RABINDRA MAHAVIDYALAYA

DEPARTMENT OF MATHEMATICS

PROGRAMME OUTCOMES (PO)

Sl.No.	Programme Outcomes
PO1	Scientific temper will be developed in Students.
PO2	Students will acquire basic Practical skills & Technical knowledge along with domain knowledge of different subjects in the science stream.
PO3	Students will become employable; they will be eligible for career opportunities in Industry, or will be able to opt for entrepreneurship.
PO4	Students will possess basic subject knowledge required for higher studies, professional and applied courses like Management Studies, Law etc.
PO5	Students will be aware of and able to develop solution-oriented approach towards various Social and Environmental issues.

PROGRAMME SPECIFIC OUTCOMES (PSO)

Sl.No.	Programme 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	Students will be aware of and able to develop solution-oriented approach towards various Social and Environmental issues.
PSO6	Enabling students to develop a positive attitude towards mathematics as an interesting and valuable subject of study.

COURSE OUTCOMES (CO)

B.Sc. Honours Programme (under CBCS)

SEMESTER - 1

Course Type	Course Code	Name of the Course	Credit Pattern (L:T:P)	Credit
CC	BMH1CC01	Calculus, Geometry & Differential Equations	5:1:0	6

Upon successful completion of this course students will be able to:

CO1	Work with functions represented in a variety of ways: graphical, numerical, analytical, or verbal. They should understand the connections among these representations.
CO2	Understand the meaning of the derivative in terms of a rate of change and local linear approximation and should be able to use derivatives to solve a variety of problems.
CO3	Understand the relationship between the derivative and the definite integral as expressed in both parts of the Fundamental Theorem of Calculus.
CO4	Model a written description of a physical situation with a function, a differential equation, or an integral.
CO5	Evaluate definite and indefinite integrals and use them in applications.
CO6	Explain the relationship between the derivative of a function as a function and the notion of the derivative as the slope of the tangent line to a function at a point.
CO7	Find maxima and minima, critical points and inflection points of functions and to determine the concavity of curves.
CO8	Understand the canonical form of a curve arises from the general equation of 2nd degree.
CO9	Gain an understanding of polar equations of conics, their tangent, normal, chord of contact etc.
CO10	Illustrate of graphing standard quadric surfaces like cone, ellipsoid etc.
CO11	Formulate Differential Equations for various Mathematical models.
CO12	Solve first order non-linear differential equation and linear differential equations of higher order using various techniques.
CO13	Apply these techniques to solve and analyze various mathematical models.

Course Type	Course Code	Name of the Course	Credit Pattern (L:T:P)	Credit
CC	BMH1CC02	Algebra	5:1:0	6

Upon successful completion of this course students will be able to:

CO1	Represent a complex number in its polar form, prove the associated De-Moivre's Theorem and apply it to solve the related mathematical problems, including the problem of finding the nth roots of unity.
CO2	Investigate the nature and location of roots and several other properties of an nth degree equation using Descartes' rule of signs, Sturm's Theorem and the relations between its roots and coefficients.
CO3	Transform an equation to a desired form, in particular transform a cubic equation in its standard form and subsequently, can solve a cubic equation by Cardan's Method and a biquadratic equation by Ferrari's method.
CO4	Solve different types of reciprocal equations.
CO5	Deal with the problems of inequality involving $AM > GM > HM$ and Cauchy-Schwartz inequality.
CO6	Handle the properties and related problems of Modern Algebra involving Equivalence relations, Partition of a set, Functions, Composition of functions, Invertible functions, One to one correspondence, Cardinality of a set etc. and keep themselves ready to apply these concepts suitably to advance studies in all branches of science and whenever necessary, to solve some problems of day to day life.
CO7	Get acquainted with several concepts of Number Theory involving Well-ordering property of positive integers, Division algorithm, Divisibility and Euclidean algorithm, Congruence relation between integers, Principle of Mathematical Induction, Fundamental Theorem of Arithmetic (only statement) etc., solve the related problems and to apply these concepts suitably to advance studies in all branches of science and whenever necessary, to solve some problems of day-to-day life.
CO8	Transform a matrix in the row-reduced Echelon form, use the concept to find the rank of a matrix and subsequently to investigate the consistency and roots of a system of linear equations.
CO9	Compute the inverse of a matrix and investigate the characterizations of invertible matrices.
CO10	Find the Characteristic Equation of a matrix, prove the Caley-Hamilton theorem and finally use this theorem to find the inverse of a matrix.
CO11	Acquire a thorough knowledge of Eigen values and Eigen vectors of a matrix and apply these concepts in other branches of Mathematics and Mathematical Sciences.
CO12	Get a fair idea about Vector spaces and subspaces, in particular, vector spaces and subspaces of $\mathbb{R}^n$ and its dimension.

SEMESTER - 2

Course Type	Course Code	Name of the Course	Credit Pattern (L:T:P)	Credit
CC	BMH2CC03	Real Analysis	5:1:0	6

Upon successful completion of this course students will be able to:

CO1	Investigate the Algebraic and order properties of $\mathbb{R}$, get acquainted with the ideas of countable and uncountable sets including uncountability of R and utilise these concepts in the other branches of higher mathematics.
CO2	Get fair knowledge of bounded and unbounded sets, suprema and infima, Completeness and its equivalent Properties, Archimedean Property and Density property of $\mathbb{R}$ and whenever necessary, utilize these concepts in the other branches of higher mathematics.
CO3	Investigate different properties of subsets of $\mathbb{R}$, using the concepts of Intervals, neighbourhood of a point, interior point, limit point, isolated point of a subset of $\mathbb{R}$, open sets, closed sets, derived sets, compact sets in $\mathbb{R}$, prove Bolzano-Weierstrass Theorem for sets, Heine-Borel Theorem and keep themselves ready to use these concepts in post-graduate studies.
CO4	Deal with the properties of Sequence of real numbers involving the concepts - Limit of a sequence, Limit inf., Limit sup., Limit Theorems, Monotone Convergence Theorem, subsequences, Monotone subsequence Theorem, Bolzano-Weierstrass Theorem for sequence, Cauchy sequence and Cauchy's Convergence Criterion.
CO5	Deal with the properties of Infinite Series of real numbers involving the concepts – Convergence & divergence of infinite series, Comparison Tests, Ratio Test, Cauchy's n^{th} root test, Integral test, Alternating series, Leibnitz test and Absolute/Conditional convergence.

Course Type	Course Code	Name of the Course	Credit Pattern (L:T:P)	Credit
CC	BMH2CC04	Differential Equations and Vector Calculus	5:1:0	6

Upon successful completion of this course students will be able to:

CO1	Solve differential equations of first order using graphical, numerical, and analytical methods.
CO2	Solve and apply linear differential equations of second order (and higher).
CO3	Find power series solutions of differential equations.
CO4	Develop the ability to apply differential equations to significant applied and/or theoretical problems.
CO5	Solve problems in ordinary differential equations, dynamical systems, stability theory, and a number of applications to scientific and engineering problems.
CO6	Demonstrate their understanding of how physical phenomena are modelled by differential equations.
CO7	Implement solution methods using appropriate technology.
CO8	Investigate the qualitative behaviour of solutions of systems of differential equations and interpret in the context of an underlying model.
CO9	Represent vectors analytically and geometrically, and compute dot and cross products for presentations of lines and planes.
CO10	Understand the meaning of vector triple product & its application.
CO11	Solve various types of differentiation & integration of vector function.
CO12	Build solutions to differential equations by superposition of known solutions.
CO13	Find the complete solution of a non-homogeneous differential equation with constant coefficients by the method of undetermined coefficients.

SEMESTER - 3

Course Type	Course Code	Name of the Course	Credit Pattern (L:T:P)	Credit
CC	BMH3CC05	Theory of Real Functions & Introduction to Metric Space	5:1:0	6

Upon successful completion of this course students will be able to:

CO1	Define Limits, continuity and Uniform Continuity of real functions along with the sequential criterion for the first two, investigate several properties of limits and continuity including intermediate value theorem, Location of roots theorem & preservation of intervals theorem and keep themselves ready to use these concepts in higher studies of Mathematics and other branches of science.
CO2	Get acquainted with the concepts of Differentiability of a function at a point and in an interval, prove the associated theorems, viz., Caratheodory's theorem, Rolle's theorem. Mean value theorems, Darboux's theorem etc., apply these theorems to solve different problems of higher mathematics and as an application of differential calculus, can handle the problems of Curvature.
CO3	Prove Cauchy's mean value theorem, Taylor's theorem with Lagrange's form of remainder, Taylor's theorem with Cauchy's form of remainder etc., derive Taylor's series, Maclaurin's series expansions of exponential and trigonometric functions, $\ln(1+x)$, $\frac{1}{ax+b}$ and $(1+x)^n$ and apply Taylor's theorem to convex functions and to solve inequalities.
CO4	Get elementary ideas of Metric spaces including the concepts – definition and examples, Open and closed balls, neighbourhoods, open sets, interior of a set, Limit point of a set, closed sets, diameter of a set, subspaces, dense sets, separable spaces etc. and keep themselves ready to apply these ideas in the higher studies of Mathematics and other branches Science.

Course Type	Course Code	Name of the Course	Credit Pattern (L:T:P)	Credit
CC	BMH3CC06	Group Theory I	5:1:0	6

Upon successful completion of this course students will be able to:

CO1	Analyze and justify whether a given mathematical structure forms a group or not and also realize the general properties of group and its applications.
CO2	Understand and realize the properties of different groups including Dihedral group, Quaternion group and permutation group.
CO3	Understand the concepts of subgroups, cyclic subgroups, normal subgroups, quotient group and its examples and also able to understand the cosets, Lagrange's theorem and its application.
CO4	Understand the idea of external direct product of finite number of groups. Student will be able to analyze Cauchy's theorem for finite abelian group and its consequences.
CO5	Know about the Factor Groups and external direct product for finite number of Groups.
CO6	Get elementary ideas on Homomorphism and Isomorphism of Groups with their properties and prove important theorems like Cayley's theorem based on it.
CO7	Analyze and understand the concepts about first, second, third isomorphism theorem.
CO8	Understand the concepts and properties of Normal Subgroups, prove the Cayley's theorems for non-abelian Groups and study its applicability.

Course Type	Course Code	Name of the Course	Credit Pattern (L:T:P)	Credit
CC	BMH3CC07	Numerical Methods & Numerical Methods Lab	5:1:0	6

Upon successful completion of this course students will be able to:

CO1	Analyse the error incumbent in any such numerical approximation.
CO2	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.
CO3	Interpolation techniques to compute the values for a tabulated function at points not in the table.
CO4	Applications of numerical differentiation and integration to convert differential equations into difference equations for numerical solutions.
CO5	Derive numerical methods for approximating the solution of problems of continuous mathematics.
CO6	Analyse the error incumbent in any such numerical approximation.
CO7	Implement solution methods using appropriate technology.
CO8	Implement a variety of numerical algorithms using appropriate technology.
CO9	Compare the viability of different approaches to the numerical solution of problems arising in roots of solution of non-linear equations, interpolation and approximation, numerical differentiation and integration, solution of linear systems.
CO10	Write code using for/do loops, while constructions, conditional statements (if, then, else), and make use of logical constructs in the context of mathematics
CO11	Identify algorithms with which to solve mathematical problems.
CO12	Verify the correctness of a solution or decide whether the result is an acceptable approximation to the solution
CO13	Write programs from the underlying algorithms, and demonstrate the ability to employ good commenting and coding techniques.

Course Type	Course Code	Name of the Course	Credit Pattern (L:T:P)	Credit
SEC	BMH3SEC11	Logic and Sets	2:0:0	2

Upon successful completion of this course students will be able to:

CO1	Acquire fair knowledge and understanding in Propositional Logic including the concepts- Propositions, Truth table, Negation, Conjunction, Disjunction, Implications, Bi-conditional propositions, converse, contrapositive and inverse propositions, precedence of logical operators etc. and deal with Propositional equivalence and Logical equivalence.
CO2	Get introductory knowledge of Predicate Logic including the concepts - Quantifiers, Binding variables and Negations.
CO3	Describe Sets, subsets, finite and infinite sets, empty set, classes of sets, Power set of a set, Venn diagrams, counting principle etc. with proper examples, perform Set operations to establish the laws of set theory and investigate the properties of empty set.
CO4	Prove Set identities using Difference and Symmetric difference of two sets and establish several laws of set theory using Generalized union and intersections.
CO5	Describe Relation using Cartesian Product of sets, along with the concepts - Composition of relations, Types of relations, Partitions, Equivalence Relations etc., giving proper examples of each concept.
CO6	Explain the concepts- congruence modulo relation. Partial ordering relations, n-array relations.

SEMESTER - 4

Course Type	Course Code	Name of the Course	Credit Pattern (L:T:P)	Credit
CC	BMH4CC08	Riemann Integration and Series of Functions	5:1:0	6

Upon successful completion of this course students will be able to:

CO1	Understanding the history and theoretical concept of Integration and its geometrical significance.
CO2	Understand Partition and refinement of partition of a closed and bounded interval.
CO3	Visualize Upper Darboux sum $U(P, f)$ and Lower Darboux sum $L(P, f)$ and their relations and their application in Upper integral and lower integral.
CO4	Realize Darboux's theorem along with its application for finding integration over a closed and bounded interval.
CO5	Learn Riemann sum, Riemann's definition of integrability and its Equivalence with Darboux definition of integrability along with the Necessary and sufficient condition for Riemann integrability.
CO6	Learn that a bounded function on a closed and bounded interval is Riemann integrable if and only if the function is continuous, monotone or no. of points of discontinuity is finite or set of points of discontinuity have finite no. of limit points.
CO7	Develop the idea of antiderivative, primitive and some properties of Riemann Integrable function.
CO8	Understand the Fundamental theorem of Integral Calculus & First Mean Value theorem of integral calculus.
CO9	Understand in which Range the integration-finite or infinite converges and learn the Necessary and sufficient condition for convergence of improper integral in both cases.
CO10	Learn the Tests of convergence: Comparison and M-test, absolute and non-absolute convergence, Abel's and Dirichlet's test for convergence on the integral of a product
CO11	Know about Beta and Gamma function and learn how to apply it for finding the value of integration.
CO12	Develop the idea of sequence of functions defined on a set, Pointwise and uniform convergence, Cauchy criterion of uniform convergence, Mn- test, continuity, integrability and differentiability of the limit function of a sequence of functions in case of uniform convergence.
CO13	Develop the idea of series of functions defined on a set, Pointwise and uniform convergence, Cauchy criterion of uniform convergence, Weierstrass' M-test, Passage to the limit term by term, integrability, differentiability of a series of functions in case of uniform convergence.

CO14	Understand the concept of power series, Cauchy-Hadamard theorem, how to find the radius of convergence, uniform and absolute convergence of power series, Abel's limit theorems, Uniqueness of power series having sum function.
CO15	Understand the concept of Fourier series,statement of sufficient condition for a trigonometric series to be a Fourier series, Fourier coefficients for periodic functions defined on $[-\pi, \pi]$. Statement of Dirichlet's condition of convergence, Statement of theorem of sum of Fourier series.

Course Type	Course Code	Name of the Course	Credit Pattern (L:T:P)	Credit
CC	BMH4CC09	Multivariate Calculus	5:1:0	6

Upon successful completion of this course students will be able to:

CO1	Compute limits, continuity and derivatives of functions of two, three or more variables.
CO2	The conceptual variations when advancing in calculus from one variable to multivariable discussions.
CO3	Understand inter-relationship amongst the line integral, double and triple integral formulations.
CO4	Evaluate double and triple integrals for area and volume.
CO5	Evaluate line integrals directly and by the fundamental theorem.
CO6	Differentiate vector fields.
CO7	Determine gradient vector fields and find potential functions.
CO8	Applications of multi variable calculus tools in physics, economics, optimization, and understanding the architecture of curves and surfaces in plane and space etc.
CO9	Analyze vector functions to find derivatives, tangent lines, integrals, arc length, and curvature.
CO10	Relate the surface and volume integral by Gauss divergence theorem.
CO11	Understand the solenoidal and irrotational vectors.
CO12	Exhibit the inter dependence of line, surface and volume integrals.
CO13	Apply the knowledge of some methods in the modelling of various physical and engineering phenomena.

Course Type	Course Code	Name of the Course	Credit Pattern (L:T:P)	Credit
CC	BMH4CC10	Ring Theory and Linear Algebra I	5:1:0	6

Upon successful completion of this course students will be able to:

CO1	Understanding the structure of different Rings and their properties. Create concept about the connection between Rings and Groups.
CO2	Understanding the concept and properties of Subrings, Integral domains and fields and interlink between these. Understand the importance of characteristic of a Ring and its usefulness for field.
CO3	Understanding the concept of Ideals and their structure. And also understand its operations and classification. Like as prime ideals and maximal ideals. Trying to understand the similar concept for normal subgroup of a Group and ideals for a Ring.
CO4	Creating Clean idea on Homomorphism and Isomorphism of Rings with their properties and the important theorems based on it. Also remind the concept for Homomorphism and Isomorphism for Group and see how similar structure they are corresponding to Homomorphism and Isomorphism of Ring.

Course Type	Course Code	Name of the Course	Credit Pattern (L:T:P)	Credit
SEC	BMH4SEC21	Graph Theory	2:0:0	2

Upon successful completion of this course students will be able to:

CO1	Develop the knowledge of Graph, subgraph their representations, degree, out-degree, in-degree and algebraic operations, isomorphism of graphs.
CO2	Develop the knowledge to classify the graph into pseudo graph, complete graph, bipartite graphs, diagraph and to construct electrical circuits using the concept of connectivity of directed graph.
CO3	Learn to differentiate Eulerian and Hamiltonian graphs by using necessary and sufficient conditions and know Eulerian circuit, Hamiltonian cycle and their related results.
CO4	Learn matrix representation of graph and classify them into Adjacency matrix and Incidence matrix.
CO5	Characterize tree, spanning tree, minimum spanning trees and their related results, apply Kruskal's algorithm to construct minimum spanning tree.
CO6	Develop algorithm for shortest path between two vertices and learn about travelling salesman problem.
CO7	Emphasis on some of the concepts in graph theory and formulate graph theoretic models to solve real world problems in day today life.

SEMESTER - 5

Course Type	Course Code	Name of the Course	Credit Pattern (L:T:P)	Credit
CC	BMH5CC11	Partial Differential Equations and Applications	5:1:0	6

Upon successful completion of this course students will be able to:

CO1	Formulate, classify and transform partial differential equations into canonical form.
CO2	Solve linear and non-linear partial differential equations using various methods; and apply these methods in solving some physical problems.
CO3	Be familiar with the modelling assumptions and derivations that lead to PDEs.
CO4	Recognize the major classification of PDEs and the qualitative differences between the classes of equations.
CO5	Be competent in solving linear PDEs using classical solution methods.
CO6	Form a PDE after eliminating constant and arbitrary functions.
CO7	Reduce a second order PDE to its canonical form and solve it.
CO8	Apply boundary value conditions to PDE.
CO9	Use the Fourier series expansion in solving elliptic differential equations.
CO10	Obtain a solution for diffusion equation using method separation of variables.
CO11	Obtain a solution of wave equation.
CO12	Demonstrate various physical models through higher order partial equations and solve such linear partial differential equations.
CO13	Construct a variety of partial differential equations and solution by exact methods/method of separation of variables.

Course Type	Course Code	Name of the Course	Credit Pattern (L:T:P)	Credit
CC	BMH5CC12	Mechanics I	5:1:0	6

Upon successful completion of this course students will be able to:

CO1	Solve problems in the equilibrium of point or rigid bodies.
CO2	Solve problems of forces in 2 and 3 dimensions.
CO3	Discuss the linear motion of a particle and also for a system of particles.
CO4	Understand, evaluate and describe the theories, concepts and principles of the current knowledge for a particle and a rigid body.
CO5	Define angular momentum for a particle and a system of particles.
CO6	Solve problems in rotational motion and the orbits of planets and other celestial bodies.
CO7	Will demonstrate an ability to apply fundamental rigid-body mechanics concepts to set up and solve problems such as equilibrium and force-balance problems for a rigid body.
CO8	Define moment of inertia and product of inertia and use it in simple problems.
CO9	Explain the origin of the Coriolis and centrifugal terms in the equation of motion in a rotating frame.
CO10	Students will demonstrate an ability to apply skills in mathematics and physics to solve engineering mechanics problems.
CO11	Master appropriate analytical, theoretical and/or practical techniques to further their understanding and skills in the chosen topic.

Course Type	Course Code	Name of the Course	Credit Pattern (L:T:P)	Credit
DSE	BMH5DSE11	Linear Programming	5:1:0	6

Upon successful completion of this course students will be able to:

CO1	Formulate a given simplified description of a suitable real-world problem as a linear programming model in general, standard and canonical forms.
CO2	Sketch a graphical representation of a two-dimensional linear programming model given in general, standard or canonical form.
CO3	Solve a two-dimensional linear programming problem graphically.
CO4	Use the simplex method to solve small linear programming models by hand, given a basic feasible point.
CO5	Use the two-phase method to solve linear programming models by hand.
CO6	Use the Big-M method to solve linear programming models by hand.
CO7	Know about Duality, formulation of dual problem, primal dual relationship, etc.
CO8	Use the Dual Simplex method to solve linear programming models by hand.
CO9	Be able to identify the special features of the transportation problem.
CO10	Become familiar with the types of problems that can be solved by applying a transportation model.
CO11	Be able to develop network and linear programming models of the transportation problem.
CO12	Know how to handle the cases of (1) unequal supply and demand, (2) unacceptable routes, and (3) maximization objective for a transportation problem.
CO13	Be able to identify the special features of the assignment problem.
CO14	Become familiar with the types of problems that can be solved by applying an assignment model.
CO15	Be able to develop network and linear programming models of the assignment problem.
CO16	Be able to identify the special features of the assignment problem.

Course Type	Course Code	Name of the Course	Credit Pattern (L:T:P)	Credit
DSE	BMH5DSE21	Probability and Statistics	5:1:0	6

Upon successful completion of this course students will be able to:

CO1	Compute probabilities and conditional probabilities in appropriate ways.
CO2	Use various methods to compute the probabilities of different types of events.
CO3	Analyze and interpret statistical data using appropriate probability distributions, e.g. binomial, Poisson and normal.
CO4	Perform a regression analysis, and compute and interpret the coefficient of correlation.
CO5	Organize, present and interpret statistical data, both numerically and graphically.
CO6	Apply central limit theorem to describe inferences.
CO7	Identify and demonstrate appropriate sampling and data collection processes.
CO8	Classify variables as quantitative or categorical, create appropriate numerical and graphical summaries for each type, and use these to explain/identify relationships between variables.
CO9	Explain and successfully apply the Central Limit Theorem appropriately to describe inferences using normal distributions.
CO10	Represent and statistically analyze data both graphically and numerically.
CO11	Explain and successfully apply all aspects of appropriate non-parametric tests.
CO12	Construct and interpret confidence intervals to estimate means, standard deviations and proportions for populations.
CO13	Explain and successfully apply all aspects of parametric testing techniques including single and multi-sample tests for mean and proportion.

SEMESTER - 6

Course Type	Course Code	Name of the Course	Credit Pattern (L:T:P)	Credit
CC	BMH6CC13	Metric Spaces and Complex Analysis	5:1:0	6

Upon successful completion of this course students will be able to:

CO1	Develop a clear concept about definition and examples of metric spaces, open ball, open set, closed set as complement of open set, interior point and interior of a set, limit point and closure of a set, boundary point and boundary of a set, diameter of a set, distance between two sets and Subspace of a metric space.
CO2	Expand their knowledge from Real space to Metric space about convergent sequences, Cauchy sequences and their properties.
CO3	Acquire a thorough knowledge of Complete metric space, Incomplete metric space and their examples, properties, comes to know Cauchy sequences may not converge and Cantor's intersection theorem.
CO4	Understand the extension of Continuous mappings, sequential criterion of continuity, Uniform continuity from real space to metric space.
CO5	Understand Compactness, Sequential compactness, Heine-Borel theorem in R, Finite intersection property, continuous functions on compact sets, relation between compactness and uniform continuity.
CO6	Develop their concept of connectedness and some examples of connected metric space, connected subsets of R, C, any interval in Real is connected.
CO7	Understand Contraction mappings, Banach Fixed point Theorem and its application to ordinary differential equations.
CO8	Develop the concepts of derivative, differentiability and analytic functions and will be familiar with the elementary complex functions, their properties, Cauchy-Riemann equations and sufficient condition for differentiability.
CO9	Get acquainted with several concepts of power series, Cauchy-Hadamard theorem, determination of radius of convergence, Uniform and absolute convergence of power series, analytic functions represented by power series, uniqueness of power series.
CO10	Understand the concept of contours, complex integration along a contour and its examples, upper bounds for moduli of contour integrals, ML-inequality, Cauchy-Goursat theorem (statement only) and its consequences, Cauchy integral formula.
CO11	Represent functions as Taylor, power and Laurent series, compute Laurent series and its examples.
CO12	Students will demonstrate the ability of different problems on metric space and some important theorem on complex analysis by presentation.

Course Type	Course Code	Name of the Course	Credit Pattern (L:T:P)	Credit
CC	BMH6CC14	Ring Theory and Linear Algebra II	5:1:0	6

Upon successful completion of this course students will be able to:

CO1	Understand and remember the properties of polynomial rings.
CO2	Understand the concepts of divisibility, irreducibility of integers in a ring and also able to understand the knowledge of ED, PID, UFD.
CO3	Understand the definition of dual spaces, double dual spaces, and able to realize the identification of transformations in double dual space with the vectors.
CO4	Determine the Jordan form and other canonical forms of a linear transformation.
CO5	Acquire knowledge about the concepts of inner product spaces and also able to construct an orthonormal basis of a vector space by Gram-Schimdt process.
CO6	Visualize Orthogonal projections and analyze a linear transformation by Spectral Theory.

Course Type	Course Code	Name of the Course	Credit Pattern (L:T:P)	Credit
DSE	BMH6DSE33	Group Theory II	5:1:0	6

Upon successful completion of this course students will be able to:

CO1	Understand the knowledge about automorphism, inner automorphism and automorphism group and also able to understand characteristic subgroup and commutator subgroup and its properties.
CO2	Understand the properties of external direct product and internal direct product.
CO3	Understand and remember the fundamental theorem for finite abelian groups. Also determine the number non-isomorphic abelian groups of a given order.
CO4	Understand the definition of Group actions, stabilizers and kernels and also Gain knowledge about the permutation representation associated with a given group action and will learn the application of Group action.
CO5	Understand Generalized Cayley's theorem, Index theorem and Gain Knowledge how can apply these theorems to Group theory. They will be able to understand and remember the class equation of a group and its consequences.
CO6	Understand and remember the Sylow's theorem and consequences and understand Cauchy theorem and learn apply these theorems to test whether a given group is simple or not.

Course Type	Course Code	Name of the Course	Credit Pattern (L:T:P)	Credit
DSE	BMH6DSE43	Mechanics II	5:1:0	6

Upon successful completion of this course students will be able to:

CO1	Understand the interpretation of Newton's laws of motion and Galilean transformation.
CO2	Understand the concept of absolute length and time. Also know the limitations of Newton's laws in solving problems.
CO3	Understand the equilibrium of fluid in a given field of force and analyze the pressure in a heavy homogeneous liquid. Also, they can acquire the knowledge of equilibrium of floating bodies.
CO4	Acquire the knowledge of Isothermal and Adiabatic changes in Gases, Convective equilibrium, Stress in continuum body and Stress quadric.
CO5	Determine the constraints and their classifications and gather knowledge about Lagrange's equation of motion for holonomic system.
CO6	Analyze Gibbs-Appell's principle of least constraint and Work-energy relation for constraint forces of shielding friction.

Course Type	Course Code	Name of the Course	Credit Pattern (L:T:P)	Credit
PW	BMH6PW01	Project Work	0:0:6	6

Upon successful completion of this course students will be able to:

CO1	Choose a topic of their own interest.
CO2	Formulate, analyse, and interpret mathematical models.
CO3	Build confidence and develop communication skills through the presentation of their project work.
CO4	Get preliminary concept of research in mathematics.
CO5	Gain in-depth knowledge independently in the specific topic.
CO6	Understand the core findings of their project and their applicability in practice .

COURSE OUTCOMES (CO)

B.Sc. General Programme (under CBCS)

SEMESTER - 1

Course Type	Course Code	Name of the Course	Credit Pattern (L:T:P)	Credit
CC	BMG1CC1A	Differential Calculus	5:1:0	6

Upon successful completion of this course students will be able to:

CO1	Work with functions represented in a variety of ways: graphical, numerical, analytical, or verbal. They should understand the connections among these representations.
CO2	Understand the meaning of the derivative in terms of a rate of change and local linear approximation and should be able to use derivatives to solve a variety of problems.
CO3	Explain the relationship between the derivative of a function as a function and the notion of the derivative as the slope of the tangent line to a function at a point.
CO4	Find maxima and minima, critical points and inflection points of functions and to determine the concavity of curves.
CO5	Apply these techniques to solve and analyze various mathematical models.

SEMESTER - 2

Course Type	Course Code	Name of the Course	Credit Pattern (L:T:P)	Credit
CC	BMG2CC1B	Differential Equations	5:1:0	6

Upon successful completion of this course students will be able to:

CO1	Solve differential equations of first order using graphical, numerical, and analytical methods.
CO2	Solve and apply linear differential equations of second order (and higher). Find the complete solution of a non-homogeneous differential equation with constant coefficients by the method of variation of parameters.
CO3	Form a PDE after eliminating constant and arbitrary functions. Formulate, classify and transform partial differential equations into canonical form.
CO4	Recognize the major classification of PDEs and the qualitative differences between the classes of equations.

CO5	Solve linear and non-linear partial differential equations using various methods; and apply these methods in solving some physical problems.
CO6	Develop the ability to apply differential equations to significant applied and/or theoretical problems.

SEMESTER - 3

Course Type	Course Code	Name of the Course	Credit Pattern (L:T:P)	Credit
CC	BMG3CC1C	Real Analysis	5:1:0	6

Upon successful completion of this course students will be able to:

CO1	Investigate the Algebraic and order properties of $\mathbb{R}$, get acquainted with the ideas of countable and uncountable sets including uncountability of R and utilise these concepts in the other branches of higher mathematics.
CO2	Get fair knowledge of bounded and unbounded sets, suprema and infima, Completeness and its equivalent Properties, Archimedean Property and Density property of $\mathbb{R}$ and whenever necessary, utilize these concepts in the other branches of higher mathematics.
CO3	Investigate different properties of subsets of $\mathbb{R}$, using the concepts of Intervals, neighbourhood of a point, interior point, limit point, isolated point of a subset of $\mathbb{R}$, open sets, closed sets, derived sets, compact sets in $\mathbb{R}$, prove Bolzano-Weierstrass Theorem for sets, Heine-Borel Theorem and keep themselves ready to use these concepts in post-graduate studies.
CO4	Deal with the properties of Sequence of real numbers involving the concepts - Limit of a sequence, Limit inf., Limit sup., Limit Theorems, Monotone Convergence Theorem, subsequences, Monotone subsequence Theorem, Bolzano-weierstrass Theorem for sequence, Cauchy sequence and Cauchy's Convergence Criterion.
CO5	Understand the point-wise and uniform convergence of a sequence and series of real valued functions.
CO6	Understand and analyze the Power series and its radius of convergence and concept of Cauchy-Hadamard theorem.

SEMESTER - 4

Course Type	Course Code	Name of the Course	Credit Pattern (L:T:P)	Credit
CC	BMG4CC1D	Algebra	5:1:0	6

Upon successful completion of this course students will be able to:

CO1	Analyze and justify whether a given mathematical structure forms a group or not and also realize the general properties of group and its applications.
CO2	Understand and realize the properties of different groups including Dihedral group, Quaternion group and permutation group.
CO3	Understand the concepts of subgroups, cyclic subgroups, normal subgroups, quotient group and its examples and also able to understand the cosets, Lagrange's theorem and its application.
CO4	Understand the idea of external direct product of finite number of groups. Student will be able to analyze Cauchy's theorem for finite abelian group and its consequences.
CO5	Understand the concepts and properties of Normal Subgroups, prove the Cayley's theorems for non-abelian Groups and study its applicability.
CO6	Understanding the structure of different Rings and their properties. Create concept about the connection between Rings and Groups.
CO7	Understanding the concept and properties of Subrings, Integral domains and fields and interlink between these. Understand the importance of characteristic of a Ring and its usefulness for field.

SEMESTER - 5

Course Type	Course Code	Name of the Course	Credit Pattern (L:T:P)	Credit
DSE	BMG5DSE1A1	Matrices	5:1:0	6

Upon successful completion of this course students will be able to:

CO1	Transform a matrix in the row-reduced Echelon form, use the concept to find the rank of a matrix and subsequently to investigate the consistency and roots of a system of linear equations.

CO2	Compute the inverse of a matrix and investigate the characterizations of invertible matrices.
CO3	Find the Characteristic Equation of a matrix, prove the Caley-Hamilton theorem and finally use this theorem to find the inverse of a matrix.
CO4	Acquire a thorough knowledge of Eigen values and Eigen vectors of a matrix and apply these concepts in other branches of Mathematics and Mathematical Sciences.
CO5	Learn to apply these techniques to solve and analyze various mathematical problems in Geometry, Physics, Chemistry, Combinatorics and Statistics.

SEMESTER - 6

Course Type	Course Code	Name of the Course	Credit Pattern (L:T:P)	Credit
DSE	BMG6DSE1B3	Linear Programming	5:1:0	6

Upon successful completion of this course students will be able to:

CO1	Get introduction to linear programming problems, Graphical solution of LPP.
CO2	Gain knowledge about Convex sets. Basic solutions and non-basic solutions. Reduction of B.F.S from B.S.
CO3	Analyze Optimality and Unboundedness.
CO4	Understand Simplex method, Two-phase method, Big- method and their comparison.
CO5	Learn Duality, formulation of the dual problem, primal-dual relationships, economic interpretation of the dual.