B.Sc in Mathematics (CBCS)

Program Outcomes (POs) of B.Sc course

After completion of B.Sc course, the students are expected to:

i. Gain knowledge about the scientific and mathematical facts related to various subjects in pure and applied sciences
ii. Understand the basic concepts, fundamental principles, and the scientific theories related to various scientific phenomena and their occurrences as well as significances in everyday life
iii. Develop the skill of observations and the ability to draw logical inferences from the scientific facts, figures, data and experiments
iv. Acquire the skills in handling scientific instruments, mathematical software, planning and performing in laboratory experiments
v. Acquire the ability to think creatively to propose novel ideas useful to the society at large
vi. Realize that the interdisciplinary approach will help in providing better solutions and create new ideas for the sustainable development of the world and the mankind
vii. Imbibe ethical, moral and social values in personal and social life leading to highly cultured and civilized personality
viii. Develop various communication skills such as reading, listening, speaking, etc., which will help in expressing ideas and views clearly and effectively
ix. Develop flair by participating in various social and cultural activities voluntarily, in order to spread knowledge, create awareness about the social evils, blind faith, etc.
x. Realize that pursuit of knowledge is a lifelong activity and in combination with untiring efforts and positive attitude and other necessary qualities lead towards a successful life.

Program Specific Outcomes (PSOs) of B.Sc Mathematics

After completion of B.Sc Mathematics course,

i. The students will get an introduction to the basic tools of calculus which are helpful in understanding their applications in the real-world problems.

ii. The students will learn the basic tools of set theory, functions, induction principle, theoryof equations, complex numbers, number theory, matrices and determinant to understand their connection with the real-world problems.

iii. The students will develop a deep and rigorous understanding of real line and of defining terms to prove the results about convergence and divergence of sequences and series of real numbers. These concepts have wide range of applications in real life scenario.

iv. The students will be introduced to the exciting world of differential equations, mathematical modeling and their applications.

v. The students will learn about the fundamental theory of groups and their homomorphisms,Symmetric groups and group of symmetries, and Fermat's Little theorem as a consequence of the Lagrange's theorem on finite groups.

vi. The students will be familiar with the basic tools of two-dimensional coordinates systems, general conics, and three-dimensional coordinate systems.

vii. The students will get an introduction to the fundamental theory of rings and their corresponding homomorphisms. Also they will be introduced to the basic concepts of ring of polynomials and irreducibility tests for polynomials over ring of integers.

viii. The students will get an introduction to the fundamental theory of vector spaces. They will be emphasized on the application of techniques using the adjoint of a linear operator and their properties to least squares approximation and minimal solutions to systems of

linear equations.

ix. The students will get an introduction to the basic ideas of analysis for complex functionswith visualization through relevant practicals. They will get acquainted with Cauchy's theorem, series expansions and calculation of residues.

x. The students will be able to solve partial differential equations and use them in solving some physical problems.

xi. The students will be able to carry out the hands-on sessions in Computer lab using various computer algebra system (CAS) software giving them a deep conceptual understanding of the above tools to widen the horizon of students' self-experience.

xii. Students will develop the ability to think critically, logically and analyticallyand hence use mathematical reasoning in everyday life.

xiii. Students will be made acquainted to a number of interesting and useful ideas in preparations for a number of mathematics careers in education, research, government sector, business sector and industry.

xiv. Students will understand and apply the programming concepts of C.

xv. Students will learn to create and typeset a LaTeX document.

xvi. Students will learn various mathematical models such as Growth model, Decay model etc. and will able to solve these models numerically using CAS.

xvii. Students will know about methods to solve systems of linear equations and Interpolation techniques using CAS.

xviii. Students will develop their communication skills and develop the confidence and art of speaking/delivering on a public platform.

Course Outcomes of CBCS course

1st Semester

Paper	Course	Course Outcome	Bloom's taxonomy level
MAT-HC-1016	Calculus (including practical)	After the completion of this course, students will be able to: • Learn first and second derivative tests for relative extremum and apply the knowledge in problems in business, economics and life sciences. • Sketch curves in a plane using its mathematical properties in different coordinatesystems. • Compute area of surfaces of revolution and the volume of solids by integrating overcross-sectional areas. • Understand the calculus of vector functions and its use to develop the basic principles ofplanetary motion.	• Remember, • Understand • Apply • Analyze,
MAT-HC-1026	Algebra	After the completion of the course, students will be able to: • Employ De Moivre's theorem in a number of applications to solve numerical problems. • Learn about equivalent classes and cardinality of a set. • Use modular arithmetic and basic properties of congruences. • Recognize consistent and inconsistent systems of linear equations by the row echelonform of the augmented matrix. • Learn about the solution sets of linear systems using matrix method and Cramer's rule.	• Remember, • Understand • Apply • Analyze, • Evaluate
MAT-HG-1016/ MAT-RC-1016	Calculus	After the completion of the course, students will be able to: • Understand continuity and differentiability in terms of limits. • Describe asymptotic behavior in terms of limits involving infinity. • Use derivatives to explore the behavior of a given function, locate and classify itsextrema, and graph the function. • Understand the importance of the Mean value theorem.	• Remember, • Understand • Apply • Analyze, • Evaluate

2nd Semester

Paper	Course	Course Outcome	Bloom's taxonomy level
MAT-HC-2016	Real Analysis	Upon successful completion of this course it is intended that a student will be able to: • Understand many properties of the real line *R*, including completeness and Archimedean properties. • Learn to define sequences in terms of functions from *N* to a subset of *R*. • Recognize bounded, convergent, divergent, Cauchy and monotonic sequences and to calculate their limit superior, limit inferior, and the limit of a bounded sequence. • Apply the ratio, root, alternating series and limit comparison tests for convergence and absolute convergence of an infinite series of real numbers.	• Remember, • Understand • Apply • Analyze, • Evaluate
MAT-HC-2026	Differential Equations(including practical)	After the completion of the course, students will be able to: • Learn the basics of differential equations and mathematical modeling. • Formulate differential equations for various mathematical models. • Solve first order nonlinear differential equations and linear differential equations of • higher order using various techniques. • Apply these techniques to solve and analyze various mathematical models.	• Remember, • Understand • Apply • Analyze, • Evaluate
MAT-HG-2016/MAT-RC-2016	Algebra	Upon successful completion of this course it is intended that a student will be able to: • Learn how to solve the cubic and biquadratic equations, also learn about symmetric functions of the roots for cubic and biquadratic. • Employ De Moivre's theorem in a number of applications to solve numerical problems. • Recognize consistent and inconsistent systems of linear equations by the row echelon form of the augmented matrix, finding inverse of a matrix with the help of Cayley- Hamilton theorem. • Recognize the mathematical objects that are groups, and classify them as abelian, cyclic and permutation groups,	• Remember, • Understand • Apply • Analyze

		rings etc. • Learn about the concept of linear independence of vectors over a field, and the dimensionof a vector space.	

3rd Semester

Paper	Course	Course Outcome	Bloom's taxonomy level
MAT-HC-3016	Theory of Real Functions	After the completion of the course, students will be able to: • Have a rigorous understanding of the concept of limit of a function. • Learn about continuity and uniform continuity of functions defined on intervals. • Understand geometrical properties of continuous functions on closed and boundedintervals. • Learn extensively about the concept of differentiability using limits, leading to a better understanding for applications. • Know about applications of Mean value theorems and Taylor's theorem.	• Remember, • Understand • Apply • Analyze, • Evaluate
MAT-HC-3026	Group Theory - I	After the completion of the course, students will be able to: • Recognize the mathematical objects that are groups, and classify them as abelian,cyclic and permutation groups, etc. • Link the fundamental concepts of groups and symmetrical figures. • Analyze the subgroups of cyclic groups and classify subgroups of cyclic groups. • Explain the significance of the notion of cosets, normal subgroups and factorgroups. • Learn about Lagrange's theorem and Fermat's Little theorem. • Know about group homomorphisms and group isomorphisms.	• Remember, • Understand • Apply • Analyze
MAT-HC-3036	Analytical Geometry	After the completion of the course, students will be able to: • Learn conic sections and transform coordinate systems. • Learn polar equation of a conic, tangent, normal and properties. • Have a rigorous understanding of the concept of three dimensional coordinates.	• Remember, • Understand • Apply • Analyze, • Evaluate
MAT-	Differential	After the completion of the course, students	• Remember,

HG-3016/MAT-RC-3016	Equations	will be able to: • Learn the basics of differential equations and mathematical modeling. • Solve first order nonlinear differential equations and linear differential equations of higher order using various techniques	• Understand • Apply
MAT-SE-3014	Computer Algebra Systems and Related Software	This course will enable the students to: • Use of software; Mathematica/MATLAB/Maxima/Maple etc. as a calculator, for plotting functions and animations. • Use of CAS for various applications of matrices such as solving systems of equations andfinding eigenvalues and eigenvectors. • Understand the use of the statistical software R as a calculator and learn to read and get datainto R. • Learn the use of R in summary calculation, pictorial representation of data and exploring relationships between data. • Analyze, test, and interpret technical arguments on the basis of geometry.	• Remember, • Understand • Apply

4th Semester

Paper	Course	Course Outcome	Bloom's taxonomy level
MAT-HC-4016	Multivariate Calculus	After the completion of the course, students will be able to: • Learn the conceptual variations when advancing in calculus from one variable to • multivariable discussion. • Understand the maximization and minimization of multivariable functions subject to the given constraints. • Learn about inter-relationship amongst the line integral, double and triple integralformulations. • Familiarize with Green's, Stokes' and Gauss divergence theorems.	• Remember, • Understand • Apply • Analyze, • Evaluate
MAT-HC-4026	Numerical Methods (including practical)	Upon successful completion of this course it is intended that a student will be able to: • Learn some numerical methods to find the zeros of nonlinear functions of a single variable and solution of a system of linear equations, up to a certain given level of precision.	• Remember, • Understand • Apply • Analyze, • Evaluate

		• Know about methods to solve systems of linear equations, such as False position method, Fixed point iteration method, Newton's method, Secant method and LU decomposition. • Interpolation techniques to compute the values for a tabulated function at points not inthe table. • Applications of numerical differentiation and integration to convert differential equations into difference equations for numerical solutions.	
MAT-HC-4036	Ring Theory	After the completion of the course, students will be able to: • Appreciate the significance of unique factorization in rings and integral domains. • Learn about the fundamental concept of rings, integral domains and fields. • Know about ring homomorphism and isomorphism theorems of rings. • Learn about the polynomial rings over commutative rings, integral domains, Euclideandomains, and UFD.	• Remember, • Understand • Apply • Analyze
MAT-HG-4016/ MAT-RC-4016	Real Analysis	Upon successful completion of this course it is intended that a student will be able to: • Understand many properties of the real line R, including completeness and Archimedeanproperties. • Learn to define sequences in terms of functions from R to a subset of R. • Recognize bounded, convergent, divergent, Cauchy and monotonic sequences and tocalculate their limit superior, limit inferior, and the limit of a bounded sequence. • Apply the ratio, root, alternating series and limit comparison tests for convergence andabsolute convergence of an infinite series of real numbers.	• Remember, • Understand • Apply
MAT-SE-4024	LaTeX and HTML	After the completion of the course, students will be able to learn: • Create and typeset a LaTeX document. • Typeset a mathematical document using LaTex. • Learn about pictures and graphics in LaTex. • Create beamer presentations.	• Remember, • Understand • Apply

5th Semester

Paper	Course	Course Outcome	Bloom's taxonomy level
MAT-HC-5016	Complex Analysis (including practical)	Upon completion of the course, students will be able to: • Learn the significance of differentiability of complex functions leading to the understanding of Cauchy–Riemann equations. • Learn some elementary functions and can evaluate the contour integrals. • Understand the role of Cauchy–Goursat theorem and the Cauchy integral formula. • Expand some simple functions as their Taylor and Laurent series, classify the nature ofsingularities, find residues and apply Cauchy Residue theorem to evaluate integrals.	• Remember, • Understand • Apply • Analyze • Evaluate
MAT-HC-5026	Linear Algebra	After the completion of the course, students will be able to: • Learn about the concept of linear independence of vectors over a field, and thedimension of a vector space. • Basic concepts of linear transformations, dimension theorem, matrix representation of a linear transformation, and the change of coordinate matrix. • Compute the characteristic polynomial, eigenvalues, eigenvectors, and eigenspaces, as well as the geometric and the algebraic multiplicities of an eigenvalue and apply the basic diagonalization result. • Compute inner products and determine orthogonality on vector spaces, including Gram-Schmidt orthogonalization to obtain orthonormal basis. • Find the adjoint, normal, unitary and orthogonal operators.	• Remember, • Understand • Apply • Analyze • Evaluate

MAT-HE-5016	Number Theory	After the completion of the course, students will be able to: • Learn about some fascinating discoveries related to the properties of prime numbers, and someof the open problems in number theory, viz., Goldbach conjecture etc. • Know about number theoretic functions and modular arithmetic. • Solve linear, quadratic and system of linear congruence equations.	• Remember, • Understand • Apply • Analyze, • Evaluate
MAT-HE-5066	Programming in C (including practical)	After completion of this course, students will be able to: • Understand and apply the programming concepts of C which is important to mathematical investigation and problem solving. • Learn about structured data-types in C and learn about applications in factorization of an integer and understanding Cartesian geometry and Pythagorean triples. • Use of containers and templates in various applications in algebra. • Use mathematical libraries for computational objectives. • Represent the outputs of programs visually in terms of well formatted text and plots.	• Remember, • Understand • Apply
MAT-RE-5016	Number Theory	After completion of this course, students will be able to: • Learn about some fascinating discoveries related to the properties of prime numbers, and someof the open problems in number theory, viz., Goldbach conjecture etc. • Know about number theoretic functions and modular arithmetic. • Solve linear, quadratic and system of linear congruence equations.	• Remember, • Understand • Apply • Analyze, • Evaluate

6th Semester

Paper	Course	Course Outcome	Bloom's taxonomy level
MAT-HC-6016	Riemann Integration and Metric spaces	After the completion of the course, students will be able to: • Learn about some of the classes and properties of Riemann integrable functions, and the applications of the Fundamental theorems of integration. • Know about improper integrals including, beta and gamma functions. • Learn various natural and abstract formulations of distance on the sets of usual or unusual entities. Become aware one such formulations leading to metric spaces. • Analyze how a theory advances from a particular frame to a general frame. • Appreciate the mathematical understanding of various geometrical concepts, viz. Balls or connected sets etc. in an abstract setting. • Know about Banach fixed point theorem, whose far-reaching consequences have resulted into an independent branch of study in analysis, known as fixed point theory. • Learn about the two important topological properties, namely connectedness and compactness of metric spaces.	• Remember, • Understand • Apply • Analyze, • Evaluate
MAT-HC-6026	Partial Differential Equations (including practical)	Upon Completion of the course students will be able to- • Formulate, classify and transform first order PDEs into canonical form. • Learn about methods of characteristics and separation of variables to solve first order PDEs. • Classify and solve second order linear PDEs. • Learn about Cauchy problem for second order PDE and homogeneous as well as nonhomogeneous wave equations. • Apply the method of separation of variables for solving second order PDEs.	• Remember, • Understand • Apply • Analyze

MAT-HE-6046	Hydromechanics	Upon completion of this course, students will be able to: • Know about Pressure equation, rotating fluids. • Learn about Fluid pressure on plane surfaces, resultant pressure on curved surfaces, Gas law,mixture of gases. • Learn about the Eulerian and Lagrangian method. • Learn about equation of continuity, examples, acceleration of a fluid at a point.	• Remember, • Understand • Apply • Analyze
MAT-HE-6066	Group Theory II	Upon completion of this course, students will be able to: • Learn about automorphisms for constructing new groups from the given group. • Learn about the fact that external direct product applies to data security and electric circuits. • Understand fundamental theorem of finite abelian groups. • Be familiar with group actions and conjugacy in S_n . • Understand Sylow theorems and their applications in checking non-simplicity.	• Remember, • Understand • Apply • Analyze, • Evaluate
MAT-RE-6016	Numerical Analysis	Upon completion of this course, students will be able to: • Learn some numerical methods to find the zeroes of nonlinear functions of a single variable andsolution of a system of linear equations, up to a certain given level of precision. • Know about iterative and non-iterative methods to solve system of linear equations. • Know interpolation techniques to compute the values for a tabulated function at points not in thetable. • Integrate a definite integral that cannot be done analytically. • Find numerical differentiation of functional values. • Solve differential equations that cannot be solved by analytical methods.	• Remember, • Understand • Apply • Analyze, • Evaluate