(i) Program Objectives

- To impart teaching so that the students could develop higher-order thinking capacities about the fundamental aspects of mathematics.
- To train the students with mathematical knowledge and computational techniques so that they can deal with the problems faced in different walks of life.
- To impart sophisticated mathematical skills so that students can undertake self- employment initiatives.
- To make the students capable of pursuing research work in various emerging fields of mathematics and its applications.

(ii) Pre-requisite

- The students should possess the knowledge on the mathematics courses at (10+2) level.
- For multidisciplinary courses the students should possess the knowledge on the mathematics courses at secondary level.

(iii) Programme Outcomes (PO): NEP 2020

- **PO1:** Development of critical thinking for solving complex problems.
- **PO2:** Skills to characterise problems, formulate a hypothesis, evaluate and validate outcomes, and draw reasonable conclusions thereof.
- **PO3:** Development of the effective scientific and technical communications in both oral and written forms.

(iv) Programme Specific Outcomes(PSO):NEP 2020

- **PSO1:** Understanding the fundamental axioms in mathematics, and capability of developing ideas based on them.
- **PSO2:** Development of mathematical reasoning and an understanding of the underlying fundamental structures of mathematics (i.e., sets, relations and functions, logical structure), and the relationship among them.
- **PSO3:** Motivation for research studies in mathematics and related fields with real life applications.
- **PSO4:** Knowledge in a wide range of mathematical techniques and applications of mathematical methods/tools in other scientific and engineering domains.
- **PSO5:** Nurturing problem-solving skills, thinking, creativity through assignments, tutorials.
- **PSO6:** Preparing for various competitive examinations at the national and international levels.

(v) Course Outcomes: NEP 2020

1st Year 1st Semester

MAJOR COURSES

Course Title: Calculus, Geometry &Vector Calculus

Course Code: MATH1011

Course Outcomes:

After completion of this course the student will be able to:

- **CO1:** gain knowledge higher order derivatives and its applications, concavity of curves, asymptotes and curve tracing techniques.
- **CO2:** gain knowledge about reduction formula for integration of functions like $\sin nx$, $\sin^n x$ etc., area of surface of revolution, parametric curves etc.
- **CO3:** gain knowledge classification of conics and conicoids, polar equation of conics.
- **CO4:** gain knowledge about vector valued functions and vector calculus.
- **CO5:** parametrize curves, sketch functions and plot them.
- **CO6:** visualize standard quadratic surfaces like cone, ellipsoid etc.
- **CO7:** apply calculus on vector valued functions.
- **CO8:** find gradient of scalar functions, divergence and curl of vector valued functions.
- **CO9:** gain a general idea of advance calculus and its applications.
- **CO10:** gain the idea of solving complex problems using vector calculus and geometry.
- **CO11:** gain analytical and reasoning skills, which improve their thinking power and enhance their problem solving ability.

MINOR COURSES

Course Title: Calculus, Geometry & Vector Calculus

Course Code: MATH1021

Course Outcomes:

After completion of this course the student will be able to:

- **CO1:** gain knowledge higher order derivatives and its applications, concavity of curves, asymptotes and curve tracing techniques.
- **CO2:** gain knowledge about reduction formula for integration of functions like $\sin nx$, $\sin^n x$ etc., area of surface of revolution, parametric curves etc.
- **CO3:** gain knowledge classification of conics and conicoids, polar equation of conics.
- **CO4:** gain knowledge about vector valued functions and vector calculus.
- **CO5:** parametrize curves, sketch functions and plot them.
- **CO6:** visualize standard quadratic surfaces like cone, ellipsoid etc.
- **CO7:** apply calculus on vector valued functions.
- **CO8:** find gradient of scalar functions, divergence and curl of vector valued functions.

- **CO9:** gain a general idea of advance calculus and its applications.
- **CO10:** gain the idea of solving complex problems using vector calculus and geometry.
- **CO11:** gain analytical and reasoning skills, which improve their thinking power and enhance their problem solving ability.

MULTIDISCIPLINARY COURSES

Course Title: Trigonometric functions and coordinate geometry

Course Code: MATH1031

Course Outcomes:

After completion of this course the student will be able to:

- **CO1:** gain knowledge about Trigonometric Functions.
- **CO2:** gain knowledge about Straight Lines.
- **CO3:** gain knowledge Conic Sections.
- **CO4:** gain knowledge about introduction to Three - dimensional Geometry.
- **CO5:** solve the problem of Trigonometric Functions.
- **CO6:** solve the problem of Straight Lines.
- **CO7:** solve the problem of Conic Sections.
- **CO8:** solve the problem of Three - dimensional Geometry.
- **CO9:** gain general idea of Trigonometric Functions, Straight Lines, Conic Sections and Introduction to Three - dimensional Geometry.
- **CO10:** gain analytical and reasoning skills, which improve their thinking power.

SKILL ENHANCEMENT COURSES

Course Title: Graph Theory

Course Code: MATH1051

Course Outcomes:

After completion of this course the student will be able to:

- **CO1:** gain knowledge about undirected and directed graphs, isomorphism of graphs, Eulerian graphs, Hamiltonian graphs.
- **CO2:** gain knowledge about various characterizations of trees with applications, bipartite graph and its characterization.
- **CO3:** gain knowledge about planar and non-planar graphs, colouring of a graph.
- **CO4:** gain knowledge about matrix representation of graphs.
- **CO5:** assimilate various graph theoretic concepts and familiarize with their applications.
- **CO6:** have efficiency in handling with discrete structures.
- **CO7:** have efficiency in notions of matrix representation of graph, planarity.
- **CO8:** have efficiency in solving concrete graph colouring problems.
- **CO9:** solve real world problems that can be modelled by graphs.
- **CO10:** gain general idea of graph theory and its real-life applications.
- **CO11:** gain understanding about graphic sequence.
- **CO12:** gain experience to apply Euler's formula.
- **CO13:** gain ability to use graphs for various map colouring problems.
- **CO14:** gain idea about the application of graphs in computer science.

1st Year 2nd Semester

MAJOR COURSES

Course Title: Introductory Algebra and Number Theory

Course Code: MATH2011

Course Outcomes:

After completion of this course the student will be able to:

- **CO1:** gain knowledge about number theory which has wide applicability in advanced mathematics and also in various practical field, e.g., cryptography, computer science and many competitive exams.
- **CO2:** gain knowledge about complex number and its properties which are equally indispensable tools for advanced studies and different practical field.
- **CO3:** gain knowledge about a basic introduction to modern algebra which has wide applicability in different branch of sciences.
- **CO4:** access and also generate different tricky examples and counter examples involving integers during their advanced study of ring theory and field theory.
- **CO5:** simplify a mathematical problem in different field of science using complex number.
- **CO6:** motivate themselves for future research after getting the glimpse of gateway of modern algebra from classical algebra and number theory and relate use of group, ring and field in different field of science.
- **CO7:** gain descriptive idea of various properties of complex number.
- **CO8:** gain knowledge of richness in number theory.
- **CO9:** gain understanding in basic concepts of group, ring and field
- **CO10:** gain expertise in solving many tricky problems in number theory, complex numbers.

MINOR COURSES

Course Title: Introductory Algebra and Number Theory

Course Code: MATH2021

Course Outcomes:

After completion of this course the student will be able to:

- **CO1:** gain knowledge about number theory which has wide applicability in advanced mathematics and also in various practical field, e.g., cryptography, computer science and many competitive exams.
- **CO2:** gain knowledge about complex number and its properties which are equally indispensable tools for advanced studies and different practical field.
- **CO3:** gain knowledge about a basic introduction to modern algebra which has wide applicability in different branch of sciences.
- **CO4:** access and also generate different tricky examples and counter examples involving integers during their advanced study of ring theory and field theory.
- **CO5:** simplify a mathematical problem in different field of science using complex number.
- **CO6:** motivate themselves for future research after getting the glimpse of gateway of modern algebra from classical algebra and number theory and relate use of group, ring and field in different field of science.

- **CO7:** gain descriptive idea of various properties of complex number.
- **CO8:** gain knowledge of richness in number theory.
- CO9: gain understanding in basic concepts of group, ring and field.
- CO10: gain expertise in solving many tricky problems in number theory, complex numbers.

MULTIDISCIPLINARY COURSES

Course Title: Algebra

Course Code: MATH2031

Course Outcomes:

After completion of this course the student will be able to:

- **CO1:** gain knowledge about principle of Mathematical Induction, Complex Numbers and Quadratic Equations.
- **CO2:** gain knowledge about Linear Inequality, Permutation and Combinations, Binomial Theorem.
- **CO3:** gain knowledge about Sequence and Series.
- **CO4:** gain knowledge about Matrices and Determinants.
- **CO5:** solve the problem by using Principle of Mathematical Induction.
- **CO6:** solve the problem of Complex Numbers and Quadratic Equations.
- **CO7:** solve Linear Inequality, Permutation and Combinations.
- **CO8:** calculate using Binomial Theorem, Sequence and Series.
- **CO9:** calculate Matrices and Determinants.
- **CO10:** gain general idea of Principle of Mathematical Induction, Complex Numbers and Quadratic Equations, Linear Inequality, Permutation and Combinations, Binomial Theorem, Sequence and Series, Matrices and Determinants.
- CO11: gain analytical and reasoning skills, which improve their thinking power.

SKILL ENHANCEMENT COURSES

Course Title: Programming in C

Course Code: MATH2051

Course Outcomes:

After completion of this course the student will be able to:

- **CO1:** gain knowledge about basics of C programming i.e., basic structure, keywords, identifiers, operators with operator precedence and associativity, input-output statements.
- **CO2:** gain knowledge about concepts of branching & looping and array.
- **CO3:** gain knowledge about user defined functions and their use.
- **CO4:** gain knowledge about use of structures and pointers.
- **CO5:** learn the keywords, identifiers, different types of operators with precedence and associativity, use of formatted and non-formatted input-output statements.
- **CO6:** use branching and looping statements for decision making**.**
- **CO7:** learn the concepts of array, string handling arrays.
- **CO8:** use library and user-defined functions along with string handling functions.

- **CO9:** write programs using structures and pointers.
- **CO10:** gain general idea about the writing of different C programs using branching & looping statements, arrays, functions, structures and pointers.
- **CO11:** gain program writing and reasoning skills which improve their thinking power.

2nd Year 3rd Semester

MAJOR COURSES

Course Title: Real Analysis I

Course Code: MATH3011

Course Outcomes:

After completion of this course the student will be able to:

- **CO1:** gain knowledge about order property, Archimedean property, completeness property of $\mathbb{R}$.
- **CO2:** gain knowledge about countable set, uncountable set, limit point, interior point, open set, closed set, compact set in $\mathbb{R}$.
- **CO3:** gain knowledge about sequences, subsequence and series of real numbers.
- **CO4:** gain knowledge about limit, continuity and uniform continuity of real valued functions defined on subsets of $\mathbb{R}$ including their interrelationship.
- **CO5:** characterize subsets of $\mathbb{R}$ which are open, closed, countable, uncountable, and compact.
- **CO6:** characterize sequences and subsequences in $\mathbb{R}$ which are convergent or divergent.
- **CO7:** determine which infinite series of real numbers is convergent and which is not by using various test in their course.
- **CO8:** calculate limit of real valued functions defined on subsets of $\mathbb{R}$.
- **CO9:** characterize real valued functions defined on subsets of $\mathbb{R}$ which are discontinuous, which continuous and which are uniformly continuous.
- **CO10:** gain some fundamental concepts of real analysis which help them to learn all the branches of mathematics smoothly.
- **CO11:** gain analytical and reasoning skills, which improve their thinking power.

Course Title: Linear Algebra

Course Code: MATH3012

Course Outcomes:

After completion of this course the student will be able to:

- **CO1:** gain knowledge about vector space and its dimension.
- **CO2:** gain knowledge about linear transformation, transpose of a linear transformation and their matrix representation.
- **CO3:** gain knowledge about system of linear equations and various methods to solve them.
- **CO4:** gain knowledge about eigenvalues, eigenvectors, diagonalizability, canonical forms of a matrix.
- **CO5:** gain knowledge about inner product space, orthogonalization process, normal and self-adjoint operators.

- **CO6:** compute a basis and dimension of a vector space.
- **CO7:** compute matrix representation of matrix and its transpose.
- **CO8:** compute the characteristic polynomial, minimal polynomial, eigenvalue, eigenvector of a matrix as well as of a linear operator and use them in the basic diagonalization result.
- **CO9:** find canonical forms of a matrix.
- **CO10:** solve system of linear equations using Gaussian elimination method and matrix inversion method.
- **CO11:** compute orthogonality of vectors in an inner product and applying Gram–Schmidt orthogonalization process they will obtain an orthonormal basis of an inner product space.
- **CO12:** gain some fundamental concepts of vector space, linear transformation, matrix representation of a linear transformation, solution methods of a system of equations, canonical forms of a matrix, diagonalization, orthogonalization, which will be useful for further studies in every branch of mathematics.
- CO13: gain analytical and reasoning skills, which improve their thinking power.

MULTIDISCIPLINARY COURSES

Course Title: Calculus

Course Code: MATH3031

Course Outcomes:

After completion of this course the student will be able to:

- **CO1:** gain knowledge about limits and continuity of a function, derivative of a function.
- **CO2:** gain knowledge about integration of a function.
- **CO3:** gain knowledge about applications of differential and integral calculus.
- **CO4:** gain knowledge about first order ordinary differential equations.
- **CO5:** find the limits of a function, check the continuity of a function.
- **CO6:** find the derivatives of a real function.
- **CO7:** find the maximum or minimum values of a function.
- **CO8:** integrate standard algebraic and trigonometric functions.
- **CO9:** find the area enclosed by a curve.
- **CO10**: understand the importance of studying Calculus.
- CO11: gain a general idea of limits, continuity, derivatives and integration of a real Functions. Also, students will understand the basic notion of differential equations.
- CO12: analytical and reasoning skills will be improved, which ultimately enhance their thinking power.

SKILL ENHANCEMENT COURSES

Course Title: Mathematical Modelling

Course Code: MATH3051

Course Outcomes:

After completion of this course the student will be able to:

- **CO1:** gain knowledge about about modelling.

- **CO2:** develop skill of model formation.
- **CO3:** update general competence.
- **CO4:** acquire basic knowledge concerning formation of various models.
- **CO5:** identify and estimate the relationship between variables, to analyze trends, to predict and make decisions from outcome in linear models.
- **CO6:** comprehend the rapid and often accelerating changes that occur in diverse natural and social systems.
- **CO7:** gain knowledge about logistic model concerning real-world problems promote students to understand the limitations and saturation points of various processes.
- **CO8:** gain knowledge about optimization models empower students to take optimal decision and maximize the desired outcomes while considering real-world limitations and constraints.
- **CO9:** gain knowledge about Probabilistic/Stochastic models help students to handle uncertainty and make reasonable decisions by quantifying the likelihood of different outcomes.
- **CO10:** gain knowledge about time series models facilitate students to analyze data, identify patterns, and make accurate predictions crucial for forecasting and understanding trends.
- **CO11:** gain knowledge about simulation models provide powerful approach to study those systems in the event of non-availability of analytical solutions, support performance evaluation, risk analysis and decision support.
- **CO12:** have exposure to various mathematical models and their real-life applications.
- **CO13:** be benefited in simulations, understanding and predicting complex systems.
- **CO14:** empower students the to understand the construction/framing mathematical models.
- **CO15:** analyze and solve the real-world problems mathematically.
- **CO16:** employ the usage of mathematical tools and techniques for the outcomes of those problems.

2nd Year 4th Semester

MAJOR COURSES

Course Title: Metric Spaces

Course Code: MATH4011

Course Outcomes:

After completion of this course the student will be able to:

- **CO1:** understand the distance function over the Euclidean spaces, space of all real valued continuous functions, sequence spaces etc.
- **CO2:** learn the geometrical meaning of each of the metric properties.
- **CO3:** classify the notion of open and closed balls for a given metric space.
- **CO4:** get exposure to the concept of continuity of functions. functions defined on subsets of $\mathbb{R}$ including their interrelationship.
- **CO5:** learn the convergence of a sequence, the Cauchyness of a sequence in a given metric space.

- **CO6:** get exposure to the general notion of compactness property on a metric space and its analogue results in classical real and complex analysis.
- **CO7:** study the metric properties on a given metric space.
- **CO8:** study the topological properties of a metric space.
- **CO9:** work out various problems independently on the allied topics.
- **CO10:** study the analogue properties of a metric space in the space of real and complex numbers.
- **CO11:** read and to learn further topics in analysis.
- **CO12:** make easier at understanding the use of functional analysis in applied problems.

Course Title: Group Theory & Ring Theory

Course Code: MATH4012

Course Outcomes:

After completion of this course the student will be able to:

- **CO1:** gain knowledge about group theory which is enough for a student to appear at different competitive examination within India and abroad.
- **CO2:** gain knowledge about ring theory which almost covers its basic areas that helps students to grasp advanced areas related to this subject by themselves.
- **CO3:** gain knowledge about its wide applicability in different branch of sciences.
- **CO4:** understand the beauty of structures and structure preserving maps.
- **CO5:** simplify a mathematical problem in different field of science using group and ring theory.
- **CO6:** initiate tricks of action of groups on a set or set with one or more structures to crack intricated problems.
- **CO7:** identify nature of a groups, specifically finite or finitely generated abelian groups.
- **CO8:** have descriptive idea of group and ring theory.
- **CO9:** properly analyze algebraic properties of ring of integers.
- **CO10:** gain knowledge of loss and gain in generalizing the algebraic concept of integers.
- **CO11:** understand categorical similarities of structures and their commonness in properties.
- **CO12:** gain expertize in solving many tricky problems in group and ring theory.

Course Title: Multivariate Calculus & Tensor Calculus

Course Code: MATH4013

Course Outcomes:

After completion of this course the student will be able to:

- **CO1:** gain knowledge about functions of several variables, their calculus.
- **CO2:** gain knowledge about extrema of functions of n variables.
- **CO3:** gain knowledge about multiple integrals and their properties.
- **CO4:** gain knowledge about tensor calculus.
- **CO5:** evaluate double limit, repeated limit etc. of functions of several variables.

- **CO6:** examine continuity of functions of several variables.
- **CO7:** find partial and total derivatives of multivariate functions.
- **CO8:** find extreme values of such functions, if they exist.
- **CO9:** calculate multiple integral of multivariate functions over certain domains, and so to find surface area and volumes of various shapes and bodies.
- **CO10:** calculate various problems on tensor algebra and tensor calculus.
- **CO11:** have general idea on limit, continuity, derivatives, integration of multivariate functions and general idea of tensors.
- **CO12:** have analytical and computing skills, which improve their visual and calculating powers.

MINOR COURSES

Course Title: Ordinary Differential Equations

Course Code: MATH4021

Course Outcomes:

After completion of this course the student will be able to:

- **CO1:** learn about qualitative analysis of the ordinary differential equations.
- **CO2:** gain knowledge about the use of ordinary differential equations in different areas of mathematics.
- **CO3:** apply the solution techniques of the ordinary differential equations in different physical problems.
- **CO4:** solve the ordinary differential equations in different methods.
- **CO5:** apply the ordinary differential equations in different areas.
- **CO6:** have general idea about the solution techniques of ordinary differential equations.
- **CO7:** know the distinct features of various types of ordinary differential equations.
- **CO8:** gain experience to solve differential equations using analytical approach.

(vi) Program Outcomes (POs) – CBCS

Definition: POs are statements that describe what the students graduating from any of the educational programs (here B Sc) should be able to do.

At the end of the B.Sc (with Mathematics), a graduate student will have:

PO1. In-depth knowledge and ability appropriate to undertake further study and research in a field of science.

PO2. Ability to develop, conduct and manage a research project.

PO3. Critically and independently reflect and analyze project results.

PO4. Ability to communicate a convincing and reasoned scientific argument at a level and style appropriate to the audience and to report scientific findings in an oral and substantial written format.

PO5. Ability to work on an advanced scientific activity both autonomously and collaboratively.

PO6. Awareness of professional practice in the relevant discipline and an understanding, appreciation and respect for appropriate conduct and practice.

PO7. Generic skills, theoretical knowledge, and specialized practical skills to either gain employment in their relevant discipline or to succeed in further study.

(vii) Program Specific Outcomes (PSOs) –CBCS (B. Sc. Hons)

Definition: PSOs are statements that describe what the graduates of a specific educational program (Mathematics Hons) should be able to do.

Department of Mathematics has specifically defined few Program Specific Outcomes which make students realize the fact that the knowledge and techniques learnt has direct implication for the betterment of society and its sustainability at the end of the program, as follows:

PSO1. Students will be able to clearly understand the concepts and applications in different branches of Mathematics.

PSO2. Students will attain the ability to identify, formulate and solve challenging problems in Mathematics.

PSO3. Students will solve complex problems by critical understanding and analysis, and proficient in some software packages & computer programming.

PSO4. Students will develop the knowledge, skills and attitudes necessary to pursue further studies in Mathematics and research
PSO5. Students will be aware of their professional and ethical responsibilities.
PSO6. Students will be able to work individually or as a team member or leader in uniform and multidisciplinary settings.
PSO7. Students will develop confidence for self-education and ability for lifelong learning.

(viii) Course Outcomes: CBCS (B. Sc. Hons)

1st Year 1st Semester

Course Title: Calculus, Geometry & Differential Equations
Course Code: BMH1CC01

Course Outcomes:
After the completion of the course the student will be able to

- **CO1:** Understand the concept of Hyperbolic functions, asymptotes, concavity and convexity.
- **CO2:** Compute the n-the derivative using the Leibnitz's rule.
- **CO3:** Become familiar with the reduction formulae for integration of *sin nx, cos nx, tan nx, sec nx* etc.
- **CO4:** Calculate of arc length, area of surface of revolution of a curve.
- **CO5:** Understand the basic knowledge of conics and quadrics.
- **CO6:** Solve different types of differential equations.
- **CO7:** Graphically demonstrate different types of curves and surfaces.

Course Title: Algebra
Course Code: BMH1CC02
Course Outcomes:

The students who complete this course successfully are expected to:

- **CO1:** Get an initial idea about the about algebraic and various properties of complex numbers, Argand plane etc.
- **CO2:** Solve different types of cubic and biquadratic equations.
- **CO3:** Get a flavour of abstract algebra by knowing set, relation, partition, equivalence relation.
- **CO4:** Know different properties of integers and aspects of the theory of numbers.
- **CO5:** Solve system of linear equations by matrix method.

- **CO6:** Understand the concepts of a linear transformation, matrix of a linear transformation, the inverse of a matrix, characterizations of invertible matrices.
- **CO7:** Gain knowledge of the theory of vector spaces.

1st Year 2nd Semester

Course Title: Real analysis
Course Code: BMH2CC03
Course Outcomes:
This course will enable the students to:

- **CO1:** Understand various properties of the real line $\mathbb{R}$.
- **CO2:** Learn the various concepts of sets in $\mathbb{R}$ in depth.
- **CO3:** Recognize bounded, convergent, divergent, Cauchy and monotonic sequences and to calculate their limit superior, limit inferior, the limit of a bounded sequence and subsequences.
- **CO4:** Apply the ratio test, root test, integral test, alternating series, Leibniz test and limit comparison tests for convergence and absolute convergence of an infinite series of real numbers.
- **CO5:** Develop an intense foundation in fundamental concepts of real analysis so that they (the student) should be able to work basic problems (proofs, construction of examples, counter-examples, or argue that a claim is false) in basic Real analysis.

Course Title: Differential Equation and Vector Calculus
Course Code: BMH2CC04
Course Outcomes:
The students who complete this course successfully are expected to:

- **CO1:** Gain clearer concepts of Lipschitz condition and Picard's Theorem, and, to understand applications of Lipschitz condition in different problems.
- **CO2:** Understand about General solution of homogeneous equation of second order, principle of super position for homogeneous equation, and also Wronskian: its properties and applications. Also know how to solve linear homogeneous and non-homogeneous equations of higher order with constant coefficients. Gain clear idea on Euler's equation, method of undetermined coefficients, and method of variation of parameters and know how to solve different problems.
- **CO3:** Be able to understand Systems of linear differential equations, types of linear systems, differential operators, an operator method for linear systems with constant coefficients, and learn its' application in business, economics and life sciences.
- **CO4:** Understand Basic Theory of linear systems in normal form, homogeneous linear systems with constant coefficients: Two Equations in two unknown functions and methods of solutions of variety of problems

with an emphasis on, homogeneous linear systems with constant coefficients.

- **CO5:** Gain clear concepts on Equilibrium points, Interpretation of the phase plane and know how to find Equilibrium points on different problems.
- **CO6:** Become able to solve Power series solution of a differential equation about an ordinary point, solution about a regular singular point with a clear idea about how to solve different physical problems.
- **CO7:** Apply differential equations to solve real world problems from both the physical and life sciences.
- **CO8:** Gain clearer concepts on vector Triple product, introduction to vector functions, operations with vector-valued functions and recapitulate on vector product of two vectors (dot & cross).
- **CO9:** Understand the concept of limits and continuity of vector functions, differentiation and integration of vector functions.
- **CO10:** Understand the Graphical Demonstration of Plotting of family of curves which are solutions of second order differential equation & Plotting of family of curves which are solutions of third order differential equation.

2nd Year 3rd Semester

Course Title: Theory of Real Functions & Introduction to Metric Space
Course Code: BMH3CC05
Course Outcomes:
The students who complete this course successfully are expected to:

- **CO1:** Understand the concepts of limit, continuity and differentiability in $\varepsilon - \delta$ approach.
- **CO2:** Gain signifaicant knowledge about the sequence and series of real numbers.
- **CO3:** Become familiar with the various properties of continous and differentiable functions.
- **CO4:** Learn about the applications of Mean Value Theorems.
- **CO5:** Gain significant knowledge about Taylor series and its applications.
- **CO6:** Get preliminary ideas about metric spaces.

Course Title: Group Theory–I
Course Code: BMH3CC06
Course Outcomes:
Upon the completion of the course the student will be able to

- **CO1:** Understand the concepts of group, commutative group, non-commutative group, subgroup, cyclic group, cosets, normal subgroup, factor group.

- **CO2:** Become familiar with the definition and properties of centralizer, normalizer and center of a group.
- **CO3:** Understand Lagrange's theorem, Fermat's little theorem and its application.
- **CO4:** Become familiar with the properties of external direct product.
- **CO5:** Familiarize with Cauchy's theorem.
- **CO6:** Gain clear idea about homomorphism, isomorphism of group.
- **CO7:** Understand the symmetries of square, different properties of permutation groups, quaternion group, Dihedral groups.

Course Title: Numerical Methods & Numerical Methods Lab
Course Code: BMH3CC07
Course Outcomes:
The students who complete this course successfully are expected to:

- **CO1:**Learn Approximation of numbers, Algebraic manipulation for avoiding loss of significance, various types of errors, Algorithms and Convergence.
- **CO2:** Learn the importance of Polynomial Interpolations, Numerical differentiation to compute the values for a tabulated function at points not in the table.
- **CO3:** Understand the error bounds and concepts of Finite difference operators.
- **CO4:** Become proficient in finding solution of algebraic and transcendental equations of a single variable numerically up to a certain given level of precision by (i) Bisection method, (ii) Newton's method, (iii) Secant method, (iv) Regula-Falsi method, (v) Fixed point iteration, (vi) Newton-Raphson method and understand the rate of convergence of these methods.
- **CO5:** Able to get solution of a system of linear algebraic equation by Gauss–Jacobi, Gauss–Seidel, Gauss Jordan and LU decomposition methods .
- **CO6:** Become proficient in various Numerical Integration methods such as Newton Cotes formula, Trapezoidal, Simpson's 1/3rd, Simpsons 3/8th, Weddle's, Boole's. Midpoint, and able to apply them to solve integrals.
- **CO7:** Able to solve of the algebraic eigenvalue problem by Power Method.
- **CO8:** Able to solve ordinary differential equations numerically by Euler's, the modified Euler and Runge-Kutta method.
- **CO9:** Develop basic knowledge and experience with the use of the standard C
  programming language.
- **CO10:** Able to write C programme on Interpolation, finding a real root of nonlinear equations, solving system of linear equations, numerical integration, solving ordinary differential equations.
- **CO11:** Able to apply Numerical Methods in diverse real-life situations in physics, engineering, and in other mathematical contexts.

Course Title: Logic and Sets
Course Code: BMH3SEC11
Course Outcomes:
After completion of this course the student will be able to:

- **CO1:** Understand the concepts of truth table, negation, conjunction and disjunction.
- **CO2:** Become familiar with predicates and quantifiers.
- **CO3:** Demonstrate the knowledge of set theory and set operations.
- **CO4:** Become familiar with the concept of counting principle.
- **CO5:** Understand the concept of relation and partition.

2nd Year 4th Semester

Course Title: Riemann Integration and Series of Functions
Course Code: BMH4CC08
Course Outcomes:
After completion of this course the student will be able to:

- **CO1:** Become familiar with the notion of Riemann integration and its properties.
- **CO2:** Check the Riemann integrability of monotone and continuous functions.
- **CO3:** Understand the intermediate value theorem for integrals.
- **CO4:** Become familiar with the concepts of improper integrals, Beta, and Gamma functions.
- **CO5:** Demonstrate the knowledge of piecewise and uniform convergence of sequence of functions.
- **CO6:** Become familiar with the various properties of series of functions.
- **CO7:** Demonstrate the knowledge of Fourier series.
- **CO8:** Become familiar with the different properties of power series.

Course Title: Multivariate Calculus
Course Code: BMH4CC09
Course Outcomes:
Upon completion of this course successfully, students are expected to:

- **CO1:** Understand the fundamental concepts of functions of several variables & the concepts of derivatives for this type of functions.
- **CO2:** Apply the concepts of derivatives to find the maxima and minima for functions of several variables.
- **CO3:** Compute double and triple integrals efficiently & also learn about change of variables in double and triple integrals.
- **CO4:** Apply double and triple integral to find area and volume.

- **CO5:** Gain knowledge on the concept of Vector operators, directional derivatives, conservative vector fields, gradient, divergence, curl and integration of vector point functions.
- **CO6:** Solve problems related to line, surface and volume integrals using Gauss's Divergence theorem, Stoke's theorem and Green's theorem.

Course Title: **Ring Theory and Linear Algebra I**
Course code: BMH4CC10
Course Outcomes:
The students who complete this course successfully are expected to :

- **CO1:** Gain clearer concept of rings, subrings, integral domains and fields and, to understand characteristic of a ring, Ideal, factor rings, prime and maximal ideals.
- **CO2:** Be able to understand ring homomorphisms and learn bout Isomorphism theorems.
- **CO3:** Able to understand Vector spaces, subspaces, quotient spaces, linear span.
- **CO4:** Understand the concepts of linear combination of vectors, linear independence, basis and dimension, dimension of subspaces.
- **CO5:** Become able to solve problems using extension, deletion and replacement theorems.
- **CO6:** Gain clearer concept of Linear transformations, algebra of linear transformations, Isomorphisms .
- **CO7:** Be able to understand range, rank and nullity of a linear transformation and matrix representationof a linear transformation.
- **CO8:** Understand the concept of changeofcoordinate matrix.

Course Title: Graph Theory
Course Code: BMH4SEC21
Course Outcomes:
The students who complete this course successfully are expected:

- **CO1:**To understand the definition of a graph and its basic properties.
- **CO2:** To develop the under-standing of pseudo graphs, complete graphs, bi-partite graphs, isomorphism of graphs and weighted graph.
- **CO3:** To understand the concept of Eulerian circuits, Eulerian graph, semi-Eulerian graph, Hamiltonian cycles, Trees, spanning tree and related theorems and learn their applications.
- **CO4:** To able to represent a graph by a matrix like Incidence matrix, Adjacency matrix etc.
- **CO5:** To solve problems on Travelling salesman's problem, Dijkstra's algorithm and Warshall algorithm.
- **CO6:** To comprehend and apply the essential notions of graph theory and relate the graph theory to the real-world problems.
- **CO7:** To handle graph theory-based tools in solving practical problems

3rd Year 5th Semester

Course Title: Partial Differential Equations and Applications
Course Code:BMH5CC11
Course Outcomes:
The students who complete this course successfully are expected to:

- **CO1:** Understand Basic concepts and Definitions various Partial Differential Equations (PDE).
- **CO2:** Able to classify the first and second order Partial Differential Equations and understand their Geometrical Interpretations.
- **CO3:** Able to reduce the first and second order PDE to their Canonical Forms and solve the first and second order PDE by the Method of Separation of Variables.
- **CO4:** Able to derive Heat equation, Wave equation and Laplace equation.
- **CO5:** Solve the Cauchy problem of 2nd order partial differential equations.
- **CO6:** Become proficient in finding solution of Cauchy problem of an infinite string, Semi-Infinite String with a fixed/Free end, Non-Homogeneous Wave Equation, Vibrating String Problem and the Heat Conduction problem.
- **CO7:** Demonstrate the capacity to model a physical phenomenon using PDE (in particular using the heat and wave equations).
- **CO8:** Become proficient in problem-solving in diverse situations in physics, engineering, and in other mathematical contexts by using the concepts and techniques from PDE's and Fourier analysis.

Course Title: Mechanics I
Course Code: BMH5CC12
Course Outcomes:
The students who complete this course successfully are expected to:

- **CO1:** Gain ability about the basic concepts of co-planar forces, astatic equilibrium, friction and equilibrium of a particle on a rough curve and understand how to solve different problems involving them.
- **CO2:** Understand the basic idea of concurrent forces, couple, and parallel forces, forces in three dimensions, Pointsot central axis, and principle of virtual work.
- **CO3:** Know how to solve the problems related to principle of virtual work, coplanar forces.
- **CO4:** Gain clear idea of centre of gravity for different bodies. also know how to find the conditions of stable and unstable equilibrium of different bodies.
- **CO5:** Be able to understand the equilibrium of flexible string (common catenary) under coplanar forces, catenary of uniform strength and solve many problems involving them.

- **CO6:** Gain clearer concepts of rectilinear motion, simple harmonic motion, damped and forced vibrations.
- **CO7:** Able to understand angular velocity and angular acceleration, tangential and normal components of velocity and acceleration, motion of a projectile under gravity.
- **CO8:** Gain clear idea about motion in a plane under central forces, central orbit in polar and pedal forms, law of force when the centre of force and the central orbit are known, stability of circular orbits, conditions for stability of circular orbits under central force, planetary motion, modification of kepler's third law, escape velocity, motion of a heavy particle on a smooth curve in a vertical plane, motion of a projectile in a resisting medium terminal velocity, motion of a particle in a plane under different laws of resistance, motion on a smooth cycloid in a vertical plane, motion of a particle along a rough curve.
- **CO9:** Solve more advanced mathematical application related to the motion of uniform sphere, cone, heavy circular cylinder along perfectly rough plane etc.
- **CO10:** Able to understand the basic idea of degrees of freedom, moments and product of inertia, radius of gyrations, D'Alembert Principle.
- **CO11:** Become able to solve various problems related two dimensional motion of a rigid body, translation and rotational motion.
- **CO12:** Gain clear idea about Motion about a fixed axis, compound pendulum, motion of a system of particles and conservation of momentum and energy.

Course Title: Linear Programming
Course code: BMH5DSE11
Course Outcomes:
The students who complete this course successfully are expected to:

- **CO1:** Gain clearer concepts of linear programming, theory of simplex method, convex sets and, to understand how to introduce artificial variables.
- **CO2:** Be able to understand two-phase method, Big-M method and their comparison.
- **CO3:** Able to understand duality, formulation of the dual problem, primal-dual relationships, economic interpretation of the dual, also dual simplex method.
- **CO4:** Understand the concept of transportation problem and its mathematical formulation, North-West Corner method, least cost method and Vogel approximation method for determination of starting basic solution.
- **CO5:** Become able to solve problems using Hungarian method, northwest-corner method, Vogel approximation method, UV method.
- **CO6:** Gain clearer concept for solving assignment problem, travelling salesman problem.

- **CO7:** Be able to understand Game theory and able to solve two person zero sum games, games with mixed strategies, graphical solution procedure of games.
- **CO8:** Understand the concept of linear programming solution of games.

Course Title: Probability and Statistics
Course Code: BMH5DSE21
Course Outcomes:
The students who complete this course successfully are expected to:

- **CO1:** Gain significant knowledge about probability and probability distribution functions.
- **CO2:** Understand the concepts of continuous and discrete distributions.
- **CO3:** Familiarize with the concepts and properties of joint distribution functions.
- **CO4:** Expected to understand with the concepts of mathematical expectation and correlation coefficients.
- **CO5:** Familiarize with the concepts of Chebysev's inequality, Central Limit theorem and Markov chains.
- **CO6:** Know about random sampling and testing of hypothesis.

3rd Year 6th Semester

Course Title: Metric Spaces and Complex Analysis
Course Code:BMH6CC13
Course Outcomes:
The students who complete this course successfully are expected to:

- **CO1:** Get ideas about the sequences in metric space.
- **CO2:** Understand the notion of continuity, connectedness, and compactness in metric space.
- **CO3:** Learn about various properties homeomorphisms and its applications.
- **CO4:** Become familiar with the concepts of limit and continuity of complex functions.
- **CO5:** Be able to understand various properties of analytic functions in complex plane.
- **CO6:** Demonstrate the knowledge about Laurent series and its applications.

Course Title: Ring Theory and Linear Algebra II
Course code: BMH6CC14
Course Outcomes:
The students who complete this course successfully are expected to:

- **CO1:** Gain clearer concepts of polynomial rings over commutative rings, division algorithm and, to understand principal ideal domains, Eisenstein criterion, and unique factorization in Z[x].
- **CO2:** Be able to understand unique factorization domains, Euclidean domains and divisibility in integral domains.
- **CO3:** Become able to solve problems using reducibility and irreducibility tests.
- **CO4:** Understand the concept of dual spaces, dual basis, double dual and transpose of a linear transformation and its matrix in the dual basis.
- **CO5:** Become able to solve problems using the concept of Cayley-Hamilton theorem, them in imal polynomial for a linear operator and canonical forms.
- **CO6:** Gain clearer concept of eigenspaces of a linear operator, annihilators and diagonalisation of matrix.
- **CO7:** Be able to understand Inner product spaces and norms, Gram-Schmidt orthogonalisation process, orthogonal complements, Bessel's inequality, the adjoint of a linear operator.
- **CO8:** Understand the concept of normal and self-adjoint operators,orthogonal projections and Spectral theorem.
- **CO9:** Solve problems using Least Squares Approximation method, Gram-Schmidt orthogonalisation process.

Course Title: Group Theory II
Course Code: BMH6DSE33
Course Outcomes:
After completing this course the student will be able to

- **CO1:** Become familiar with the concept and properties of automorphism, automorphism groups, inner automorphism.
- **CO2:** Understand the concept of commutator subgroup, characteristic subgroup.
- **CO3:** Demonstrate the knowledge of internal and external direct product of groups.
- **CO4:** Become familiar with the concept of group action, kernel of group action, stabilizer, Cayley's theorem.
- **CO5:** Gain knowledge about class equation, Cauchy's theorem, Sylow's theorems and their applications,
- **CO6:** Understand the simplicity of A_n for $n \geq 5$
- **CO7:** Test the simplicity of groups of different orders.

Course Title: Mechanics II
Course Code: BMH6DSE43
Course Outcomes:
The students who complete this course successfully are expected to:

- **CO1:** Gain clearer concepts of interpretation of Newton's laws of motion and limitations of Newton's laws in solving problems in mechanics.

- **CO2:** Understand the concepts of inertial and non-inertial frames of references, Galilean transformation, concept of absolute length and time.
- **CO3:** Understand the basic idea about fluid pressure and its elementary properties, density, homogeneous and non-homogeneous fluid, equation of pressure, condition of equilibrium.
- **CO4:** Become familiar with pressure derivative in terms of force, equilibrium of fluids in a given field of force and equi-pressure surfaces. Also handle the problems involving equilibrium of fluids under different conditions.
- **CO5:** Gain clear concepts about the relation among pressure volume and temperature, Boyle's and Charles's law, ideal gas, internal energy of a Gas, equilibrium of an isothermal atmosphere & convective equilibrium etc.
- **CO6:** Become able to understand about continuum, strain, and stress, stress quadric and related topics.
- **CO7:** Know about the basic concept of constraints and their classifications, also familiar with different examples involving them.
- **CO8:** Gain clear concepts of generalized coordinates, holonomic, rheonomic, conservative, non-conservative constraints of a dynamical system. Also know the derivation technique of Lagrange's equation of motion for holonomic system.
- **CO9:** Understand the basic idea about Gibbs-Appell's principle of least constraint, Work energy relation for constraint forces.

Course Title: Project Work
Course Code:BMH6PW01
Course Outcomes:
The students who complete this course successfully are expected to:

- **CO1:** Learn new knowledge about modern mathematics and its application.
- **CO2:** Get exposure to research topics.
- **CO3:** Formulate new mathematical problems.
- **CO4:** Understand how mathematics can be used to solve complex real world problems.

(ix) Program Specific Outcomes (PSOs) (B. Sc. General/Minor) -CBCS

After the successful completion of the specific program (B. Sc. (General) in Mathematics) :

- **PSO1:** Students will demonstrate in-depth knowledge of Mathematics, both in theory and applications.
- **PSO2:** Students will attain the ability to identify, formulate, analyze, and solve challenging problems in Mathematics.

- **PSO3:** Ability to apply knowledge of mathematics to solve the problems related to the associated fields of the students.
- **PSO4:** Students will be aware of their professional and ethical responsibilities.
- **PSO5:** Students will be able to work individually or as a team member or leader in uniform and multidisciplinary settings.
- **PSO6:** Students will develop confidence for self-education and ability for lifelong learning.

(x) Course Outcomes—CBCS (B. Sc. General)

1st Year 1st Semester

Course Title: Differential Calculus
Course Code: BMG1CC1A
Course Outcomes:
The students who complete this course successfully are expected to:

- **CO1:** Gain clear idea about limit, continuity and types of discontinuity. Also gain proficiency in solving problems involving them.
- **CO2:**Understand about higher order derivatives and, to know Leibnitz theorem and its applications.
- **CO3:** Get a strong foundation in partial differentiation, Euler's theorem on homogeneous function and chain rule with application.
- **CO4:** Able to understand and evaluate the tangent and normal, envelopes, asymptotes, test for concavity, convexity, inflection points and curve tracing (for standard curves, Cartesian, parametric and polar).
- **CO5:** Gain clear concepts about Rolle's theorem, mean value theorem, and Taylor are Theorem with Lagrange's and Cauchy's form of remainders, and apply these for different functions.
- **CO6:** Able to understand and evaluate Taylor's series, Maclaurin's series for some standard functions.

1st Year 2nd Semester

Course Title: Differential Equations
Course Code: BMG2CC1B
Course Outcomes:
After completing this course the student will be able to:

- **CO1:** Solve exact differential equations.
- **CO2:** Calculate integrating factors of first order differential equation.
- **CO3:** Solve linear homogeneous differential equations with constant coefficients and non-homogeneous differential equations.
- **CO4:** Find solutions of Cauchy-Euler differential equation and Simultaneous differential equations.

- **CO5:** Understand the concept of linear and non-linear partial differential equations.
- **CO6:** Solve partial differential equations using Lagrange's and Charpit's method.
- **CO7:** Classify the second order partial differential equations.

2nd Year 3rd Semester

Course Title: Real Analysis
Course Code: BMG3CC1C
Course Outcomes:
After completion of this course the student will be able to:

- **CO1:** Become familiar with the concept of countability of sets.
- **CO2:** Understand the properties of sequence of real numbers.
- **CO3:** Demonstrate the knowledge of infinite series.
- **CO4:** Test the convergence of different infinite series.
- **CO5:** Become familiar with the notion of uniform and pointwise convergence of sequence of functions.
- **CO6:** Understand the properties of series of functions.
- **CO7:** Become familiar with the properties of power series.

Course Title: Logic and Sets
Course Code: BMG3SEC11
Course Outcomes:
After completion of this course the student will be able to:

- **CO1:** Familiarize with the concepts proposition, truth table, negation, conjunction, disjunction,
- **CO2:** Understand logical equivalence, predicates and quantifiers.
- **CO3:** Demonstrate the knowledge of set theory.
- **CO4:** Gain knowledge about set operations.
- **CO5:** Understand the concepts of power sets and product set.
- **CO6:** Familiarize with the concepts of relations and partitions.

2nd Year 4th Semester

Course Title: Algebra
Course Code: BMG4CC1D
Course Outcomes:
After successful completion of this course the student will be able to:

- **CO1:** Understand the concept of group theory.
- **CO2:** Become familiar with the notion Abelian and nonabelian groups and its properties.
- **CO3:** Demonstrate the knowledge of subgroups, cyclic groups, cosets, normal subgroups.

- **CO4:** Become familiar with the concept of Lagrange's theorem and its applications.
- **CO5:** Understand the concept of permutation group.
- **CO6:** Gain knowledge about ring theory.
- **CO7:** Familiarize with the notion of subrings and ideals.

Course Title: Vector Calculus
Course Code: BMG4SEC21
Course Outcomes:
After completing this course successfully the student will be able to:

- **CO1:** Differentiate and partially differentiate a vector function.
- **CO2:** Differentiate the dot product and cross-product of two vectors.
- **CO3:** Find the gradient, divergence and curl and understand its properties.

3rd Year 5th Semester

Course Title: Matrices
Course Code: BMG5DSE1A1
Course Outcomes:
After completion of this course the student will be able to:

- **CO1:** Understand the concept of vector space and subspace and their various properties.
- **CO2:** Demonstrate the knowledge of linear dependence, linear combinations.
- **CO3:** Become familiar with the concept of translation, dilation, reflection, rotation and their matrix representations.
- **CO4:** Calculate the rank of matrix.
- **CO5:** Find solutions of linear and non-linear homogeneous equations using matrix.
- **CO6:** Compute inverse of matrix using elementary row operations.
- **CO7:** Apply the concept of matrix to solve various problems in Physics, Chemistry, Statistics, Geometry and Combinatorics.

Course Title: Probability and Statistics
Course Code: BMG5SEC31

Course Outcomes:
The students who complete this course successfully are expected to:

- **CO1:** Understand the basic concept of probability, like classical and axiomatic definitions of probability, sample space, Bayes/ theorem etc. and properties.
- **CO2:** Know about random variables, various discrete and continuous distribution functions.

- **CO3:** Gain clearer concepts of transformation of random variables; discrete and continuous distribution in two dimension and related area of study.
- **CO4:** Understand and solve independently the problems on mathematical expectation in one and two variables,
- **CO5:** Know how to find the mean, variance and standard deviation of some standard distributions.
- **CO6:** Understand the clear concepts about moments, measures of skewness and kurtosis, moment generating function, characteristic function, conditional expectation, covariance, co-relation coefficient, regression curves.
- **CO7:** Know the technique of finding mean, variance and standard deviation from characteristic function of different standard distributions.

3rd Year 6th Semester

Course Title: Linear Programming
Course Code: BMG6DSE1B3
Course Outcomes:
After completion of this course the student will be able to:

- **CO1:** Formulate Linear Programming Problems.
- **CO2:** Solve Linear Programming Problems graphically.
- **CO3:** Become familiar with the notion of convex sets and hyperplane.
- **CO4:** Find solutions of Linear Programming Problems by Simplex. Two Phase and Big-M methods.
- **CO5:** Become familiar with the notion of duality in Linear Programming.
- **CO6:** Formulate Dual problems.
- **CO7:** Become familiar with the applications of duality.

Course Title: Transportation and Game Theory
Course Code: BMG6SEC42
Course Outcomes:
After completion of this course the student will be able to:

- **CO1:** Formulate transportation problems.
- **CO2:** Solve transportation problems.
- **CO3:** Become familiar with the formulation assignment problems.
- **CO4:** Understand the procedure of solving assignment problems.
- **CO5:** Formulate two person zero sum games.
- **CO6:** Become familiar with the strategies of solutions of two person-zero sum games.

(xi) Course Outcomes for 1-1-1 pattern system for Hons students—Annual system

B.Sc Hons: 3rd year, Part III (1-1-1 pattern)

COURSE TITLE: Analysis, Complex Analysis, Metric Spaces

Paper –V

Course Outcomes:

The students who complete this course successfully are expected to:

CO1. gain clearer concepts of sequence, subsequence and convergence criterion, Bolzano-Weierstrass theorem, Heine-Borel theorem.

CO2. familiar of series of negative terms and many types of test for convergence, alternating series.

CO3. able to understands the series of numerical terms, convergence of series and Riemann's rearrangement theorem.

CO4. understands the criterion of uniform convergence, continuity, term-by-term differentiation and integration of uniformly convergent series of some functions.

CO5. gain clearer concepts about Fourier series and related theorems.

CO6. able to understands theory of maxima and minima, Lagrange's method of multipliers, Jacobian, Implicit function, inverse function theorem and about functions of several variables.

CO7. able to solve differentiation and integrals under the sign of integration, integrals as a function of parameter.

CO8. gain clearer concept of complex number including its representation, its differentiability, continuity, Cauchy-Riemann (C-R) equations.

CO9. understand analytic functions and able to solve problem.

CO10. gain concept about power series, radius of convergence, Cauchy-Handamard theorem.

CO11. gain knowledge about extended complex plane, stereographic projection, bilinear transformation.

CO12. understand Mobius transformation and its applications

CO13. gain clearer concepts about Metric spaces and their examples.

CO14. gain knowledge about open and closed balls, metric topology, limit point, interior point, closure, dense subset, basis, separable space, Lindelof space, second countable space and relation between them.

CO15. understand Hausdorff property, Cauchy sequence, convergence sequence and theorem about compactness.

CO16. gain clearer concepts about Cantor intersection theorem, uniform continuity of a function.

CO17. familiar about compactness and related theorems, and finite intersection property of closed sets.

CO18. understand connectedness, boundedness and Heine Borel theorem.

B.Sc Hons: 3rd year, Part III (1-1-1 pattern)

Course Title: Elements of Continuum Mechanics, Classical Dynamics, Dynamics of a system of Particles and rigid body, Statics and Hydrostatics

Paper –VI

Course Outcomes:

The students who complete this course successfully are expected to:

CO1. gain clearer concepts of continuum, strain, stress and related topics.

CO2. understand the concepts about Newton's law of motions, inertial frame, Galilean transformation etc.

CO3. able to understand the basic concepts of dynamics of particles, like as linear momentum, angular momentum, kinetic energy, potential energy and conservative system of forces.

CO4. able to understand the basic idea of moments and product of inertia, radius of gyrations, D'Alembert Principle.

CO5. become able to solve various problems related two dimensional motion of a rigid body, translation and rotational motion.

CO6. solve more advanced mathematical application related to the motion of uniform sphere, heavy circular cylinder along perfectly rough plane etc.

CO7. gain ability about the basic concepts of concurrent forces, couple, parallel forces, forces in three dimensions, Pointsot central axis, and principle of virtual work.

CO8. able to solve the problems related to principle of virtual work, coplanar forces.

CO9. understand the basic idea about fluid pressure and its elementary properties, density, homogeneous and non homogeneous fluid, equation of pressure, condition of equilibrium, Archimedes principle etc.

CO10. gain the concepts about thrust on a plane and curved surface, stability of equilibrium.

CO11. gain clear concepts about the relation among pressure volume and temperature, Boyle's and Charles's law, ideal gas, internal energy of a gas, equilibrium of an isothermal atmosphere etc.

B.Sc Hons: 3rd year, Part III (1-1-1 pattern)

Course Title: Mathematical Probability, Statistics and Operations Research
Paper VII
Course Outcomes:
The students who complete this course successfully are expected to:

- **CO1.** know about the basic concept of probability, Boole's inequality and Bonferroni's inequality.
- **CO2.** understand about Random Variables, various Discrete and continuous distribution functions
- **CO3.** gain clearer concepts of Transformation of random variables; Discrete and continuous distribution in two dimension and related area of study
- **CO4.** understand and solve independently the problems on Mathematical expectation in one and two variables, Moments, Measures of skewness and kurtosis, Moment generating function, Characteristic function, Conditional expectation, covariance, co-relation coefficient, Regression curves, and –distribution.
- **CO5.** understand about the concept of convergence in probability, Tchebycheff's inequality, Law of large numbers, Concept of asymptotically normal distribution, Central limit theorem.
- **CO6.** handle the problems of least square and curve fitting.
- **CO7.** gain clearer concepts of sampling theory, sampling distribution.
- **CO8.** understand about Theory of estimation, point estimation, and Interval estimation
- **CO9.** Gain clearer concepts of Testing of hypothesis,
- **CO10.** know about Reduction of a feasible solution to basic feasible solution and learn about some definition and problems.
- **CO11.** Gain clearer concepts of Fundamental theorem of L.P.P and solve various types of problems.
- **CO12.** Learn Simplex method, Big M method, Two phase method
- **CO13.** gain concept of duality, Fundamental theorem of duality, and able to solve problems by Dual simplex method.
- **CO14.** Gain clearer concepts of Transportation Problem and Assignment Problem, and solve problems
- **CO15.** Gain clearer concepts of Theory of Games and solve several of problems.

B.Sc Hons: 3rd year, part III (1-1-1 pattern)

Course Title: Numerical Analysis and Computer Programming
Paper VIII
Course Outcomes:

The students who complete this course successfully are expected to:

CO1. learn Approximation of numbers, Algebraic manipulation for avoiding loss of significance, various types of errors

CO2. learn the importance of Polynomial Interpolations of the knowing the formula like Lagrange's interpolating formula, Newton's divided difference interpolating formula, Newton's forward and backward difference interpolation formulae. central interpolation formulae (Stirling and Bessel's formulae) and their applications.

CO3. gain clearer concept of piece-wise polynomial interpolation and Idea of Inverse interpolation

CO4. become proficient in finding solution of algebraic and transcendental equations numerically by (i) Method of Bisection, (ii) Regula Falsi Method (iii) Secant Method (iv) Newton – Raphson Method (v) Fixed point iteration method and understand their theoretical backgrounds.

CO5. able to get solution of a system of linear algebraic equation by Gauss' Elimination and Gauss Jordan methods, Pivoting methods, Jacobi and Gauss-Seidel methods with convergence criteria

CO6. Become proficient in Numerical Integration by trapezoidal rule, Simpson's one-third rule and understand their theoretical backgrounds.

CO7. Able to solve of first-order ordinary differential equation numerically by Picard's method, Euler's method, Modified Euler's method, Taylor's method, Runge-Kutta's method of second and fourth orders and understand their theoretical backgrounds.

CO8. develop knowledge and experience with the use of the standard C programming language

CO9. develop knowledge of machine language, Assembly language, High-level language, Interpreter, Compiler, Source and Object programs

CO10. gain concepts of binary, decimal, octal and hexadecimal number systems and their conversions

CO11. understand Control Statements, Subscripted variables, Sub-program Simple programs of C programming language

CO12. able to apply Numerical analysis which has enormous application in the field

B.Sc Hons: 3rd year, Part III (1-1-1 pattern)

Course Title: Computer Aided Numerical Methods: Practical (using C programming)

Paper IX

Course Outcomes:

The students who complete this course successfully are expected to:

CO1. write C programme on Interpolation (taking at least six points) by (a) Lagrange's interpolation formula, (b) Newton's Forward Difference formula

CO2. write C programme for solving of a first-order ordinary differential equation by (a) Modified Euler's method, (b) Fourth-order Runge-Kutta method

CO3. write C programme for solving of system of linear equations by Gauss elimination method

CO4. write C programme for Finding a real root of an equation by (a) Fixed point iteration method, (b) Newton-Raphson's method

CO5. write C programme for evaluating Integration (taking at least 10 sub-intervals) by (a) Trapezoidal rule, (b) Simpson's 1/3 rd rule

B. Sc General: 3rd year, Part III (1-1-1 pattern)

Course title: Numerical analysis
Paper: IV
On completion of the course students will be able to

CO1. Apply Numerical analysis which has enormous application in the field of Science and allied fields.

CO2. Familiar with finite precision computation.

CO3. Familiar with calculation and interpretation of errors in numerical method

CO4. Familiar with numerical solutions of nonlinear equations in a single variable

CO5. Familiar with numerical integration and numerical solution of ordinary differential equations. Students will use differential equations to model phenomena arising from various applications and will learn to choose appropriate numerical methods to solve such problems

CO6. become proficient in writing computer programs in C to solve various mathematical problems and will learn to present results in appropriate ways.