

PROGRAM OBJECTIVES:

Students who choose BMATH(H) Program, develop the ability to think critically, logically and analytically and hence use mathematical reasoning in everyday life. Pursuing a degree in mathematics will introduce the students 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. The program covers the full range of mathematics. The course lays a structured foundation of Calculus, Real and Complex analysis, Algebra, Differential equations and Mathematical modelling, Number theory, Graph theory, Mechanics and C-programming. An exceptionally broad range of topics covering Pure and Applied Mathematics: Linear Algebra, Metric spaces, Statistics, Linear Programming and Applications, Mathematical Finance, and Bio-Mathematics cater to varied interests and ambitions. Also, to carry out the hand on sessions in Computer lab using various CAS software to have a deep conceptual understanding of the above tools to widen the horizon of students self experience.

PROGRAM LEARNING OUTCOMES:

The completion of the BMATH(H) Program shall enable a student to:

- **PO1:** Communicate mathematics effectively by oral, written, computational and graphic means.
- **PO2:** Create mathematical ideas from basic axioms.
- **PO3:** Gauge the hypothesis, theories, techniques and proofs provisionally.

- **PO3:** Utilize mathematics to solve theoretical and applied problems by critical understanding, analysis and synthesis.
- **PO4:** Identify applications of mathematics in other disciplines and in the real world, leading to enhancement of career prospects in a plethora of fields.
- **PO5:** Appreciate the requirement of lifelong learning through continued education and research.

PROGRAM SPECIFIC OUTCOMES:

- **PSO1:** A student should be able to recall basic facts about mathematics and should be able to display knowledge of conventions such as notations, terminology.
- **PSO2:** A student should get adequate exposure to global and local concerns that explore them many aspects of mathematical sciences.
- **PSO3:** Student is equipped with mathematical modeling ability, problem solving skills, creative talent and power of communication necessary for various kinds of employment.
- **PSO4:** Student should be able to apply their skills and knowledge that is translate information presented verbally into mathematical form, select and use appropriate mathematical formulae or techniques in order to process the information and draw the relevant conclusion
- **PSO5:** Enabling students to develop a positive attitude towards mathematics as an interesting and valuable subject of study.

SEMESTER-I

Paper code: MAT-HC-1016

Paper Name: Calculus (including practical)

Course Objectives:

The primary objective of this course is to introduce the basic tools of calculus and geometric properties of different conic sections which are helpful in understanding their applications in planetary motion, design of telescope and to the real-world problems. Also, to carry out the hand on sessions in computer lab to have a deep conceptual understanding of the above tools to widen the horizon of students' self-experience.

Course Learning Outcomes:

This course will enable the students to:

- Learn first and second derivative tests for relative extrema and apply the knowledge in problems in business, economics and life sciences.
- Sketch curves in a plane using its mathematical properties in the different coordinate systems of reference.
- Compute area of surfaces of revolution and the volume of solids by integrating over cross-sectional areas.
- Understand the calculus of vector functions and its use to develop the basic principles of planetary motion.

Paper Code: MAT-HC-1026

Paper Name: Algebra

Course Objectives:

The primary objective of this course is to introduce the basic tools of set theory, functions, induction principle, theory of equations, complex numbers, number theory, matrices and determinant understand their connection with the real-world problems.

Course Learning Outcomes:

This course will enable the students 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 echelon form of the augmented matrix.
- Learn about the solution sets of linear systems using matrix method and Cramer's rule.

Paper Code: MAT-HG-1016/ MAT-RC-1016

Paper Name: Calculus

Course Objectives:

Calculus is referred as 'Mathematics of change' and is concerned with describing the precise way in which changes in one variable relate to the changes in another. Through this course, students can understand the quantitative change in the behaviour of the variables and apply them on the problems related to the environment.

Course Learning Outcomes:

The students who take this course 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, locating and classifying its extrema, and graphing the function.
- Understand the importance of mean value theorems.

Semester-II

Paper Code: MAT-HC-2016

Paper Name: REAL ANALYSIS

Course Objectives:

The course will develop a deep and rigorous understanding of real line \mathbb{R} 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.

Course Learning Outcomes:

This course will enable the students to:

- Understand many properties of the real line \mathbb{R} , including completeness and Archimedean properties.
- Learn to define sequences in terms of functions from \mathbb{N} to a subset of \mathbb{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.

Paper Code: MAT-HC-2026:

Paper Name: DIFFERENTIAL EQUATIONS (Including Practical)

Course Objectives:

The main objective of this course is to introduce the students to the exciting world of differential equations, mathematical modeling and their applications.

Course Learning Outcomes:

The course will enable the students to:

- Learn basics of differential equations and mathematical modeling.
- Formulate differential equations for various mathematical models.
- Solve first order non-linear differential equations and linear differential equations of higher order using various techniques.

- Apply these techniques to solve and analyze various mathematical models.

Paper Code: MAT-HG-2016/MAT-RC-2016:

Paper Name: Algebra

Course Objectives:

The primary objective of this course is to introduce the basic tools of theory of equations, complex numbers, number theory, matrices, determinant, along with algebraic structures like group, ring and vector space to understand their connection with the real-world problems.

Course Learning Outcomes: This course will enable the students 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.
- Recognize the mathematical objects that are groups, and classify them as abelian, cyclic and permutation groups, ring etc.

SEMESTER-III

Paper code: MAT-HC-3016:

Paper Name: THEORY OF REAL FUNCTIONS

Course Objectives:

It is a basic course on the study of real valued functions that would develop an analytical ability to have a more matured perspective of the key concepts of calculus, namely; limits, continuity, differentiability and their applications.

Course Learning Outcomes:

This course will enable the students 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 bounded intervals.
- 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

Paper Code: MAT-HC-3026

Paper Name: Group Theory-I

Course Objectives:

The objective of the course is to introduce the fundamental theory of groups and their homomorphisms. Symmetric groups and group of symmetries are also studied

in detail. Fermat's Little theorem is studied as a consequence of the Lagrange's theorem on finite groups.

Course Learning Outcomes: The course will enable the students 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 factor groups.
- Learn about Lagrange's theorem and Fermat's Little theorem.
- Know about group homomorphisms and group isomorphisms.

Paper Code: MAT-HC-3036

Paper Name: Analytical Geometry

Course Objectives:

The primary objective of this course is to introduce the basic tools of two-dimensional coordinates systems, general conics, and three-dimensional coordinate systems.

Course Learning Outcomes:

This course will enable the students to:

- Learn conic sections and transform co-ordinate systems.

- Learn polar equation of a conic, tangent, normal and properties.
- Have a rigorous understanding of the concept of three-dimensional coordinates systems.

SKILL ENHANCEMENT COURSES

Paper Code: MAT-SE-3014:

Paper Name: Computer Algebra Systems and Related Software

Course Objectives:

This course aims at familiarizing students with the usage of mathematical software (Mathematica/MATLAB/Maxima/Maple) and the statistical software R. The basic emphasis is on plotting and working with matrices using CAS. Data entry and summary commands will be studied in R. Graphical representation of data shall also be explored.

Course Learning Outcomes:

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 system of equations and finding eigenvalues and eigen vectors.
- Understand the use of the statistical software R as calculator and learn to read and get data into R.
- Learn the use of R in summary calculation, pictorial representation of data and exploring relationship between data.

- Analyze, test, and interpret technical arguments on the basis of geometry

Paper Code: MAT-HG-3016/MAT-RC-3016

Paper Name: Differential Equations

Course Objectives:

The main objective of this course is to introduce the students to the exciting world of ordinary differential equations, mathematical modeling and their applications.

Course Learning Out comes:

The course will enable the students to:

- Learn basics of differential equations and mathematical modelling.
- Solve first order non-linear differential equations and linear differential equations of higher order using various techniques.

SEMESTER-IV

Paper Code: MAT-HC-4016

Paper Name: Multivariate Calculus

Course Objectives:

To understand the extension of the studies of single variable differential and integral calculus to functions of two or more independent variables. Also, the emphasis will be on the use of Computer Algebra Systems by which these concepts may be analyzed and visualized to have a better understanding. This course will

facilitate to become aware of applications of multivariable calculus tools in physics, economics, optimization, and understanding the architecture of curves and surfaces in plane and space etc.

Course Learning Outcomes:

This course will enable the students 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 on variables.
- Learn about inter-relationship amongst the line integral, double and triple integral formulations.
- Familiarize with Green's, Stokes' and Gauss divergence theorems

Paper Code: MAT-HC-4026

Paper Name: Numerical Methods (including practical)

Course Objectives:

To comprehend various computational techniques to find approximate value for possible root(s) of non-algebraic equations, to find the approximate solutions of system of linear equations and ordinary differential equations. Also, the use of Computer Algebra System (CAS) by which the numerical problems can be solved both numerically and analytically, and to enhance the problem solving skills.

Course Learning Outcomes:

The course will enable the students to:

- 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.
- Know about methods to solve system of linear equations, such as False position method, Fixed point iteration method, Newton's method, Secant method, LU decomposition.
- Interpolation techniques to compute the values for a tabulated function at points not in the table.
- Applications of numerical differentiation and integration to convert differential equations into difference equations for numerical solutions.

Paper Code: MAT-HC-4036

Paper Name: Ring Theory

Course Objectives:

The objective of this course is to introduce the fundamental theory of rings and their corresponding homomorphisms. Also introduces the basic concepts of ring of polynomials and irreducibility tests for polynomials over ring of integers.

Courses Learning Outcomes:

On completion of this course, the student 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 homomorphisms and isomorphisms theorems of rings.
- learn about the polynomial rings over commutative rings, integral domains, Euclidean domains, and UFD

Paper Code: MAT-SE-4024

Paper Name: LaTeX and HTML (practical)

Course Objectives:

The purpose of this course is to acquaint students with the latest type setting skills, which shall enable them to prepare high quality typesetting, beamer presentation and webpages

Course Learning Outcomes:

After studying this course the student will be able to:

- Create and typeset a LaTeX document.
- Typeset a mathematical document using LaTeX.
- Learn about pictures and graphics in LaTeX.
- Create beamer presentations.
- Create web page using HTML.

Paper Code: MAT-HG-4016/ MAT-RC-4016

Paper Name: Real Analysis

Course Objectives:

The course will develop a deep and rigorous understanding of real line \mathbb{R} 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.

Course Learning Outcomes:

This course will enable the students to:

- Understand many properties of the real line \mathbb{R} , including completeness and Archimedean properties.
- Learn to define sequences in terms of functions from \mathbb{R} to a subset of \mathbb{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 and limit comparison tests for convergence and absolute convergence of an infinite series of real numbers.

SEMESTER-V

Paper Code: MAT-HC-5016

Paper Name: Complex Analysis (including practical)

Course Learning Outcomes:

The completion of the course will enable the students to:

- Learn the significance of differentiability of complex functions leading to the understanding of Cauchy–Riemann equations.
- Learn some elementary functions and 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 of singularities, find residues and apply Cauchy Residue theorem to evaluate integrals.

Paper Code: MAT-HC-5026

Paper Name: Linear Algebra

Course Objectives:

The objective of this course is to introduce the fundamental theory of vector spaces, also emphasizes 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.

Course Learning Outcomes:

The course will enable the students to:

- Learn about the concept of linear independence of vectors over a field, and the dimension 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.

DSE-1

Paper Code: MAT-HE-5016:

Paper Name: Number Theory

Course Objectives:

In number theory there are challenging open problems which are comprehensible at undergraduate level, this course is intended to build a micro aptitude of understanding aesthetic aspect of mathematical instructions and gear young minds to ponder upon such problems.

Course Learning Outcomes:

This course will enable the students to:

- 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.
- Know about number theoretic functions and modular arithmetic.

- Solve linear, quadratic and system of linear congruence equations.

Paper Code: MAT-HE-5026

Paper Name: Mechanics

Course Objectives:

The course aims at understanding the various concepts of physical quantities and their late defects on different bodies using mathematical techniques. It emphasizes knowledge building for applying mathematics in physical world.

Course Learning Outcomes:

The course will enable the students to:

- Know about the concepts in statics such as moments, couples, equilibrium in both two and three dimensions.
- Understand the theory behind friction and center of gravity.
- Know about conservation of mechanical energy and work-energy equations.
- Learn about translational and rotational motion of rigid bodies.

Paper Code: MAT-HE-5066:

Paper name: Programming in C (including practical)

Course Objectives:

This course introduces C programming in the idiom and context of mathematics and imparts a starting orientation using available mathematical libraries, and their applications.

Course Learning Outcomes:

After completion of this paper, student 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.
- In practical students learn about the roots of a quadratic equation, solution of an equation using N-R algorithm, $\sin(x)$, $\cos(x)$ with the help of functions.

SEMESTER-VI

Paper Code: MAT-HC-6016

Paper Name: Riemann Integration and Metric spaces

Course Objectives:

To understand the integration of bounded functions on a closed and bounded interval and its extension to the cases where either the interval of integration is infinite, or the integrand has infinite limits at a finite number of points on the interval of integration. Up to this stage, students do study the concepts of analysis which evidently rely on the notion of distance. In this course, the objective is to develop the usual idea of distance into an abstract form on any set of objects, maintaining its inherent characteristics, and the resulting consequences.

Course Learning Outcomes:

The course will enable the students 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.
- Analyse 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.

Paper Code: MAT-HC-6026

Paper Name: Partial Differential Equations (including practical)

Course Objectives:

The main objectives of this course are to teach students to form and solve partial differential equations and use them in solving some physical problems.

Course Learning Outcomes:

The course will enable the students to:

- Formulate, classify and transform first order PDEs into canonical form.
- Learn about method of characteristics and separation of variables to solve first order PDE's.
- Classify and solve second order linear PDEs.
- Learn about Cauchy problem for second order PDE and homogeneous and non-homogeneous wave equations.
- Apply the method of separation of variables for solving many well-known second order PDEs.

Paper Code: MAT-HE-6046

Paper Name: Hydromechanics

Course Objectives:

The main objectives of this course are to teach students about fluid pressure on plane surfaces, curved surfaces and Gas law. Also introduce velocity of a fluid at a

point, Eulerian and Lagrangian method, velocity potential and acceleration of a fluid at a point.

Course Learning Outcomes:

The course will enable the students 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