DEPARTMENT OF MATHEMATICS

Course	Outcomes
MAT-HC-1016: Calculus (including practical)	**This course will enable the students 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 coordinate systems.** • **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.**
MAT-HC-1026:Algebra	**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.**
MAT-HG-1016/ MAT-RC-1016:Calculus	**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.**
MAT-HG-1026: Analytic Geometry	**This course will enable the students to:** • **Transform coordinate systems, conic sections.** • **Learn polar equation of a conic, tangent, normal and related properties.** • **Have a rigorous understanding of the concept of three dimensional coordinate systems.** • **Understand geometrical properties of dot product, cross product of vectors.**
MAT-HC-2016: Real Analysis	**This course will enable the students 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.**
MAT-HC-2026: Differential Equations(including practical)	**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.**
MAT-HG-2016/MAT-RC-2016: Algebra	**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 with the help of Cayley-Hamilton theorem** • **Recognize the mathematical objects that are groups, and classify them as abelian, cyclic and permutation groups, ring etc.** • **Learn about the concept of linear independence of vectors over a field, and the dimension of a vector space.**
MAT-HG-2026: Discrete Mathematics	**After the course, the student will be able to:** • **Understand the notion of ordered sets and maps between ordered sets.** • **Learn about lattices, modular and distributive lattices, sublattices and homomorphisms between lattices.** • **Become familiar with Boolean algebra, Boolean homomorphism, Karnaugh diagrams, switching circuits and their applications.**
MAT-HC-3016: Theory of Real Functions	**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.**
MAT-HC-3026: Group Theory - I	**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.**
MAT-HC-3036: Analytical Geometry	**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.**
MAT-SE-3014: Computer Algebra Systems and Related Software	**This course will enable the students to:** • **Use of softwares; 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 eigenvectors.** • **Understand the use of the statistical software R as calculator and learn to read and get data into R.**
MAT-SE-3024: Combinatorics and Graph Theory	**This course will enable the students to:** • **Learn about the counting principles, permutations and combinations, Pigeonhole principle** • **Understand the basics of graph theory and learn about social networks, Eulerian and Hamiltonian graphs, diagram tracing puzzles and Knight's tour problem.**
MAT-HG-3016/MAT-RC-3016: Differential Equations	**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.**
MAT-HG-3026: Linear Programming	**This course will enable the students to:** • **Learn about the graphical solution of linear programming problem with two variables.** • **Learn about the relation between basic feasible solutions and extreme points.** • **Understand the theory of the simplex method used to solve linear programming problems.** • **Learn about two-phase and big-M methods to deal with problems involving artificial variables.** • **Learn about the relationships between the primal and dual problems.** • **Solve transportation and assignment problems.** • **Apply linear programming method to solve two-person zero-sum game problems.**
MAT-HC-4016: Multivariate Calculus	**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** • **Learn about inter-relationship amongst the line integral, double and triple integral formulations.** • **Familiarize with Green's, Stokes' and Gauss divergence theorems.**
MAT-HC-4026: Numerical Methods (including practical)	**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 and 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.**
MAT-HC-4036: Ring Theory	**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 homomorphism and isomorphism theorems of rings.** • **Learn about the polynomial rings over commutative rings, integral domains, Euclidean domains, and UFD.**
MAT-SE-4014: R Programming	**This course will enable the students to:** • **Become familiar with R syntax and to use R as a calculator.** • **Understand the concepts of objects, vectors and data types.** • **Know about summary commands and summary table in R.** • **Visualize distribution of data in R and learn about normality test.** • **Plot various graphs and charts using R.**
MAT-SE-4024: LaTeX and HTML (practical)	**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.**
MAT-HG-4016/ MAT-RC-4016: Real Analysis	**This course will enable the students to:** • **Understand many properties of the real line R, including completeness and Archimedean properties.** • **Learn to define sequences in terms of functions from R 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.**
MAT-HG-4026: Numerical Analysis	**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 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 the table.** • **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.
MAT-HC-5016: Complex Analysis (including practical)	**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 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 of singularities, find residues and apply Cauchy Residue theorem to evaluate integrals.**
MAT-HC-5026: Linear Algebra	**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.**
MAT-HE-5016: Number Theory	**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.**
MAT-HE-5026: Mechanics	**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.**
MAT-HE-5036: Probability and Statistics	**This course will enable the students to:** • **Learn about probability density and moment generating functions.** • **Know about various univariate distributions such as Bernoulli, Binomial, Poisson, gamma and exponential distributions.** • **Learn about distributions to study the joint behavior of two random variables.** • **Measure the scale of association between two variables, and to establish a formulation helping to predict one variable in terms of the other, i.e., correlation and linear regression.** • **Understand central limit theorem, which helps to understand the remarkable fact that: the empirical frequencies of so many natural populations, exhibit a bell-shaped curve, i.e., a normal distribution.**
MAT-HE-5046: Linear Programming	**This course will enable the students to:** • **Learn about the graphical solution of linear programming problem with two variables.** • **Learn about the relation between basic feasible solutions and extreme points.** • **Understand the theory of the simplex method used to solve linear programming problems.** • **Learn about two-phase and big-M methods to deal with problems involving artificial variables.** • **Learn about the relationships between the primal and dual problems.** • **Solve transportation and assignment problems.** • **Apply linear programming method to solve two-person zero-sum game problems.**
MAT-HE-5056: Spherical Trigonometry and Astronomy	**This course will enable the students to:** • **Learn about the properties of spherical and polar triangles** • **know about fundamental formulae of spherical triangles** • **learn about the celestial sphere, circumpolar star, rate of change of zenith distance and azimuth** • **learn about Keplar's law of planetary motion, Cassini's hypothesis, differential equation for fraction.**
MAT-HE-5066: Programming in C (including practical)	**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.**
MAT-HC-6016: Riemann Integration and Metric spaces	**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.**
MAT-HC-6026: Partial Differential Equations (including practical)	**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 as well as nonhomogeneous wave equations.** • **Apply the method of separation of variables for solving second order PDEs.**
MAT-HE-6016: Boolean Algebra and Automata	**The course will enable the students to:** • **Learn about the order isomorphism, Hasse diagrams,**

Theory	**building new ordered set.** • **Learn about the algebraic structure lattices, properties of modular and distributive lattices.** • **Get ideas about the Boolean algebra, Switching circuits and applications of switching circuits.** • **Appreciate the theory of automata and its applications.**
MAT-HE-6026: Bio-Mathematics	**Apropos conclusion of the course will empower the student to:** • **Learn the development, analysis and interpretation of bio mathematical models such as population growth, cell division, and predator-prey models.** • **Learn about the mathematics behind heartbeat model and nerve impulse transmission model.** • **Appreciate the theory of bifurcation and chaos.** • **Learn to apply the basic concepts of probability to molecular evolution and genetics.**
MAT-HE-6036: Mathematical Modelling (including practical)	**The course will enable the students to:** • **Know about power series solution of a differential equation and learn about Legendre's and Bessel's equations.** • **Use of Laplace transform and inverse transform for solving initial value problems.** • **Learn about various models such as Monte Carlo simulation models, queuing models, and linear programming models.**
MAT-HE-6046: Hydromechanics	**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**
MAT-HE-6056: Rigid Dynamics	**The course will enable the students to:** • **Know how to find the moments and products of inertia.** • **Learn about the motion of the centre of inertia** • **Learn about the D'Alembert's principle and Lagrange's equations.** • **Learn about motion of a body in two dimension.**
MAT-HE-6066: Group Theory II	**The course shall enable students 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**

FOUR YEAR UNDERGRADUATE PROGRAME (FYUGP)

MAT-0100104: Classical Algebra (Core)	**This course will enable the students to:** • **Employ De Moivre's theorem in a number of applications to solve numerical problems.** • **Learn the basic concepts of exponential, logarithmic and hyperbolic functions of complex numbers.** • **Learn how to find the nature of the roots of a given polynomial equation by Descartes' rule , also learn about symmetric functions of the roots for cubic and biquadratic equations.** • **Learn how to solve cubic and biquadratic equations.** • **Recognize consistent and inconsistent systems of linear equations by the row echelon form of the augmented matrix. Finding inverse and rank of a matrix.**
MDC-0100203: Foundations of Mathematical Sciences- I	**This course will enable the students to:** • **Learn about numbers, conversion of decimal numbers in binary system and binary to decimal system.** • **Relate indices and logarithm /antilogarithm and learn about properties of logarithms.** • **Learn basic mathematical tools to solve real life problems.** • **Know application of mathematical tools in decision making problems** • **Acquire the skill of statistical analysis of data from real life situation in a scientific manner.** • **Acquire knowledge on the basic aspects of statistical reasoning and drawing conclusions.**
SEC-0101303: Basic programming in C	**After completing this course, the students will be** • **Familiar with what a programming language is** • **Familiar with flowchart and pseudo code** • **Familiar with the constructs of C programming languages** • **Capable of writing basic C programs**
Calculus	**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.** • **Understand the importance of mean value theorems.**