of tangents from an external point, chord of contact, Polar equations of straight lines and conics. Equation of chord joining two points. Equations of tangent and normal. Straight lines in 3D, sphere, cylindrical surfaces. central conicoids, paraboloids, plane sectionsof conicoids, generating lines, classificationof quadrics, illustrations of graphing standard quadric surfaces like cone, ellipsoid.

MATH-H-DC06 **Coursetitle: Linear Algebra** After completion of this course, the students will mainly be able to • Understand vectors paces over a	. • Definition and examples of vector spaces. • subspaces, linear combination of vectors. • linear span, linear dependence and independence, bases and dimension • Linear transformations, null space, range. • rank and nullity of a linear transformation,

field and subspaces and apply their Properties. • Understand linear independence and dependence. • Find the basis and dimension of a vector space, and understand the Change of basis. • Compute linear transformations, kernel and range, and inverse linear Transformations, and find matrices of general linear transformations. • Find eigen values and eigen vectors of a matrix and of linear Transformation. • The Cayley-Hamilton Theorem and its use in finding the inverse of a matrix Understand various concepts of Linear Algebra.	• matrix representation of a linear transformation, • algebra of linear transformations. • Isomorphisms. Isomorphism theorems, • invertibility and isomorphisms, change of coordinate matrix • Linear operator and its eigen value and eigen vectors, • characteristic equation, eigen space, algebrai and geometric multiplicity of eigen values. • Diagonalization, conditions for diagonalizability. • Invariant subspace and Cayley-Hamiltontheorem, • simple application of Caley-Hamilton Theorem. • Inner products and norms, special emphasis on Euclidean spaces. • Orthogonal and orthonormal vectors, • Gram-Schmidt orthogonalisation process, • orthogonal complements. • The adjoint of a linear operator, unitary, orthogonal and normaloperators
Course: MATH-H-DC-07 **Course title: Multivariate Calculus & Tensor Analysis** After completion of this unit of the course which covers the following topics on multiple integrals, line integrals etc., the student will be able to apply theseconcepts to solve many real-life problemsthat may arise in different fields.	• 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. • Euler's theorem for homogenous function, total differentiability and Jacobian. • sufficient condition for differentiability, Mean value theorem, Taylor's theorem,. • Extrema of functions of two variables, method of Lagrange multipliers, constrained optimizationproblems. • Double integration over a rectangular region. Double integration over non-rectangular regions. • Changing the order of integration. • 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. • Triple product, introduction to vector fields • operations with vector-valued functions • , limits and continuity of vector functions, • gradient, divergence and curl. • Curves and their parameterization,

	• line integration of vector functions, circulation. Sur- face and volume integration • Gauss’s theorem, Green’s theorem, Stoke’s theorem and their simple applications

MATH-H-DC08 **Course title: Differential Equation** After the completion of this course the students will be able to conceptualize the basic concepts differential equarion. • Understand differential equation with order and degree, application of differential equation in real life. • Determine integrating factor of a first order differential equation. • Find general solution , singular solution and particular solution of a differential equation.. • Compute particular integral by using D operator method, and complementary function. • Find eigen values and eigen vectors of a boundary value problem Concept of partial and ordinary differential equation. Solve PDD by lagrange , charpit method.	• Exact, linear and Bernoulli's equations. Equations not of first degree, • Clairaut's equations ,singular solution. • Lipschitz condition and Picard's Theorem (Statement only). • General solution of homogeneous equation of second order, • principle of super position for homogeneous equation, • Wronskian and its properties. Linear homogeneous and non-homogeneous equations of higher order with constant coefficients, • Euler's equation, method of undetermined coefficients, • method of variation of parameters, Eigenvalue problem • 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 reg- ular singular point. • Legendre polynomials,Bessel functions of the first kind and their properties • Partial differential equations, basic concepts and definitions. • First- Order Equations: classi- fication, construction and geometrical interpretation • Method of characteristics for obtaining general solution of quasi linear equations • Canonical forms of first-order linear equations. Solution by Lagrange's and Charpit's method

MATH-H-DC09 **Mechanics** The main objective of this course is to conceptualized the students with the statics and dynamics.	• Coplanar forces in general. • An arbitrary force system in space: Moment of a force about an axis, Varignon’s theorem. • Static friction and dynamic friction. • Virtual work. • Stability of equilibrium. • Kinematics of a particle. • Newton laws of motion and law of gravitation. • Work, power, kinetic energy, • Impulsive forces • Particle dynamics. • Planar motion of a particle. • Central orbits. • Kepler’s laws on planetary motion. • motion of artificial satellites.

Course: MATH-H-DC-10 **Course title: Probability and Statistics** The main objective of this course is to provide students with the foundations of probabilistic and statistical analysis mostlyused in varied applications in engineering and science like disease modeling, climate prediction and computer networks etc.	• 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, geometric, negative binomial, 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, bivariate normal distribution, correlation coefficient. • 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: Unbiasedness, • consistency, the method of moments and the method of maximum likelihood estimation, • confidence intervals for parameters in one sample problems of normal populations, • confidence intervals for proportions, problems. • Testing of hypothesis: Null and alternative hypotheses, • the critical and acceptance regions, two types of error, • Neyman-Pearson Fundamental Lemma, • tests for one sample problems for normal populations, tests for proportions, • Chi-square goodness of fit test and its applications. .

MATH-H-DC11 **Course title: Advanced Analysis on R & C** On successful completion of the course students will be able to develop conceptual understanding of metric spaces and complex analysis. The students will be able to demonstrate understanding of the basic concepts and fundamental definitions underlying complex analysis. They can prove and explain concepts of series and integrationof complex functions and clearly understandproblem-solving using complex analysis, techniques.	•Metric spaces: Definition and examples. •Open balls, closed balls. •Neighbourhood, open set. •Interior of a set. •Limit point of a set. •Closed set. •Closure. •Subspaces. •Dense sets. •Separable spaces. •Sequences and their convergence in matric spaces. •Cauchy sequences. •Complete Matric Spaces. •Cantor's theorem. •Continuous mappings. •Sequential criterion of continuity. •Characterizations of continuity. •Uniform continuity. •Connectedness of a metric space. •Compactness of a metric space. •Limits and continuity of the complex functions. •Complex differentiation. •Cauchy- Riemann equations. •Analytic functions, examples of analytic functions. •Elementary properties of analytic functions. •Harmonic function. •Evaluation of the harmonic conjugate. •Complex power series and radius of convergence. •Complex exponential function. •Complex trigonometric functions. •Hyperbolic functions. •Complex logarithm. •Analytic branch of logarithm. •Introduction to conformal mapping. •Complex valued function defined on real intervals in the complex plane. •Complex valued function defined on curves in the complex plane. •Complex valued function defined on paths in the complex plane. •Parameterization of curves and its elementary properties. •Parameterization of contour and its elementary properties. •Complex line integrals. •Cauchy- Goursat theorem. •Cauchy's theorem and its simple application.

	• Cauchy’s integral formula. • Power series representation of complex functions, Taylor series representation. • Laurent series representation.

MATH-H-DC12 **Numerical Methods & C Programming Language** After completion of this course, the students will be able to apply numerical methods to obtain approximate solutions to mathematical problems, solve the nonlinear equations, system of linear equations and interpolation problems using numerical methods, examine the appropriate numerical differentiation and integration methods to solve problems, apply the numerical methods to solve algebraic as well as differential equations. Moreover the students abel to understand the basic C programming language.	• Numerical error. • Finding roots of equations by Bisection method, Newton's method, Secant method, Regula-falsi method, fixed point iteration, Newton-Raphson method. 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. • Interpolation: Newton's and Lagrange methods Central difference interpolation. • Numerical differentiation. • Numerical Integration: Newton Cotes formula, Trapezoidal rule, Simpson's 1/3rd rule, Simpsons3/8th rule, Weddle's rule, Boole's Rule. Midpoint rule,Gauss quadrature formula. Power method. • 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. • Basic of the C-Programming Languages, Data Type, Constants and Variables, if-else, switch, for Loop, while Loop,do-while Loop, break and continue, functions, array.

MATH-H-DC13 **Coursetitle: Linear Programming Problems & Game Theory** After the completion of this course the students will be able to conceptualize the basic concepts about Group theory, ring and field. The objective of this course is to study basic theory of Linear Programming, Integer Programming and Two-Person Zero-Sum Games with economic applications. The emphasis is on the formulation of the mathematical model, and also on the methods for solving linear and integer programming problems. Students will get knowledge on the basic theory and some models of Linear Programming, Integer Programming and Game Theory.	• Linear programming modeling, • Optimal solutions and graphical interpretation of optimality. • Notion of convexset, convex function ,their properties and applications in context of LPP. • Preliminary definitions (like convex combination, extreme point etc.). • Optimal hyper-plane and existence of optimal solution of LPP. • Basic feasible solutions: algebraic interpretation of extreme point. • Relationship between extreme points and corresponding BFS. • Adjacent extreme points and corresponding BFS along with examples. • Fundamental theorem of LPP and its illustration through examples • LPP in canonical form to get the initial BFS and method of improving current BFS. • Theory of simplex method, graphical solution, convex sets, optimality and un boundedness, • 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 • Vogel approximation method for determination of starting basic solution, • algorithm for solving transportation problem, • assignment problem and its mathematical formulation, • Hungarian method for solving assignment problem • Game theory: formulation of two person zero sum games, • solving two person zero sum games, games with mixed strategies, • graphical solution procedure, linear programming solutions of game

MATH-H-DSE1(1) **Advanced Algebra** After completion of this course students will be able to conceptualized the concept about automorphism, group actions, direct product,sylow theorem, basic about rign.	• Automorphism, inner automorphism. • Characteristic subgroups, Commutator subgroup. • external direct products,internal direct products, Fundamental Theorem of finite abelian groups. • Group actions. • Sylow's theorems and consequences, Cauchys theorem. • Polynomial rings over commutative rings, division algorithm and consequences, principal ideal domains, reducibility and irreducibility.unique factorization domains, Euclidean domains.

MATH-H-DSE02 **Coursetitle:Fluid machanics** After the completion of this course the students will be able to conceptualize the basic concepts about fluid dynamics in real life.	• Perfect fluid. Pressure at a point. Pressure of heavy fluid. • Pressure at any point of a fluid at rest is the same in every directions. • Conditions of equilibrium for homogeneous, heterogeneous, and elastic fluid. • Lines of force. Surfaces of equal pressure and density. • Pressure gradient, pressure function and equation of equilibrium. • Homogeneous fluid at rest under gravity • Definition of center of pressure. • Formula for the depth of the center of pressure of a plane area. • Position of center of pressure. Thrusts on plane and curved surfaces. • Rotating fluid. Pressure at any point and surfaces of equipressure when a mass of homogeneous fluid contained in a vessel revolves uniformly about a vertical axis. • Floating bodies. Stability of equilibrium of floating bodies • Kinematics of Fluid: Scalar and Vector Field, flow field, • Description of Fluid Motion. Lagrangian method, • Eulerian method, Relation between Eulerian and Lagrangian method, • Variation off low parameters in time and space • Steady and unsteady flow, uniform and non uniform flow • Material derivative and acceleration: temporal derivative, convective derivative • Conservation Equation: Control mass system, • control volume system, Isolated system. • Conservation of Mass-The Continuity equation: • Differential form and vector form, integral form. • Conservation of Momentum: Momentum theorem, Reynolds transport theorem. Conservation of energy.

MATH-H-DSE3(1) **Course title: Point Set Topology** On the completion of his course, the students will understand the basic concepts of Topological spaces in Topology.	• Countable and Uncountable Sets. • Schroeder-Bernstein Theorem. • Cantors Theorem. • Cardinal Numbers and Cardinal Arithmetic. • Continuum Hypothesis. • Zorns Lemma, Axiom of Choice. • Well-Ordered Sets, Hausdorffs Maximal Principle. Ordinal Numbers. • Topological spaces. • Basis and Subbasis for a topology. • Subspace Topology. • Interior Points. • Limit Points. • Derived Set. • Boundary of a set. • Closed Sets, Closure. • Interior of a set. • Continuous Functions. • Open maps, Closed maps. • Homeomorphisms. • Product Topology. • Quotient Topology. • Metric Topology. • Baire Category Theorem. • Connected Spaces. • Path Connected Spaces. • Connected Sets in R. • Components and Path Components. • Local Connectedness. • Compact Spaces, Compact Sets in R. • Compactness in Metric Spaces. • Totally Bounded Spaces, Ascoli-Arzela Theorem. • The Lebesgue Number Lemma. • Local Compactness.

MATH-H-DSE4 **Course title: Dissertation/Project** On the completion of this course, the students will understand the basicconcepts of undertaking specialized research and identifying unsolved yet relevant problem in a specific field.	• Undergone relevant (taught) courses required for undertaking specialized research. • Identifying unsolved yet relevant problem in a specific field. • Articulating ideas and strategies for addressing a research problem. • Undertaken original research on a particular topic. • Effectively communicating research, through journal publications and conference presentations, to the mathematics community. • Disseminating research to a broader audience. • Generate publications in reputed mathematical journals. • Provide scope for interaction with international researchers and developing collaborations. • Demonstrate the highest standard of ethics in research. • Provide opportunities to research students for communication (and discussion) of advanced mathematical topics to undergraduate and graduate students Produce next generation researchers in mathematics.

MATH-H- SEC01 **Course title: Discrete Mathematics** This is a standard course in graph theory, assuming little introductory knowledge of graphs. It aim is to present all usual basic concepts of graph theory, graph properties (with simplified proofs) and formulations of typical graph problems. This is also supplemented with some abstract-level algorithms for the presented problems, and with some advanced graph theory topics. At the end of the course, successful students shall understand in depth and tell all the basicterms of graph theory; be able to reproduce the proofs of some fundamental statements on graphs; be able to solve new graph problems; and be ready to apply thisknowledge in (especially) computer science applications, Also, this course is designed to introduce basic concepts of Logic and Boolean Algebra to undergraduate students. After completion students will be able to use logic and boolean algebra to solve problems. • Use truth tables and laws of identity,distributive, commutative, and domination. • Simplify and prove boolean expressions • Compute sum of products and product of sum expansions. • Convert boolean expressions to logicgates and vice-versa. Will learn about different lattices and Boolean algebra.	• Definition of undirected graphs. • Using of graphs to solve different puzzles and problems. • Multi- graphs. Walks, Trails, Paths, Circuits and cycles. • Eulerian circuits and paths. • Eulerian graphs, example of Eulerian graphs. • Hamiltonian cycles and Hamiltonian graphs. • Weighted graphs and Travelling salespersons Problem. • Dijkstra’s algorithm to find shortest path. • Definition of Trees and their elementary properties. • Definition of Planar graphs, Kuratowski’s graphs. • Partial Order relations and lattices, Chains and antichains. • Pigeon hole Principle. • Introduction, propositions. • Truth table, negation. • Conjunction and disjunction. • Implications, biconditional propositions, converse, contra positive and inverse propositions and precedence of logical operators. • Propositional equivalence: Logical equivalences. • Predicates and quantifiers: Introduction, Quantifiers. • Binding variables and Negations. • 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. • 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. • Applications of switching circuits. •

MATH-H-SEC02 **Problem Solving Techniques in Probability & Statistics** At the end of this course the students will understand the practical uses of solving technique of the topic distributions, central tendency, correlations coefficients, fit a polynomial, line regression, attributes.	• Application problems based on Classical Definition of Probability, Bayes' Theorem. • Fitting of binomial distributions, Poisson distributions and negative binomial distribution.• Application problems based on binomial distribution, Poisson distribution and negative binomial distribution. • Problems based on measures of central tendency,measures of dispersion, combined mean and variance and coefficient of variation, moments, skewness and kurtosis. • Fitting of polynomials, exponential curves• Karl Pearson correlation coefficient.• Partial and multiple correlations • Spearman rank correlation with and without ties. • Correlation coefficient for a bivariate frequency distribution • Lines of regression, angle between lines and estimated values of variables. • • attributes.