Course and Programme Outcomes of Mathematics Honours Under CBCS

Course Outcomes

Semester-1

Paper: MTMACOR01T

Calculus, Geometry and Ordinary Differential equations

Learning Outcomes: On completion of this area of the course, the student will be able to

- Understand the nature of Hyperbolic functions.
- Find higher order derivatives and apply the Leibnitz rule to solve problems related to such derivatives.
- Plot the graphs of polynomials of degree 4 and 5, the derivative graph, the second derivative graph and compare them.
- Apply the concept and principles of differential calculus to find the curvature, concavity and points of inflection, envelopes, rectilinear asymptotes (Cartesian & parametric form only) of different curves.
- Apply the concept and principles of differential calculus to solve different geometric and physical problems that may arise in business, economics and life sciences.
- Solve various limit problems using L' Hospital's rule·
- Derive Reduction formulae for some complex integrations and hence Integrate functions of a much higher degree which are applicable in real life situations.
- Apply the integral calculus to find arc length of a curve, arc length of parametric curves, area under a curve, surface area and volume of surface of revolution.
- Transform the co-ordinate system especially by Rotation of axes, thus reducing different second-degree equations to their corresponding simplest forms and also classify the conics using the discriminant.
- Become familiar with the polar equations of conics & their tangents and normal
- Understand the geometrical terminology and have a detailed clear-cut idea of the Planes, Straight lines in 3D, Spheres, Cylindrical surfaces, Central conicoids, Paraboloids, Plane sections of conicoids along with the Tangent and normal of the conicoids.
- Have an idea of classification of quadrics.
- First order differential equations: Exact differential equations and integrating factors, special integrating factors and transformations, linear equations and Bernoulli equations, the existence and uniqueness theorem of Picard (Statement only). Linear equations and equations reducible to linear form.

Graphical Demonstration

- Visualize and graphically demonstrate geometric figures and classify different geometric solids using teaching aid - preferably free software's :
  - ✓ Tracing of conics in cartesian coordinates/ polar coordinates.
  - ✓ Sketching ellipsoid, hyperboloid of one and two sheets, elliptic cone, elliptic, paraboloid, and hyperbolic paraboloid using cartesian coordinates.
- Understand the basic applications of the analytical plane and solid geometry.

Paper: MTMACOR02T
Algebra

Learning Outcomes: On completion of this course, the student will have a clear-cut understanding of some important concepts of Classical Algebra, Abstract Algebra & Linear Algebra as follows:

- Polar representation of complex numbers, *n*-th roots of unity, De Moivre's theorem for rational indices and its applications. Exponential, logarithmic, trigonometric and hyperbolic functions of the complex variable.
- Theory of equations: Relation between roots and coefficients, transformation of the equation, Descartes rule of signs, Sturm's theorem, cubic equation (solution by Cardan's method) and biquadratic equation (solution by Ferrari's method).
- Inequality: The inequality involving $AM \geq GM \geq HM$, Cauchy-Schwartz inequality.
- Relation: equivalence relation, equivalence classes & partition, partial order relation, poset, linear order relation.
- Mapping: injective, surjective, one to one correspondence, invertible mapping, composition of mappings, relation between the composition of mappings and various set theoretic operations.
- Well-ordering property of positive integers, Principles of Mathematical induction, division algorithm, di-visibility and Euclidean algorithm. Prime numbers and their properties, Euclid's theorem. Congruence relation between integers. Fundamental Theorem of Arithmetic. Chinese remainder theorem. Arithmetic functions, some arithmetic functions such as φ, τ, σ and their properties
- Rank of a matrix, inverse of a matrix, characterizations of invertible matrices.
- Systems of linear equations, row reduction and echelon forms, vector equations, the matrix equation $AX = B$, solution sets of linear systems, applications of linear systems.

Semester-2
Paper: MTMACOR03T
Real Analysis

Learning Outcomes:

After completion of this course, the students will be able to think about the basic proof techniques and fundamental definitions related to the real number system. They can demonstrate some of the fundamental theorems of analysis. The students will gradually develop Analysis skills in sets, sequences and infinite series of Real Numbers covered by the following topics:

- Intuitive idea of real numbers. Mathematical operations and usual order of real numbers revisited with their properties (closure, commutative, associative, identity, inverse, distributive). Idea of countable sets, un-countable sets and uncountability of R. Concept of bounded and unbounded sets in R. L.U.B. (supremum), G.L.B. (infimum) of a set and their properties. L.U.B. axiom or order completeness axiom. Archimedean property of R. Density of rational (and Irrational) numbers in R.
- Intervals. Neighbourhood of a point. Interior point. Open set. Union, intersection of open sets. Limit point and isolated point of a set. Bolzano-Weirstrass theorem for sets. Existence of limit point of every uncountable set as a consequence of Bolzano-Weirstrass theorem. Derived set. Closed set. Complement of open set and closed set. Union and intersection of closed sets as a consequence. No nonempty proper subset of R is both open and closed. Dense set in R as a set having non-

empty intersection with every open interval.

- Real sequence. Bounded sequence. Convergence and non-convergence. Examples. Boundedness of convergent sequence. Uniqueness of limit. Algebra of limits.
- Relation between the limit point of a set and the limit of a convergent sequence of distinct elements. Monotone sequences and their convergence. Sandwich rule. Nested interval theorem. Limit of some important sequences. Cauchy's first and second limit theorems.
- Every sequence has a monotone subsequence. Bolzano-Weirstrass theorem for sequence. Cauchy's convergence criterion. Cauchy sequence.
- Infinite series, convergence and non-convergence of infinite series, Cauchy criterion, tests for convergence: comparison test, limit comparison test, ratio test, Cauchy's n-th root test, Alternating series, Leibniz test. Absolute and conditional convergence.

Graphical Demonstration (Teaching Aid-Preferably by computer software's)

The students will gain hands on expertise in graphical demonstration of the following, using computer software or otherwise:

- Plotting of recursive sequences.
- Study the convergence of sequences through plotting.
- Verify Bolzano-Weierstrass theorem through plotting of sequences and hence identify convergent subsequences from the plot.
- Study the convergence/divergence of infinite series by plotting their sequences of partial sum.
- Cauchy's root test by plotting n-th roots.
- Ratio test by plotting the ratio of n-th and $(n + 1)$-th term.

Paper: MTMACOR04T

Differential Equation and Vector Calculus

On completion of this course, the student will be able to identify the type of a given differential equation and select and apply the appropriate analytical technique for finding the solution. The students will be well conversant with the following types of differential equations and vector calculus:

- First order higher degree equations solvable for x, y and p. Clairaut's equations and singular solution.
- Basic Theory of linear systems in normal form, homogeneous linear systems with constant coefficients: Two Equations in two unknown functions.
- Linear differential equations of second order, Wronskian: its properties and applications, Euler equation, method of undetermined coefficients, method of variation of parameters.
- System of linear differential equations, types of linear systems, differential operators, an operator method for linear systems with constant coefficients.
- Planar linear autonomous systems: Equilibrium (critical) points, Interpretation of the phase plane and phase portraits.
- Power series solution of a differential equation about an ordinary point, solution about a regular singular point (up to second order).
- Vector triple product, introduction to vector functions, operations with vector valued functions, differentiation and integration of vector functions.
- Plotting of family of curves which are solutions of second order and third order differential equations.

Semester-3

Paper: MTMACOR05T
Theory of Real Functions

Learning Outcomes: After completion of this course, the students will be able to understand the concept of real-valued functions, limit, continuity, and differentiability in detail. They can find expansions of real functions in series forms. The students will become conversant with many of the important theorems of Differential Calculus after the completion of this Core Course which has been covered in the following topics:

- Limits of functions, sequential criterion for limits. Algebra of limits for functions, effect of limit on inequality involving functions, one sided limit. Infinite limits and limits at infinity. Some Important examples of limits.
- Continuity of a function on an interval and at an isolated point. Sequential criteria for continuity. Concept of oscillation of a function at a point. A function is continuous at x if and only if its oscillation at x is zero. Familiarity with the figures of some well-known functions: $y = x^a$ ($a = 2, 3, -1, -2$), $|x|$, sin x, cos x, tan x, log x, e^x. Algebra of continuous functions as a consequence of algebra of limits. Continuity of composite functions. Examples of continuous functions. Continuity of a function at a point does not necessarily imply the continuity in some neighborhood of that point.
- Bounded functions. Neighborhood properties of continuous functions regarding boundedness and maintenance of the same sign. Continuous function on $[a, b]$ is bounded and attains its bounds. Intermediate value theorem.
- Discontinuity of functions, type of discontinuity. Step functions. Piecewise continuity. Monotone functions. Monotone functions can have only jump discontinuity. Monotone functions can have at most countably many points of discontinuity. Monotone bijective function from an interval to an interval is continuous and its inverse is also continuous.
- Uniform continuity. Functions continuous on a closed and bounded interval is uniformly continuous. A necessary and sufficient condition under which a continuous function on a bounded open interval will be uniformly continuous. A sufficient condition under which a continuous function on an unbounded open interval will be uniformly continuous (statement only). Lipschitz condition and uniform continuity.
- Differentiability of a function at a point and in an interval, algebra of differentiable functions. Meaning of sign of derivative. Chain rule.
- Darbaux theorem, Rolle 's Theorem, Mean value theorems of Lagrange and Cauchy — as an application of Rolle's theorem. Taylor's theorem on closed and bounded interval with Lagrange's and Cauchy's form of remainder deduced from Lagrange's and Cauchy's mean value theorem respectively. Expansion of e^x, log $(1 + x)$, $(1 + x)^m$, sin x, cos x with their range of validity (assuming relevant theorems). Application of Taylor's theorem to inequalities.
- Statement of L' Hospital's rule and its consequences. Point of local extremum (maximum, minimum) of a function in an interval. Sufficient condition for the existence of a local maximum/minimum of a function at a point (statement only). Determination of local extremum using first order derivative. Application of the principle of maximum/minimum in geometrical problems.

Paper: MTMACOR06T
Group Theory-1

Learning Outcomes: On the completion of this course, the students will understand the basic concepts of Group Theory in Abstract/Modern Algebra covered by the following topics:

- Symmetries of a square, definition of group, examples of groups including permutation groups, dihedral groups and quaternion groups (through matrices), elementary properties of groups, examples of commutative and non-commutative groups. Subgroups and examples of subgroups, necessary and sufficient condition for a nonempty subset of a group to be a subgroup. Normalizer, centralizer, center of a group, product of two subgroups.
- Properties of cyclic groups, classification of subgroups of cyclic groups. Cycle notation for permutations, properties of permutations, even and odd permutations, alternating group, properties of cosets, order of an element, order of a group. Lagrange's theorem and consequences including Fermat's Little theorem.
- Normal subgroup and its properties. Quotient group. Group homomorphisms, properties of homomorphisms, correspondence theorem and one-one correspondence between the set of all normal subgroups of a group and the set of all congruence on that group, Cayley's theorem, properties of isomorphisms. First, Second and Third isomorphism theorems.

Paper: MTMACOR07T
Numerical Methods

Learning Outcomes: On the 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. The course will be covered in the following topics:
- Representation of real numbers, Machine Numbers - floating point and fixed point. Sources of Errors, Rounding of numbers, significant digits and Error Propagation in machine arithmetic operations. Numerical Algorithms - stability and convergence.
- Approximation: Classes of approximating functions, Types of approximations-polynomial approximation, The Weierstrass polynomial approximation theorem (statement only).
- Interpolation: Lagrange and Newton's methods. Error bounds. Finite difference operators. Newton (Gregory) forward and backward difference interpolation.
- Different interpolation zones, Error estimation. Hermite interpolation.
- Numerical differentiation: Methods based on interpolations; methods based on finite differences.
- Numerical Integration: Newton Cotes formula, Trapezoidal rule, Simpson's 1/3-rd rule, Simpson's 3/8-th rule, Weddle's rule, Boole's Rule, midpoint rule. Composite

trapezoidal rule, composite Simpson's 1/3-rd rule, composite Weddle's rule. Gaussian quadrature formula.

- Transcendental and polynomial equations: Bisection method, Secant method, Regula-falsi method, fixed point iteration, Newton-Raphson method. Condition of convergence (if any), Order of convergence, Rate of convergence of these methods. System of linear algebraic equations:
- Direct methods: Gaussian elimination and Gauss Jordan methods, Pivoting strategies.
- Iterative methods: Gauss Jacobi method, Gauss Seidel method and their convergence analysis. LU decomposition method (Crout's LU decomposition method).
- Matrix inversion: Gaussian elimination and LU decomposition method (Crout's LU decomposition method) (operational counts).
- The algebraic eigen value problem: Power method.
- Ordinary differential equations: Single-step difference equation methods- error, convergence. The method of successive approximations (Picard), Euler's method, the modified Euler method, Runge-Kutta methods of orders two and four.

Core Course-7 Practical (Numerical Methods Lab)

Learning Outcomes: For any of the CAS (Computer Aided software), students are introduced to Data types-simple data types, floating data types, character data types, arithmetic operators and operator precedence, variables and constant declarations, expressions, input/output, relational operators, logical operators and logical expressions, control statements and loop statements, Arrays. The students become expert in solving different numerical problems (listed below) by using computer programming techniques *of C/ C++/ FORTRAN 90*

- Calculate the sum 1+½+1/3+ +1/N
- Enter 100 integers into an array and sort them in an ascendingorder.
- Solution of transcendental and algebraic equations by

  i) Bisection method

  ii) Newton Raphson method (Simple root, multiple roots, complex roots).

  iii) Secant method.

  iv) Regula Falsi method.
- Solut on of system of linear equations

  i) LU decomposition method

  ii) Gaussian elimination method

  iii) Gauss-Jacobi method

  iv) Gauss-Seidel method
- Interpolation

  i) Lagrange Interpolation

  i) Newton's forward, backward and divided difference interpolations
- Numerical Integration

  i) Trapezoidal Rule

  ii) Simpson's one third rule

  iii) Weddle's Rule

  iv) Gauss Quadrature

- Method of finding Eigenvalue by Power method (up to 4×4)

- Fitting a Polynomial Function (up to third degree)
- Solution of ordinary differential equations

  i) Euler method
  ii) Modified Euler method
  iii) Runge Kutta method (order 4)

Semester-4

Paper: MTMACOR08T

Riemann Integration and series of Functions

Learning Outcomes: On completion of this course, the student will be able to

- Understand Partition and refinement of partition of a closed and bounded interval.
- Conceptualise Upper Darboux sum U(P, f) and lower Darboux sum L(P, f) and associated results. Upper integral and lower integral.
- Understand Darboux's theorem along with Darboux's definition of integration over a closed and bounded interval.
- Learn Riemann's definition of integrability and its Equivalence with Darboux definition of integrability along with the Necessary and sufficient condition for Riemann integrability.
- Conceptualize negligible set (or zero set) defined as a set covered by countable number of open intervals sum of whose lengths is arbitrary small, Examples of negligible sets: any subset of a negligible set, finite set, countable union of negligible sets.
- Learn that a bounded function on a closed and bounded interval is Riemann integrable if and only if the set of points of discontinuity is negligible.
- Develop the capacity to integrate, while understanding the examples of Riemann integrable functions.
- Develop the concept of Integrability of sum, scalar multiple, product, quotient, modulus of Riemann integrable functions & properties of Riemann integrable functions arising from the above results.
- Have an idea of the functions defined by definite integral and its properties, Antiderivative (primitive or indefinite integral) and also the properties of Logarithmic function defined as the definite integral.\
- Understand the Fundamental theorem of Integral Calculus & First Mean Value theorem of integral calculus.
- Understand well the Range of integration-finite or infinite and learn the Necessary and sufficient condition for convergence of improper integral in both cases.
- Learn the Tests of convergence: Comparison and M-test, Absolute and non-absolute convergence and inter-relations.
- Understand the Statement of Abel's and Dirichlet's test for convergence on the integral of a product.
- Develop an idea of convergence and working knowledge of Beta and Gamma and their interrelation.
- Compute different integrals when they exist (using Beta and Gamma function).
- Sequence of functions defined on a set, Pointwise and uniform convergence. Cauchy

criterion of uniform convergence. Weirstrass' M- test. Boundedness, continuity, integrability and differentiability of the limit function of a sequence of functions in case of uniform convergence.

- Series of functions defined on a set, Pointwise and uniform convergence. Cauchy criterion of uniform convergence. Weierstrass' M-test. Passage to the limit term by term. Boundedness, continuity, integrability, differentiability of a series of functions in case of uniform convergence.
- Power series: Fundamental theorem of power series. Cauchy-Hadamard theorem. Determination of radius of convergence. Uniform and absolute convergence of power series. Properties of sum function. Differentiation and integration of power series. Abel's limit theorems. Uniqueness of power series having sum function.
- Fourier series: Trigonometric series. Statement of sufficient condition for a trigonometric series to be a Fourier series. Fourier coefficients for periodic functions defined on $[-\pi, \pi]$. Statement of Dirichlet's condition of convergence. Statement of theorem of sum of Fourier series.

Paper: MTMACOR09T
Multivariate Calculus

Learning Outcomes: On completion of this course, the student will be able to

- Understand the concept of neighborhood of a point in Rn (n > 1), interior point, limit point, open set and closed set in Rn (n > 1).
- Identify functions from Rn(n > 1) to Rm(m ≥ 1)
- Develop concepts on limit and continuity of functions of two or more variables, their partial derivatives, total derivative and differentiability,along with the sufficient condition for differentiability, Chain rule for one and two independent parameters, directional derivatives, the gradient, maximal and normal property of the gradient, tangent planes.
- Find Extrema of functions of two variables & understand the use of the method of Lagrange multipliers & solve constrained optimization problems.
- Multiple integral: Concept of upper sum, lower sum, upper integral, lower-integral and double integral (no rigorous treatment is needed). Statement of existence theorem for continuous functions. Iterated or repeated integral, change of order of integration. Triple integral. Cylindrical and spherical coordinates. Change of variables in double integrals and triple integrals. Transformation of double and triple inte-grals (problems only). Determination of volume and surface area by multiple integrals (problems only). Differentiation under the integral sign, Leibniz's rule (problems only).
- Definition of vector field, divergence and curl. Line integrals, applications of line integral: 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.

Paper: MTMACOR10T
Ring theory and Linear Algebra-I

Learning Outcomes: After completion of this course, the students will mainly be able to

- Develop a concept on Ring Theory of Abstract Algebra in details.
- Understand vector spaces over a 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 eigenvectors of a matrix and of linear transformation.
- The Cayley-Hamilton Theorem and its use in finding the inverse of a matrix.

Semester-5

Paper: MTMACOR11T

Partial Differential Equation and Application of Ordinary differential Equations

Learning Outcomes: On completion of this course, the student will be able to understand, derive and solve different types of partial differential equations which may arise in real life problems:

- Partial differential equations of the first order, Lagrange's solution non- linear first order partial differential equations, Charpit's general method of solution, some special types of equations which can be solved easily by methods other than the general method
- Derivation of heat equation, wave equation and Laplace equation. Classification of second order linear equations as hyperbolic, parabolic or elliptic. Reduction of second order linear equations to canonical forms.
- The Cauchy problem, Cauchy-Kowalewskaya theorem, Cauchy problem of finite and infinite string. Initial boundary value problems. Semi-infinite string with a fixed end, semi-infinite string with a free end. Equations with non-homogeneous boundary conditions. Non- homogeneous wave equation. Method of separation of variables, solving the vibrating string problem. Solving the heat conduction problem.
- Applications of Ordinary differential equations in different problems of Mechanics namely, Central Force, Constrained motion, Varying Mass, tangent and normal components of acceleration, modelling ballistics and planetary motion, Kepler's Second Law.
- Graphical demonstration of solution of Cauchy Problem for first order Partial differential equations, plotting integral surfaces for first order PDE with initial data.

Paper: MTMACOR12T

Group Theory-II

Learning outcomes: After completion of this course the students will be able to demonstrate the mathematical maturity of understanding the advance aspects of Group Theory

- Automorphism, inner automorphism, automorphism groups, automorphism groups of finite and infinite cyclic groups, applications of factor groups to automorphism groups.
- External direct product and its properties, the group of units modulo n as an external direct product, internal direct product, Fundamental theorem of finite abelian groups, Fundamental theorem of finite abelian groups.

- Group actions, generalized Cayley's theorem, Index theorem, Stabilizer and Kernels etc.
- Groups acting on themselves by conjugation, Sylow's theorems and consequences, Cauchy's theorem etc.

Paper: MTMACOR13T
Metric Spaces and Complex Analysis

Learning Outcomes: On successful completion of the course students will be able to develop conceptual understanding of the following:

- Definition and examples of metric spaces. Open ball. Open set. Closed set as complement of open set. Interior point and interior of a set. Limit point and closure of a set. Boundary point and boundary of a set. Properties of interior, closure and boundary. Bounded set and diameter of a set. Distance between two sets. Subspace of a metric space.
- Convergent sequence. Cauchy sequence. Every convergent sequence is Cauchy and bounded, but the converse is not true. Completeness. Cantor's intersection theorem. R is a complete metric space. Q is not complete.
- Continuous mappings, sequential criterion of continuity. Uniform continuity.
- Compactness, Sequential compactness, Heine-Borel theorem in R. Finite intersection property, continuous functions on compact sets.
- Concept of connectedness and some examples of connected metric space, connected subsets of R, C.
- Contraction mappings, Banach Fixed point Theorem and its application
- to ordinary differential equations.
- Limits, limits involving the point at infinity. Continuity of functions of complex variables.
- Derivatives, differentiation formulas, Cauchy-Riemann equations, sufficient conditions for differentiability. Analytic functions, exponential function, logarithmic function, trigonometric functions, hyperbolic functions.
- Determination of radius of convergence. Uniform and absolute convergence of power series. Analytic functions represented by power series. Uniqueness of power series.
- Contours, complex integration along a contour and its examples, upper bounds for moduli of contour integrals. Cauchy- Goursat theorem (statement only) and its consequences, Cauchy integral formula.

Paper: MTMACOR14T
Ring Theory and Linear Algebra II

Learning Outcomes: On successful completion of the course students will be able to develop conceptual understanding of the following:

- Polynomial rings over commutative rings, Division algorithm and consequences, Unique Factorization domains, Euclidean Domains etc.
- Inner product spaces and norms, Gram-Schmidt orthonormalization process, orthogonal complements, Bessel's inequality, the adjoint of a linear operator and its basic properties.

- Bilinear and quadratic forms, Diagonalization of symmetric matrices, Second derivative test for critical point of a function of several variables, Hessian matrix, Sylvester's law of inertia. Index, signature.
- Dual spaces, dual basis, double dual, transpose of a linear transformation and its matrix in the dual basis, annihilators. Eigen spaces of a linear operator, diagonalizability, invariant subspaces and Cayley-Hamilton theorem, the minimal polynomial for a linear operator, canonical forms (Jordan & rational).

Skill Enhancement Courses (Semester-III, Semester-IV)

After the completion of these courses the students will acquire skills in thinking more logically in Mathematics, as well as they will understand the importance of C programming or object- oriented programming C++, both of which are very good programming tools for solving many real-life problems.

Generic Elective of Mathematics
Semester-I
Paper: MTMHGEC01T
Differential calculus

Learning Outcomes: On completion of this area of the course, the student will beable to develop a clear concept of the following:

- Limit and continuity, successive differentiation, partial differentiation, Euler's theorem on homogeneous functions.
- Tangents and normal, curvature, asymptotes, singular points, tracing of various types of curves.
- Rolle's Theorem and different type of Mean Value Theorems, Concept of Taylor Series and Maclaurin Series, indeterminate forms.

Semester-II
Paper: MTMHGEC02T
Differential Equations

Learning Outcomes: On completion of this area of the course, the student will beable to develop a clear concept of the following:

- First order exact equations, first order higher degree equations, methods of solutions and properties.
- Solving a differential equation by reducing it order.
- Linear homogeneous equation, linear non-homogeneous equations, Cauchy-Euler equation, Simultaneous Differential equations, Total differential Equations.
- Formation, different methods of solutions of Partial Differential equations (first order).
- Classification of second order partial differential equations.

Programme Outcome

The Bachelor's Degree in B.Sc. (Hons) Mathematics is awarded to the students on the basis of knowledge, understanding, skills, attitudes, values and academic achievements sought to be acquired by learners at the end of this program. Hence, the learning outcomes of mathematics for this course are aimed at facilitating the learners to acquire these attributes, keeping in view of their preferences and aspirations for knowledge of mathematics. Mathematics is the study of quantity, structure, space and change. It has very broad scope in science, engineering and social sciences. The key areas of study in mathematics are Calculus, Algebra, Geometry, Analysis, Differential Equations and Mechanics. Programme Specific Outcome of B.Sc. (Hons) Mathematics

- Think in a critical manner.
- Familiarize the students with suitable tools of mathematical analysis to handle issues and problems in mathematics and related sciences.
- Acquire good knowledge and understanding to solve specific theoretical and applied problems in advanced areas of mathematics and statistics.
- Provide students/learners sufficient knowledge and skills enabling them to undertake further studies in mathematics and its allied areas on multiple disciplines concerned with mathematics.
- Encourage the students to develop a range of generic skills helpful in employment, internships and social activities.

Bachelor's degree in mathematics is the culmination of in-depth knowledge of algebra, calculus, geometry, differential equations and several other branches of mathematics. This also leads to study of related areas like computer science, Financial Mathematics, statistics and many more. Thus, this programme helps learners in building a solid foundation for higher studies in mathematics. The skills and knowledge gained has intrinsic beauty, which also leads to proficiency in analytical reasoning. This can be utilized in modelling and solving real life problems. They also share ideas and insights while seeking and benefitting from knowledge and insight of others. This helps them to learn behave responsibly in a rapidly changing interdependent society. Students completing this programme will be able to present mathematics clearly and precisely, describe mathematical ideas from multiple perspectives and explain fundamental concepts of mathematics to non-mathematicians. Completion of this programme will also enable the learners to join teaching profession in Primary, Secondary and Higher Secondary schools. This programme will also help students to enhance their employability for government jobs, jobs in banking, insurance and investment sectors, data analyst jobs and jobs in various other public and private enterprises.