Department of Mathematics

Programme Specific Outcome (B.Sc Mathematics Honours and Generic)

The Completion of the B.Sc MATH Program shall enable a student to

1. Communicate Mathematics effectively by oral, written, computational and graphic means.
2. Create Mathematical ideas from basic axioms.
3. Gauge the hypothesis, theories, techniques and proofs provisionally.
4. Utilize Mathematics to solve theoretical and applied problems by critical understanding, analysis and synthesis.
5. Identify applications of Mathematics in other disciplines and in the real world, leading to enhancement of career prospects in a plethora of fields.
6. Appreciate the requirement of lifelong learning through continued education and research.

COURSE OUTCOMES

Sl. No	Semester	Course name and Course code	Course Outcome	Unit No. and Name	Bloom's Taxonomy Level
1.	**Sem-1(H)**	Paper Name: **Calculus** (Including Practical) Paper Code: MAT-HC-1016	This course will enable the students to: i) Learn first and second derivative tests for relative extremum and apply the knowledge in problems in business, economics and life sciences. ii) Sketch curves in a plane using its mathematical properties in different coordinate systems. iii) Compute area of surfaces of revolution and the volume of solids by integrating over	Unit1 : Higher order derivatives, it's application, geometrical interpretation.	Remember, understand, apply, evaluate.
				Unit2 : Reduction formula for integration and application of integration in geometry.	Remember, understand, apply, evaluate.
				Unit3 : Vector functions and it's applications.	Remember, understand, apply, evaluate.

			cross-sectional areas. iv) Understand the calculus of vector functions and its use to develop the basic principles of planetary motion.		
Sl. No	**Semester**	**Course name and Course code**	**Course Outcome**	**Unit No. and Name**	**Bloom's Taxonomy Level**
2.	Sem-1(H)	Paper Name: **Algebra** Paper Code:MAT-HC-1026	This course will enable the students to: i) Employ De Moivre's theorem in a number of applications to solve numerical problems. ii) Learn about equivalent classes and cardinality of a set. iii) Use modular arithmetic and basic properties of congruences. iv) Recognize consistent and inconsistent systems of linear equations by the row echelon form of the augmented matrix. v) Learn about the solution sets of linear systems using matrix method and Cramer's rule	Unit1 : Polar representation of complex numbers, De Moivre's theorem and applications.	Remember, understand, apply, evaluate
				Unit2 : Mathematical logic, sets, functions	Remember, understand, apply, evaluate
				Unit3 : Relations, Induction principles, GCD of integers	Remember, understand, apply, evaluate
				Unit4 : Linear equations, matrix and it's applications	Remember, understand, apply, evaluate

Sl.no	Semester	Course name and Course code	Course Outcome	Unit No. and Name	Bloom's Taxonomy Level
3.	Sem2(H)	Paper Name: **Real Analysis** Paper Code:MAT-HC-2016	This course will enable the students to: i) Understand many properties of the real line R, including completeness and Archimedean properties. ii) Learn to define sequences in terms of functions from N to a subset of R. iii) Recognize bounded, convergent, divergent, Cauchy and monotonic sequences and to calculate their limit superior, limit inferior, and the limit of a bounded sequence.	Unit1 :Algebraic and order properties of R.	Remember, understand, apply, evaluate
				Unit2 :Real sequences and it's convergence	Remember, understand, apply
				Unit3 :Infinite series and it's convergence	Remember, understand, apply

Sl.no	Semester	Course name and Course code	Course Outcome	Unit No. and Name	Bloom's Taxonomy Level
4.	Sem2(H)	Paper Name: **Differential Equations** Paper Code:MAT-HC-2026	The course will enable the students to: i) Learn basics of differential equations and mathematical modeling. ii) Formulate differential equations for various mathematical models. iii) Solve first order non-linear differential equations and linear differential equations of higher order usingvarious techniques. iv) Apply these techniques to solve and analyze various mathematical models.	Unit1 :Basics of Mathematica l Model, solution of 1st order differential equations.	Remember, understand, apply, analyse.
				Unit2: Introduction and analysis of different models.	Understand, apply, evaluate, create
				Unit3 :Solutions of 2nd order differential equations.	Remember, understand, apply, analyse.

Sl. No.	Semester	Course Name and Code	Course Outcome	Unit No. and Name	Bloom's Taxonomy Level
5.	Sem 3 (H)	Paper Name: **Theory of Real functions** Paper Code:	This course will enable the students to:	Unit1 : Limit point of sets, limits o9f functions.	Remember, understand

		MAT-HC-3016	i) Have a rigorous understanding of the concept of limit of a function. ii) Learn about continuity and uniform continuity of functions defined on intervals. iii) Understand geometrical properties of continuous functions on closed and bounded intervals. iv) Learn extensively about the concept of differentiability using limits, leading to a better understanding for applications.		
				Unit2 : Continuous functions and related theorems	Understand, Remember
				Unit3 : Differentiability of a function and related theorems	Remember, understand analysis

Sl. No.	**Semester**	**Course Name and Code**	**Course Outcome**	**Unit No. and Name**	**Bloom's Taxonomy Level**
6.	Sem 3(H)	Paper Name: **Group Theory-1** Paper Code:MAT-HC-3026	The course will enable the students to: i) Recognize the mathematical objects that are groups, and classify them as abelian, cyclic and permutationgroups, etc. ii) Link the	Unit1 : Definition and examples of group, subgroups, cyclic groups.	Remember, understand, analyse.
				Unit2 : Permutations, Lagrange's theorem, normal	Understand, Remember

			fundamental concepts of groups and symmetrical figures. iii) Analyze the subgroups of cyclic groups and classify subgroups of cyclic groups. iv) Explain the significance of the notion of cosets, normal subgroups and factor groups. v) Learn about Lagrange's theorem and Fermat's Little theorem. vi) Know about group homomorphisms and group isomorphisms.	subgroups and factor groups.	
				Unit3 : Group homomorphism and related theorems	Remember, understand,analyse.

Sl. No.	Semester	Course Name and Code	Course Outcome	Unit No. and Name	Bloom's Taxonomy Level
7.	Sem 3 (H)	Paper Name: **Analytical Geometry** Paper Code:MAT-HC-3036	This course will enable the students to: i) Learn conic sections and transform co-ordinate systems ii) Learn polar equation of a conic, tangent, normal and properties iii) Have a	Unit1 : Transformation of co-ordinates, pair of straight lines, different types of conics with general form.	Remember, understand, analyse, apply.
				Unit2 :Plane, sphere,cone, cylinder, central conicoid	Remember, understand, apply.

			rigorous understanding of the concept of three dimensional coordinates system.		

Sl. No.	Semester	Course Name and Code	Course Outcome	Unit No. and Name	Bloom's Taxonomy Level
8.	Sem 4 (H)	Paper Name: **Multivariate Calculus** Paper Code:MAT-HC-4016	This course will enable the students to: i) Learn the conceptual variations when advancing in calculus from one variable to multivariable discussion. ii) Understand the maximization and minimization of multivariable functions subject to the given constraints iii) Learn about inter-relationship amongst the line integral, double and triple integral formulations. iv) Familiarize with Green's, Stokes' and Gauss divergence theorems.	Unit1 : Functions of several variables, limit,continuity, partial derivatives, chain rule, level curves, tangent,gradient, directional derivative, total differential.	Remember, understand, apply, analyse, create.
				Unit2 : Extrema of functions of several variables	Understand, Remember, apply, evaluate.
				Unit3 : Double and triple integration, volume, area, surface area by it.	Remember, understand analyse, apply, create
				Unit4 : Line , surface integral. Green, Stokes, Divergence theorem and applications.	Apply, analyse, evaluate.

Sl. No.	Semester	Course Name and Code	Course Outcome	Unit No. and Name	Bloom's Taxonomy Level
9.	Sem 4 (H)	Paper Name: **Numerical Methods (Including Practical)** Paper Code:MAT-HC-4026	The course will enable the students to: i) Learn some numerical methods to find the zeroes of nonlinear functions of a single variable and solution of a system of linear equations, up to a certain given level of precision. ii) Know about methods to solve system of linear equations, such as False position method, Fixed point iteration method, Newton's method, Secant method and LU decomposition. iii) Interpolation techniques to compute the values for a tabulated function at points not in the table. iv) Applications of numerical differentiation and integration to convert differential equations into difference equations for numerical solutions.	Unit1 :Algorithms, convergence, Solution of system of equations by different methods, LU decomposition	Remember, understand, apply, evaluate.
				Unit2 :Lagrange and Newton interpolation, finite difference operators.	Remember, understand, apply, evaluate.
				Unit3 : Numerical differentiation and integration. Trapezoidal, Simpson's and Euler's rule.	Understand, apply, analyse, evaluate.

Sl. No.	Semester	Course name and Code	Course Outcome	Unit No. and Name	Bloom's Taxonomy Level

10.	Sem 4(H)	Paper Name: **Ring Theory** Paper Code:MAT-HC-4036	This course will enable the students to: i) appreciate the significance of unique factorization in rings and integral domains ii) learn about fundamental concepts of ring, integral domains and fields. iii) know about ring homomorphism and isomorphisms theorems of rings. iv)learn about polynomial rings over commutative rings and about UFD.	Unit1 :Definition, examples and properties of rings, sub ring, ideal, integral domains, fields. Isomorphisms and homomorphisms of rings and related theorems.	Remember, understand, analyse.
				Unit2 :Polynomial rings over commutative rings, division algorithm, principal and prime ideals, UFD and Euclidean domains, divisibility in integral domains.	Remember, understand, analyse.

Sl. No.	**Semester**	**Course name and Code**	**Course Outcome**	**Unit No. and Name**	**Bloom's Taxonomy Level**
11.	Sem 4(H)	Paper Name: **Multivariate Calculus** Paper Code:MAT-HC-4016	This course will enable the students to: i) Learn the conceptual variations when advancing in calculus from one variable to multivariable discussion. ii) Understand the maximization and minimization of multivariable functions subject to the given constraints iii) Learn about inter-relationship amongst the line	Unit1 : Functions of several variables, limit, continuity, partial derivatives, chain rule, level curves, tangent, gradient, directional derivative, total differential.	Remember, understand, apply, analyse, create.
				Unit2 : Extrema of functions of several variables	Understand, Remember, apply, evaluate.
				Unit3 : Double and triple integration, volume, area, surface area by it.	Remember, understand analyse, apply, create
				Unit4 : Line , surface integral. Green, Stokes, Divergence theorem and applications.	Apply, analyse, evaluate.

			integral, double and triple integral formulations. iv) Familiarize with Green's, Stokes' and Gauss divergence theorems.		

Sl. No.	**Semester**	**Course name and Code**	**Course Outcome**	**Unit No. and Name**	**Bloom's Taxonomy Level**
12.	Sem5(H)	Paper Name:**Complex Analysis (Including Practical)** Paper Code:MAT-HC-5016	The course will enable the students to: i) Learn the significance of differentiability of complex functions leading to the understanding ofCauchy−Riemann equations. ii) Learn some elementary functions and can evaluate the contour integrals. iii)Understand the role of Cauchy−Goursat theorem and the Cauchy integral formula and their applications in evaluating complex integrals.	Unit1 :Function of a complex variable. Limit, continuity, differentiability of complex numbers. Cauchy Riemann equations.	Remember, understand, apply, analyse.
				Unit2 :Analytic functions, harmonic functions, exponential, logarithmic and trigonometric functions, derivative and definite integral of functions.	Remember, apply, evaluate.
				Unit3 :Contours, contour integrals and examples	Remember, analyse, apply, evaluate.
				Unit4 :Antiderivative, Cauchy-Goursat theorem, Cauchy integral formula, Liouville's	Apply, analyse, evaluate, create.

				theorem and fundamental theorem of algebra.	

Sl. No.	Semester	Course name and Code	Course Outcome	Unit No. and Name	Bloom's Taxonomy Level
13.	Sem5(H)	Paper Name: **Linear Algebra** Paper Code:MAT-HC-5026	The course will enable the students to: i)Learn about the concept of linear independence of vectors over a field, dimension of a vector space. ii) Basic concepts of linear transformations, dimension theorem, matrix representation of LT and change of co-ordinate matrix. iii) Compute characteristic polynomial, eigen values, eigen vectors, eigen space. Apply basic diagonalization results. iv) Compute inner products and determine orthogonality on vector spaces.	Unit1 :Vector spaces, subspaces, null and column space, linear transformations, kernel, range, base, dimension, rank of vector space, change of basis.	Remember, understand, analyse, apply.
				Unit2 :Eigen vectors and eigen values of a matrix, the characteristics equation, diagonalization, eigen vectors of a LT, complex eigen values. Invariant subspaces and Caley Hamilton theorem.	Remember, apply, evaluate.

				Unit3 :Inner product, length, orthogonality, orthogonal sets and projections. Gram Schmidt process, inner product space. Diagonalization of symmetric matrices and spectral theorem.	Remember, understand,analyse, evaluate.

Sl. No.	**Semester**	**Course name and Code**	**Course Outcome**	**Unit No. and Name**	**Bloom's Taxonomy Level**
14.	Sem5(H)	Paper Name: **Number Theory** Paper Code:MAT-HE-5016	This course will enable the students to: i) Learn about some fascinating discoveries related to the properties of prime numbers, and some of the open problems in number theory, viz., Goldbach conjecture etc. ii) Know about number theoretic functions and modular arithmetic. iii) Solve linear, quadratic and system of linear congruence equations.	Unit1 :Linear Diophantine equation, prime counting function, Goldbach conjecture, linear congruence, residue, dhinese remainder theorem, Fermat's Little theorem, Wilson's theorem.	Remember, understand, analyse.
				Unit2 : Number theoretic functions, sum and number of divisors, totally multiplicative functions, definition and properties of Dirichlet product, Mobius inversion formula, the greatest integer function, Euler's phi function, Euler's theorem, residue.	Remember, understand, analyse.

Sl No	Semester	**Course name and Code**	Course Outcome	Unit No. and Name	Bloom's Taxonomy Level
15	Sem5(H)	Paper Name:	The course will enable	Unit1 : Variables,	Understand,

		Programming in C (Including Practical) Paper Code:MAT-HE-5066	the students to: i) Understand and apply the programming concepts of C which is important to mathematical investigation and problem solving. ii) Learn about structured data types in C and learn aboutdifferent applications iii)Represent the outputs of programs visually in terms of well formatted text and plots. iv) Practical will enable the students to create and evaluate different problems using C	constants, different terms related to C and it's library functions, structure of a C program, input/output functions and statements.	apply, create.
				Unit2 :Control statements, if-else statements, switch statement.	Understand, apply, create.
				Unit3 :Arrays and subscripted variables, function, function declaration, actual and formal arguments, function prototype, recursive function.	Understand, apply, analyse, create.

6th Semester (Honours)

Paper Name: **Riemann Integration and Metric spaces**

Paper Code: MAT-HC-6016

Sl No	**Semester**	**Course Name and Code**	**Course Outcome**	**Unit No. and Name**	**Bloom's Taxonomy Level**
16.	Sem-VI(M)	Paper Name: **Riemann Integration and Metric spaces** Paper Code: MAT-HC-6016	The course will enable the students to: i) Learn about some of the classes and properties of Riemann integrable functions, and the applications of the Fundamental theorems of integration. ii) Know about improper integrals including, beta and gamma functions. iii) Learn various natural and abstract	Unit1 :Riemann integration concepts and some related theorems. Concepts of improper integrals, Gamma functions.	Remember, understand, apply, analyse, evaluate.
				Unit2 :Metric spaces, definition, examples sequence and Cauchy sequence, open and closed ball, complete metric space, subspace, dense and separable space.	Remember, Understand, analyse.

			formulations of distance on the sets of usual or unusual entities. Become aware one such formulations leading to metric spaces. iv) Analyse how a theory advances from a particular frame to a general frame. v) Appreciate the mathematical understanding of various geometrical concepts, viz. Balls or connected sets etc. in an abstract setting.	Unit3. Continuous mappings, sequential criterion , uniform continuity, homeomorphism, contraction mapping, connectedness.	Remember, understand analyse.

Sl. No.	**Semester**	**Course name and Code**	**Course Outcome**	**Unit No. and Name**	**Bloom's Taxonomy Level**
17.	Sem VI(M)	Paper Name: **Partial Differential Equations (Including practical)** Paper Code:MAT-HC-6026	The course will enable the students to: i) Formulate, classify and transform first order PDEs into canonical form. ii) Learn about method of characteristics and separation of variables to solve first order PDE's. iii) Classify and solve second order linear PDEs. iv) Learn about Cauchy problem for second order PDE and homogeneous as well as nonhomogeneous waveequations.	Unit 1 : Introduction, classification, construction of first order PDE, Cauchy problem, Integral surface, Cauchy, Charpit and Jacobi's method of solution.	Remember, understand, analyse, evaluate.
				Unit2 :Canonical form of 1^{st} order PDE, Method of separation of variables	Understand, analyse, apply.
				Unit3 : Reduction to canonical forms, equations with constant co-efficients, general solution.	Understand, apply, evaluate.

Sl. No	Semester	**Course name and Code**	Course Outcome	Unit No. and Name	Bloom's Taxonomy Level
18.	SemVI (M)	Paper Name: **Hydromechanics** Paper Code: MAT-HE-6046	The course will enable the students to: i) Know about Pressure equation, rotating fluids. ii) Learn about Fluid pressure on plane surfaces, resultant pressure on curved surfaces, Gas law, mixture ofgases iii) Learn about the Eulerian and Lagrangian method. iv) Learn about equation of continuity, examples, acceleration of a fluid at a point	Unit1 :Pressure equation, equilibrium conditions, homogeneous and heterogeneous fluids, rotating fluid, pressure on curved and plane surfaces, centre of pressure, gas, mixture of gases, adiabatic expansion.	Remember, understand, analyse. Apply.
				Unit2 :Velocity , acceleration of fluid at a point, Lagrangean and Eulerian methods of study of fluid motion, equation of continuity and equation of motion of fluid.	Remember, understand, analyse, apply.

<u>COURSE OUTCOMES (Generic and Regular Course)</u>

Sl. No.	**Semester**	**Course name and Code**	**Course Outcome**	**Unit No. and Name**	**Bloom's Taxonomy Level**
1.	Sem 1 (R/G)	Paper Name: **Calculus** Paper Code: MAT-HG-1016/ MAT-	Completion of the course will enable the students to:	Unit1 : Graph of different functions	Understand, apply, analyse, create.

		RC-1016	i) Understand continuity and differentiability in terms of limit. ii) Describe asymptotic behavior in terms of limit involving infinity. iii) Understand importance of Mean value theorems. iv) Use derivative to explore behavior of a function and graphing it.	Unit2 : Limits and continuity of functions, properties of continuous functions, intermediate value theorem.	Remember, apply, evaluate.
				Unit3 : Differentiability, successive differentiation, Leibnitz theorem, higher order derivatives.	Understand, apply, evaluate.
				Unit4 :. Rolle's Theorem, Lagrange's mean value theorem, geometrical interpretation and application, Taylor;s theorem, Maclaurin's theorem,	Remember, apply, analyse, evaluate.
				Unit5 :Functions of two and more variables, level curves, partial differentiation.	Understand, apply, create.

Sl. No.	**Semester**	**Course name and Code**	**Course Outcome**	**Unit No. and Name**	**Bloom's Taxonomy Level**
2.	Sem 2 (R/G)	Paper Name: **Algebra** Paper Code: MAT-HG-2016/ MAT-RC-2016	The course will enable the students to: i) Learn to solve cubic and biquadratic equations. Also learn relation between the roots and coefficients and it's uses. ii) Employ De Moivre's theorem in a number of applications. iii) Recognize consistent and inconsistent system of	Unit1 :Theory of equations, De Moivre's Theorem, roots of complex numbers.	Remember, understand, apply, evaluate.
				Unit2 :Matrices, algebra, row echelon and reduced row echelon form, inverse, rank , solution of system of equations.	Understand, apply, evaluate.

			equations by row echelon form of matrix. Learn to find rank and inverse. iv) Learn basic ideas of group, subgroup, permutation group, cyclic group and preliminary knowledge of rings.	Unit3 :Groups and rings. Permutation and cyclic groups.	Remember, understand, analyse.

Sl. No.	Semester	Course name and Code	Course Outcome	Unit No. and Name	Bloom's Taxonomy Level
3.	Sem 2 (R/G)	Paper Name: **Differential Equations** Paper Code: MAT-HG-3016/ MAT-RC-3016	This course will enable the students to: i)Learn basics of differential equations and it's applications ii) learn to classify 1st order linear differential equations and different methods of solutions. iii) learn to solve 2nd order linear homogeneous as well as nonhomogeneous differential equations by different methods.	Unit1 :First order equations and methods of solutions, orthogonal and oblique trajectories, Wronskian and it's properties.	Remember, understand, analyse, apply.
				Unit2 :Solutions of 2nd order linear homogeneous and nonhomogeneous equations, Cauchy-Euler equations, simultaneous equations.	Remember, understand, analyse, apply.

Sl. No.	Semester	Course name and Code	Course Outcome	Unit No. and Name	Bloom's Taxonomy Level
4.	Sem 4(R/G)	Paper Name: **Real Analysis** Paper Code: MAT-HG-4016/ MAT-RC-4016	This course will enable the students to: i) understand many properties of real line R, including Archimedean and completeness properties. ii) learn to define sequences in terms of functions from R to a subset of R. iii) Recognize bounded, convergent, divergent, Cauchy and monotonic sequences and to calculate their limit superior, limit inferior and limits of bounded sequences.	Unit1 :Algebraic and order properties of real numbers, open and closed sets. Limits and continuity of a function and their properties, uniform continuity.	Remember, understand, analyse, apply.
				Unit2 :Sequences, convergent and Cauchy sequences, subsequences , limits of sequence. Infinite series and convergence.	Remember, understand, apply, evaluate.

			iv) learn to apply different tests to test convergence of infinite series.		

Sl. No.	Semester	Course name and Coder	Course Outcome	Unit No. and Name	Bloom's Taxonomy Level
5.	Sem 5 (R)	Paper Name: **Number Theory** Paper Code: MAT-RE-5016	This course will enable the students to: i) Learn about some fascinating discoveries related to the properties of prime numbers, and some of the open problems in number theory, viz., Goldbach conjecture etc. ii) Know about number theoretic functions and modular arithmetic. iii) Solve linear, quadratic and system of linear congruence equations.	Unit 1: Linear Diophantine equation, prime counting function, Goldbach conjecture, linear congruence, residue, Chinese remainder theorem, Fermat's Little theorem, Wilson's theorem.	Remember, understand, analyse, apply.
				Unit 2: Number theoretic functions, sum and number of divisors, totally multiplicative functions, definition and properties of Dirichlet product, Mobius inversion formula, the greatest integer function, Euler's phi function, Euler's theorem, residue.	Remember, understand, apply, evaluate.

Sl. No.	Semester	Course name and code	Course Outcome	Unit No. and Name	Bloom's Taxonomy Level
6.	Sem 6 (R)	Paper Name: **Numerical Analysis** Paper Code: MAT-RE-6016	This course will enable the students to: i) Learn some numerical methods to find the zeroes of nonlinear functions of a single variable and solution of a system of linear equations, up to a certain given level of precision. ii) Know about iterative and non-iterative methods to	Unit 1: Gaussian elimination method (with row pivoting), Gauss-Jordan method; Iterative methods**:** Jacobi method, Gauss-Seidel method; Interpolation**:** Lagrange form, Newton form, Finite difference operators, Gregory-Newton	Remember, understand, analyse, apply.

			solve system of linear equations. iii) Know interpolation techniques to compute the values for a tabulated function at points not in the table. iv) Integrate a definite integral that cannot be done analytically. v) Find numerical differentiation of functional values. vi) Solve differential equations that cannot be solved by analytical methods.	forward and backward difference interpolations, Piecewise polynomial interpolation (Linear and Quadratic).	
				Unit 2: Numerical differentiation**:** First and second order derivatives; Numerical integration**:** Trapezoid rule, Simpson's rule; Extrapolation methods**:** Richardson extrapolation, Romberg integration; Ordinary differential equation**:** Euler's method, Modified Euler's methods **(**Heun and Mid-point).	Remember, understand, apply, evaluate.