B.Sc. (Hons.) Mathematics
Learning Outcomes

The completion of the B.Sc. (Hons.) Mathematics Programme will enable a student to:

i) Communicate mathematics effectively by written, computational and graphic means.

ii) Create mathematical ideas from basic axioms.

iii) Gauge the hypothesis, theories, techniques and proofs provisionally.

iv) Utilize mathematics to solve theoretical and applied problems by critical understanding, analysis and synthesis.

v) Identify applications of mathematics in other disciplines and in the real-world, leading to enhancement of career prospects in a plethora of fields and research.

Semester-I
BMATH101: Calculus

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

BMATH102: Algebra

Course Learning Outcomes: This course will enable the students to:
i) Employ De Moivre's theorem in a number of applications to solve numerical problems.
ii) Learn about equivalent classes and cardinality of a set.
iii) Use modular arithmetic and basic properties of congruences.
iv) Recognize consistent and inconsistent systems of linear equations by the row echelon form of the augmented matrix.
v) Find eigenvalues and corresponding eigenvectors for a square matrix.

रिंग रोड, राजा गार्डन, नई दिल्ली-110027 / Ring Road, Raja Garden, New Delhi – 110027 • ऑफिस/Off.: 011-25155551
टेलीफैक्स/Telefax: 011-25116644 • ई-मेल/Email: shivajicollege.ac@gmail.com • वेब/Website: www.shivajicollege.ac.in

Semester-II
BMATH203: Real Analysis

Course Learning Outcomes: This course will enable the students to:
i) Understand many properties of the real line $\mathbb{R}$, including completeness and Archimedean properties.
ii) Learn to define sequences in terms of functions from $\mathbb{N}$ to a subset of $\mathbb{R}$.
iii) Recognize bounded, convergent, divergent, Cauchy and monotonic sequences and to calculate their limit superior, limit inferior, and the limit of a bounded sequence.
iv) Apply the ratio, root, alternating series and limit comparison tests for convergence and absolute convergence of an infinite series of real numbers.

BMATH204: Differential Equations

Course Learning Outcomes: The course will enable the students to:
i) Learn basics of differential equations and mathematical modeling.
ii) Formulate differential equations for various mathematical models.
iii) Solve first order non-linear differential equations and linear differential equations of higher order using various techniques.
iv) Apply these techniques to solve and analyze various mathematical models.

Semester-III
BMATH305: Theory of Real Functions

Course Learning Outcomes: This course will enable the students to:
i) Have a rigorous understanding of the concept of limit of a function.
ii) Learn about continuity and uniform continuity of functions defined on intervals.
iii) Understand geometrical properties of continuous functions on closed and bounded intervals.
iv) Learn extensively about the concept of differentiability using limits, leading to a better understanding for applications.
v) Know about applications of mean value theorems and Taylor's theorem.

BMATH306: Group Theory-I

Course Learning Outcomes: The course will enable the students to:
i) Recognize the mathematical objects that are groups, and classify them as abelian, cyclic and permutation groups, etc.
ii) Link the fundamental concepts of groups and symmetrical figures.
iii) Analyze the subgroups of cyclic groups and classify subgroups of cyclic groups.
iv) Explain the significance of the notion of cosets, normal subgroups and factor groups.
v) Learn about Lagrange's theorem and Fermat's Little theorem.
vi) Know about group homomorphisms and group isomorphisms.

BMATH307: Multivariate Calculus

Course Learning Outcomes: This course will enable the students to:

i) Learn the conceptual variations when advancing in calculus from one variable to multivariable discussion.
ii) Understand the maximization and minimization of multivariable functions subject to the given constraints on variables.
iii) Learn about inter-relationship amongst the line integral, double and triple integral formulations.
iv) Familiarize with Green's, Stokes' and Gauss divergence theorems.

Skill Enhancement Paper
SEC-1: LaTeX and HTML

Course Learning Outcomes: After studying this course the student will be able to:
i) Create and typeset a LaTeX document.
ii) Typeset a mathematical document using LaTex.
iii) Learn about pictures and graphics in LaTex.
iv) Create beamer presentations.
v) Create web page using HTML.

Semester-IV
BMATH408: Partial Differential Equations

Course Learning Outcomes: The course will enable the students to:
i) Formulate, classify and transform first order PDEs into canonical form.
ii) Learn about method of characteristics and separation of variables to solve first order PDE's.
iii) Classify and solve second order linear PDEs.
iv) Learn about Cauchy problem for second order PDE and homogeneous and nonhomogeneous wave equations.
v) Apply the method of separation of variables for solving many well-known second order PDEs.

BMATH409: Riemann Integration & Series of Functions

Course Learning Outcomes: The course will enable the students to:
i) Learn about some of the classes and properties of Riemann integrable functions, and the applications of the Fundamental theorems of integration.
ii) Know about improper integrals including, beta and gamma functions.
iii) Learn about Cauchy criterion for uniform convergence and Weierstrass M-test for uniform convergence.
iv) Know about the constraints for the inter-changeability of differentiability and inerrability with infinite sum.
v) Approximate transcendental functions in terms of power series as well as, differentiation and integration of power series.

BMATH410: Ring Theory & Linear Algebra-I

Course Learning Outcomes: The course will enable the students to:
i) Learn about the fundamental concept of rings, integral domains and fields.
ii) Know about ring homomorphisms and isomorphisms theorems of rings.
iii) Learn about the concept of linear independence of vectors over a field, and the dimension of a vector space.

iv) Basic concepts of linear transformations, dimension theorem, matrix representation of a linear transformation, and the change of coordinate matrix.

Skill Enhancement Paper
SEC-2: Computer Algebra Systems and Related Software

Course Learning Outcomes: This course will enable the students to:
i) Use of computer algebra systems (Mathematica/MATLAB/Maxima/Maple etc.) as a calculator, for plotting functions and animations
ii) Use of CAS for various applications of matrices such as solving system of equations and finding eigenvalues and eigenvectors.
iii) Understand the use of the statistical software **R** as calculator and learn to read and get data into **R.**
iv) Learn the use of **R** in summary calculation, pictorial representation of data and exploring relationship between data.
v) Analyze, test, and interpret technical arguments on the basis of geometry.

Semester-V
BMATH511: Metric Spaces

Course Learning Outcomes: The course will enable the students to:
i) Learn various natural and abstract formulations of distance on the sets of usual or unusual entities. Become aware one such formulations leading to metric spaces.
ii) Analyse how a theory advances from a particular frame to a general frame.
iii) Appreciate the mathematical understanding of various geometrical concepts, viz. balls or connected sets etc. in an abstract setting.
iv) Know about Banach fixed point theorem, whose far-reaching consequences have resulted into an independent branch of study in analysis, known as fixed point theory.
v) Learn about the two important topological properties, namely connectedness and compactness of metric spaces.

BMATH512: Group Theory-II

Course Learning Outcomes: The course shall enable students to:
i) Learn about automorphisms for constructing new groups from the given group.
ii) Learn about the fact that external direct product applies to data security and electric circuits.
iii) Understand fundamental theorem of finite abelian groups.
iv) Be familiar with group actions and conjugacy in ._.
v) Understand Sylow theorems and their applications in checking nonsimplicity.

DSE-1 (i): Numerical Analysis

Course Learning Outcomes: The course will enable the students to:
i) Learn some numerical methods to find the zeroes of nonlinear functions of a single variable and solution of a system of linear equations, up to a certain given level of precision.
ii) Know about methods to solve system of linear equations, such as Gauss−Jacobi, Gauss−Seidel and SOR methods.
iii) Interpolation techniques to compute the values for a tabulated function at points not in the table.

iv) Applications of numerical differentiation and integration to convert differential equations into difference equations for numerical solutions.

DSE-1 (ii): Mathematical Modeling and Graph Theory

Course Learning Outcomes: The course will enable the students to:
i) Know about power series solution of a differential equation and learn about Legendre's and Bessel's equations.
ii) Use of Laplace transform and inverse transform for solving initial value problems.
iii) Learn about various models such as Monte Carlo simulation models, queuing models, and linear programming models.
iv) Understand the basics of graph theory and learn about social networks, Eulerian and Hamiltonian graphs, diagram tracing puzzles and knight's tour problem.

DSE-2 (i): Probability Theory and Statistics

Course Learning Outcomes: This course will enable the students to:
i) Learn about probability density and moment generating functions.
ii) Know about various univariate distributions such as Bernoulli, Binomial, Poisson, gamma and exponential distributions.
iii) Learn about distributions to study the joint behavior of two random variables.
iv) Measure the scale of association between two variables, and to establish a formulation helping to predict one variable in terms of the other, i.e., correlation and linear regression.
v) Understand central limit theorem, which helps to understand the remarkable fact that**:** the empirical frequencies of so many natural populations, exhibit a bell-shaped curve, i.e., a normal distribution.

DSE-2 (ii): Discrete Mathematics

Course Learning outcomes: After the course, the student will be able to:
i) Understand the notion of ordered sets and maps between ordered sets.
ii) Learn about lattices, modular and distributive lattices, sublattices and homomorphisms between lattices.
iii) Become familiar with Boolean algebra, Boolean homomorphism, Karnaugh diagrams, switching circuits and their applications.
iv) Learn about basics of graph theory, including Eulerian graphs, Hamiltonian graphs.
v) Learn about the applications of graph theory in the study of shortest path algorithms.

Semester-VI
BMATH613: Complex Analysis

Course Learning Outcomes: The completion of the course will enable the students to:
i) Learn the significance of differentiability of complex functions leading to the understanding of Cauchy−Riemann equations.
ii) Learn some elementary functions and valuate the contour integrals.
iii) Understand the role of Cauchy−Goursat theorem and the Cauchy integral formula.
iv) Expand some simple functions as their Taylor and Laurent series, classify the nature of singularities, find residues and apply Cauchy Residue theorem to evaluate integrals.

BMATH614: Ring Theory and Linear Algebra-II

Courses Learning Outcomes: On completion of this course, the student will be able to:
i) Appreciate the significance of unique factorization in rings and integral domains.
ii) Compute the characteristic polynomial, eigenvalues, eigenvectors, and eigenspaces, as well as the geometric and the algebraic multiplicities of an eigenvalue and apply the basic diagonalization result.
iii) Compute inner products and determine orthogonality on vector spaces, including Gram−Schmidt orthogonalization to obtain orthonormal basis.
iv) Find the adjoint, normal, unitary and orthogonal operators.

DSE-3 (i): Mathematical Finance

Course Learning outcomes: On completion of this course, the student will be able to:
i) Know the basics of financial markets and derivatives including options and futures.
ii) Learn about pricing and hedging of options, as well as interest rate swaps.
iii) Learn about no-arbitrage pricing concept and types of options.
iv) Learn stochastic analysis (Ito formula, Ito integration) and the Black−Scholes model.
v) Understand the concepts of trading strategies and valuation of currency swaps.

DSE-4 (i): Number Theory

Course Learning Outcomes: This course will enable the students to:
i) Learn about some fascinating discoveries related to the properties of prime numbers, and some of the open problems in number theory, viz., Goldbach conjecture etc.
ii) Know about number theoretic functions and modular arithmetic.
iii) Solve linear, quadratic and system of linear congruence equations.
iv) Learn about public key crypto systems, in particular, RSA.

DSE-4 (ii): Linear Programming and Applications
Course Learning Outcomes: This course will enable the students to:
i) Learn about the graphical solution of linear programming problem with two variables.
ii) Learn about the relation between basic feasible solutions and extreme points.
iii) Understand the theory of the simplex method used to solve linear programming problems.
iv) Learn about two-phase and big-M methods to deal with problems involving artificial variables.
v) Learn about the relationships between the primal and dual problems.
vi) Solve transportation and assignment problems.
vii) Apply linear programming method to solve two-person zero-sum game problems.