SLC(University of Delhi)

Shyam Lal College

Programme Specific Outcomes and Course Outcomes

B.Sc. (H) Mathematics

Programme Specific Outcomes:

Programme	Programme Specific Outcomes
B.Sc. (H) Mathematics	**PSO-1:** Inculcate strong interest in learning mathematics. **PSO-2:** Evolve broad and balanced knowledge and understanding of definitions, key concepts, principles and theorems in Mathematics **PSO-3:** Enable learners/students to apply the knowledge and skills acquired by them during the programme to solve specific theoretical and applied problems in mathematics. **PSO-4:** Develop in students the ability to apply relevant tools developed in mathematical theory to handle issues and problems in social and natural sciences. **PSO-5:** Provide students with sufficient knowledge and skills that enable them to undertake further studies in mathematics and related disciplines **PSO-6:** Enable students to develop a range of generic skills which will be helpful in wage employment, self-employment and entrepreneurship.

Course Outcomes:

Semester 1:

Course Name	Learning Outcomes
BMATH101: Calculus	**CO1:** Learn first and second derivative tests for relative extrema and apply the knowledge in problems in business, economics and life sciences. **CO2:** Sketch curves in a plane using its mathematical properties in the different coordinate systems of reference. **CO3:** Compute area of surfaces of revolution and the volume of solids by integrating over cross-sectional areas. **CO4:** Understand the calculus of vector functions and its use to develop the basic principles of planetary motion.
BMATH102: Algebra	**CO1:** Employ De Moivre's theorem in a number of applications to solve numerical problems.

	CO2: Learn about equivalent classes and cardinality of a set. **CO3:** Use modular arithmetic and basic properties of congruences. **CO4:** Recognize consistent and inconsistent systems of linear equations by the row Echelon form of the augmented matrix. **CO5:** Find eigenvalues and corresponding eigenvectors for a square matrix.

Semester 2:

Course Name	Learning Outcomes
BMATH203: Real Analysis	**CO1:** Understand many properties of the real line $\mathbb{R}$, including completeness and Archimedean properties. **CO2:** Learn to define sequences in terms of functions from $\mathbb{N}$ to a subset of $\mathbb{R}$. **CO3:** Recognize bounded, convergent, divergent, Cauchy and monotonic sequences and to calculate their limit superior, limit inferior, and the limit of a bounded sequence. **CO4:** 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	**CO1:** Learn basics of differential equations and mathematical modeling. **CO2:** Formulate differential equations for various mathematical models. **CO3:** Solve first order non-linear differential equations and linear differential equations of higher order using various techniques. **CO4:** Apply these techniques to solve and analyze various mathematical models

Semester 3:

Course Name	Learning Outcomes
BMATH305: Theory of	**CO1:** Have a rigorous understanding of the concept of limit of a

Real Functions	function. **CO2:** Learn about continuity and uniform continuity of functions defined on intervals. **CO3:** Understand geometrical properties of continuous functions on closed and bounded intervals. **CO4:** Learn extensively about the concept of differentiability using limits, leading to a Better understanding for applications. **CO5:** Know about applications of mean value theorems and Taylor's theorem.
BMATH306: Group Theory-I	**CO1:** Recognize the mathematical objects that are groups, and classify them as abelian, Cyclic and permutation groups, etc. **CO2:** Link the fundamental concepts of groups and symmetrical figures. **CO3:** Analyze the subgroups of cyclic groups and classify subgroups of cyclic groups. **CO4:** Explain the significance of the notion of cosets, normal subgroups and factor groups. **CO5:** Learn about Lagrange's theorem and Fermat's Little theorem. **CO6:** Know about group homomorphisms and group isomorphisms.
BMATH307: Multivariate Calculus	**CO1:** Learn the conceptual variations when advancing in calculus from one variable to multivariable discussion. **CO2:** Understand the maximization and minimization of multivariable functions subject to the given constraints on variables. **CO3:** Learn about inter-relationship amongst the line integral, double and triple integral formulations. **CO4:** Familiarize with Green's, Stokes' and Gauss divergence theorems.
SEC-1: LaTeX and HTML	**CO1:** Create and typeset a LaTeX document. **CO2:** Typeset a mathematical document using LaTex. **CO3:** Learn about pictures and graphics in LaTex.

	CO4: Create beamer presentations. **CO5:** Create web page using HTML.

Semester 4:

Course Name	Learning Outcomes
BMATH408: Partial Differential Equations	**CO1:** Formulate, classify and transform first order PDE's into canonical form. **CO2:** Learn about method of characteristics and separation of variables to solve first order PDE's. **CO3:** Classify and solve second order linear PDE's. **CO4:** Learn about Cauchy problem for second order PDE and homogeneous and non-homogeneous wave equations. **CO5:** Apply the method of separation of variables for solving many well-known second order PDE's.
BMATH409: Riemann Integration & Series of Functions	**CO1:** Learn about some of the classes and properties of Riemann integrable functions, and the applications of the Fundamental theorems of integration. **CO2:** Know about improper integrals including, beta and gamma functions. **CO3:** Learn about Cauchy criterion for uniform convergence and Weierstrass M-test for uniform convergence. **CO4:** Know about the constraints for the inter-changeability of differentiability and integrability with infinite sum. **CO5:** Approximate transcendental functions in terms of power series as well as, differentiation and integration of power series.
BMATH410: Ring Theory & Linear Algebra-I	**CO1:** Learn about the fundamental concept of rings, integral domains and fields. **CO2:** Know about ring homomorphisms and isomorphisms theorems of rings.

	CO3: Learn about the concept of linear independence of vectors over a field, and the dimension of a vector space. **CO4:** Basic concepts of linear transformations, dimension theorem, matrix representation of a linear transformation, and the change of coordinate matrix.
SEC-2: Computer Algebra Systems and Related Software	**CO1:** Use of computer algebra systems (Mathematica/MATLAB/Maxima/Maple etc.) as a calculator, for plotting functions and animations **CO2:** Use of CAS for various applications of matrices such as solving system of equations and finding eigenvalues and eigenvectors. **CO3:** Understand the use of the statistical software R as calculator and learn to read and get data into R. **CO4:** Learn the use of R in summary calculation, pictorial representation of data and exploring relationship between data. **CO5:** Analyze, test, and interpret technical arguments on the basis of geometry.

Semester 5:

Course Name	Learning Outcomes
BMATH511: Metric Spaces	**CO1:** 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. **CO2:** Analyse how a theory advances from a particular frame to a general frame. **CO3:** Appreciate the mathematical understanding of various geometrical concepts, viz. balls or connected sets etc. in an abstract setting. **CO4:** 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. **CO5:** Learn about the two important topological properties, namely connectedness and compactness of metric spaces
BMATH512: Group Theory-II	**CO1:** Learn about automorphisms for constructing new groups from the given group.

	CO2: Learn about the fact that external direct product applies to data security and electric circuits. **CO3:** Understand fundamental theorem of finite abelian groups. **CO4:** Be familiar with group actions and conjugacy in Sn. **CO5:** Understand Sylow theorems and their applications in checking non simplicity.
DSE-1 (i): Numerical Analysis	**CO1:** 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. **CO2:** Know about methods to solve system of linear equations, such as Gauss−Jacobi, Gauss−Seidel and SOR methods. **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.
DSE-1 (ii): Mathematical Modeling and Graph Theory	**CO1:** Know about power series solution of a differential equation and learn about Legendre's and Bessel's equations. **CO2:** Use of Laplace transform and inverse transform for solving initial value problems. **CO3:** Learn about various models such as Monte Carlo simulation models, queuing models, and linear programming models. **CO4:** Understand the basics of graph theory and learn about social networks, Eulerian and Hamiltonian graphs, diagram tracing puzzles and knight's tour problem.
DSE-1 (iii): C++ Programming for Mathematics	**CO1:** Understand and apply the programming concepts of C++ which is important to mathematical investigation and problem solving. **CO2:** Learn about structured data-types in C++ and learn about applications in factorization of an integer and understanding Cartesian geometry and Pythagorean triples. **CO3:** Use of containers and templates in various applications in algebra. **CO4:** Use mathematical libraries for computational objectives.

	CO5: Represent the outputs of programs visually in terms of well formatted text and plots.
DSE-2 (i): Probability Theory and Statistics	**CO1:** Learn about probability density and moment generating functions. **CO2:** Know about various univariate distributions such as Bernoulli, Binomial, Poisson, gamma and exponential distributions. **CO3:** Learn about distributions to study the joint behavior of two random variables. **CO4:** 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. **CO5:** 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	**CO1:** Understand the notion of ordered sets and maps between ordered sets. **CO2:** Learn about lattices, modular and distributive lattices, sublattices and homomorphisms between lattices. **CO3:** Become familiar with Boolean algebra, Boolean homomorphism, Karnaugh diagrams, switching circuits and their applications. **CO4:** Learn about basics of graph theory, including Eulerian graphs, Hamiltonian graphs. **CO5:** Learn about the applications of graph theory in the study of shortest path algorithms.
DSE-2 (iii): Cryptography and Network Security	**CO1:** Understand the fundamentals of cryptography and computer security attacks. **CO2:** Learn about various ciphers and data encryption standard. **CO3:** Review basic concepts of number theory and finite fields. **CO4:** Learn about advanced encryption standard. **CO5:** Understand the fundamentals of RSA and elliptic curve cryptography.

	CO6: Encrypt and decrypt messages using block ciphers, sign and verify messages using well known signature generation and verification algorithms.

Semester 6:

Course Name	Learning Outcomes
BMATH613: Complex Analysis	**CO1:** Learn the significance of differentiability of complex functions leading to the understanding of Cauchy−Riemann equations. **CO2:** Learn some elementary functions and valuate the contour integrals. **CO3:** Understand the role of Cauchy−Goursat theorem and the Cauchy integral formula. **CO4:** 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	**CO1:** Appreciate the significance of unique factorization in rings and integral domains. **CO2:** 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. **CO3:** Compute inner products and determine orthogonality on vector spaces, including Gram−Schmidt orthogonalization to obtain orthonormal basis. **CO4:** Find the adjoint, normal, unitary and orthogonal operators.
DSE-3 (i): Mathematical Finance	**CO1:** Know the basics of financial markets and derivatives including options and futures. **CO2:** Learn about pricing and hedging of options, as well as interest rate swaps. **CO3:** Learn about no-arbitrage pricing concept and types of options. **CO4:** Learn stochastic analysis (Ito formula, Ito integration) and the Black−Scholes model.

	CO5: Understand the concepts of trading strategies and valuation of currency swaps.
DSE-3 (ii): Introduction to Information Theory and Coding	**CO1:** Learn about the basic concepts of information theory. **CO2:** Know about basic relationship among different entropies and interpretation of Shannon's fundamental inequalities. **CO3:** Learn about the detection and correction of errors while transmission. **CO4:** Representation of a linear code by matrices. **CO5:** Learn about encoding and decoding of linear codes.
DSE-3 (iii): Biomathematics	**CO1:** Learn the development, analysis and interpretation of bio mathematical models such as population growth, cell division, and predator-prey models. **CO2:** Learn about the mathematics behind heartbeat model and nerve impulse transmission model. **CO3:** Appreciate the theory of bifurcation and chaos. **CO4:** Learn to apply the basic concepts of probability to molecular evolution and genetics.
DSE-4 (i): Number Theory	**CO1:** 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. **CO2:** Know about number theoretic functions and modular arithmetic. **CO3:** Solve linear, quadratic and system of linear congruence equations. **CO4:** Learn about public key crypto systems, in particular, RSA.
DSE-4 (ii): Linear Programming and Applications	**CO1:** Learn about the graphical solution of linear programming problem with two variables. **CO2:** Learn about the relation between basic feasible solutions and extreme points. **CO3:** Understand the theory of the simplex method used to solve linear programming problems.

	CO4: Learn about two-phase and big-M methods to deal with problems involving artificial variables. **CO5:** Learn about the relationships between the primal and dual problems. **CO6:** Solve transportation and assignment problems. **CO7:** Apply linear programming method to solve two-person zero-sum game problems.
DSE-4 (iii): Mechanics	**CO1:** Know about the concepts in statics such as moments, couples, equilibrium in both two and three dimensions. **CO2:** Understand the theory behind friction and center of gravity. **CO3:** Calculate moments of inertia of areas and rigid bodies. **CO4:** Know about conservation of mechanical energy and work-energy equations. **CO5:** Learn about translational and rotational motion of rigid bodies.