

# SEWNARAWAN RAMESWAR FATEPURIA COLLEGE

## Department of Mathematics

**Name of the Programme: B.Sc. (Hons.)**

### **Programme Specific Outcome (PSO) and Course Outcome (CO)**

Mathematics is an indispensable tool for much of science and engineering. It provides the basic language for understanding the world and lends precision to scientific thought. The mathematics program at University of Kalyani aims to provide a foundation for pursuing research in Mathematics as well as to provide essential quantitative skills to those interested in related fields. With the maturing of the Indian industry, there is a large demand for people with strong analytical skills and broad-based background in the mathematical sciences. The current focus in higher education is to shift from teacher-centric approach to learner centric approach. For this as one of the aims, UGC has introduced the learning outcomes-based curriculum framework for undergraduate education. The learning outcomes-based curriculum framework for B.Sc. (Hons.) Mathematics is prepared keeping this in view. The framework is expected to provide a student with knowledge and skills in mathematics along with generic and transferable skills in other areas that help in personal development, employment and higher education in the global world. The programme-learning outcomes and course learning outcomes have been clearly specified to help prospective students, parents and employers understand the nature and extent of the degree programme; to maintain national and international standards, and to help in student mobility.

The curriculum for B.Sc. (Hons.) Mathematics is prepared keeping in mind the needs and aspirations of students in mathematics as well as the evolving nature of mathematics as a subject. The course learning outcomes and the programme learning outcomes specify the knowledge, understanding, skills, attitudes and values that a student completing this degree is expected to know. The qualification of B.Sc. (Hons.) Mathematics is awarded to a student who can demonstrating the attainment of these outcomes. Mathematics is usually described as the abstract science of number, quantity and space along with their operations. The scope of Mathematics is very broad and it has a wide range of applications in natural sciences, engineering, economics and social sciences. B.Sc. (Hons.) Mathematics Programme aims at developing the ability to think critically, logically and analytically and hence use mathematical reasoning in everyday life. Pursuing a degree in mathematics will introduce the students to a number of interesting and useful ideas in preparations for a number of mathematics careers in education, research, government sector, business sector and industry. The B.Sc. (Hons.) Mathematics programme covers the full range of mathematics, from classical Calculus to Modern Cryptography, Information Theory, and Network Security. The course lays a structured foundation of Calculus, Real & Complex analysis, Abstract Algebra, Differential Equations (including Mathematical Modelling), Number Theory, Graph Theory, and C++ Programming exclusively for Mathematics. An exceptionally broad range of topics covering Pure & Applied Mathematics: Linear Algebra, Metric Spaces, Statistics, Linear Programming, Numerical Analysis, Mechanics and Biomathematics cater to varied interests and Department of Mathematics, University of Kalyani.

## SEMESTER-I

Course Code	Course Title	Course Credit	Full Marks	Course Outcome
UG B.Sc-H-CC-T-01	Calculus and Analytical Geometry	6	75	<p>This course will enable the students to</p> <ul style="list-style-type: none"> <li>▪ Learn first and second and higher derivative tests for relative extrema and apply the knowledge in problems in business, economics and life sciences.</li> <li>▪ Sketch curves in a plane using its mathematical properties in the different coordinate systems of reference over cross-sectional areas.</li> <li>▪ Transform the co-ordinate system especially by Rotation of axes, thus reducing different second-degree equations to their corresponding simplest forms and also classify the conics using the discriminant.</li> <li>▪ Become familiar with the polar equations of conics &amp; their tangents and normal.</li> <li>▪ Understand the geometrical terminology and have a detailed clear-cut idea of the Planes, Straight lines in 3D, Spheres, Cylindrical surfaces, Central conicoids, Paraboloids, Plane sections of conicoids along with the Tangent and normals of the conicoids.</li> </ul>
UG B.Sc-H-CC-T-02	Algebra	6	75	<p>This course will enable the students to</p> <ul style="list-style-type: none"> <li>▪ Employ De Moivre's theorem in a number of applications to solve numerical problems.</li> <li>▪ Learn about equivalent classes and cardinality of a set.</li> <li>▪ Use modular arithmetic and basic properties of congruences.</li> <li>▪ Recognize consistent and inconsistent systems of linear equations by the row echelon form of the augmented matrix. Find eigenvalues and corresponding eigenvectors for a square matrix.</li> <li>▪ Recognize the mathematical objects that are groups, and classify them as abelian and permutation groups, etc.</li> <li>▪ Link the fundamental concepts of groups and symmetrical figures.</li> </ul>
UG B.Sc-H-GE-T-01	Calculus and Analytical Geometry	6	75	<p>This course will enable the students to</p> <ul style="list-style-type: none"> <li>▪ Learn first and second and higher derivative tests for relative extrema and apply the knowledge in problems in business, economics and life sciences.</li> <li>▪ Sketch curves in a plane using its mathematical properties in the different coordinate systems of reference over cross-sectional areas.</li> <li>▪ Transform the co-ordinate system especially by Rotation of axes, thus reducing different second-degree equations to their corresponding simplest forms and also classify the conics using the discriminant.</li> <li>▪ Become familiar with the polar equations of conics &amp; their tangents and normal.</li> <li>▪ Understand the geometrical terminology and have a detailed clear-cut idea of the Planes, Straight lines in 3D, Spheres, Cylindrical surfaces, Central conicoid, Paraboloids, Plane sections of conicoid along with the Tangent and normal of the conicoid.</li> </ul>
UG B.Sc-H-AECC-T-01	Environmental Studies	2	50	<ul style="list-style-type: none"> <li>▪ The course helps the students to gain a basic knowledge about the Environment. In addition, with that, it also helps them to understand the significance of our Environment to sustain lives in the Earth.</li> </ul>

## SEMESTER-II

Course Code	Course Title	Course Credit	Full Mark	Course Outcome
UG B.Sc-H-CC-T-03	Real Analysis	6	75	<p>This course will enable the students to</p> <ul style="list-style-type: none"> <li>▪ Understand many properties of the real line <math>\mathbb{R}</math>, including completeness and Archimedean properties.</li> <li>▪ Learn to define sequences in terms of functions from <math>\mathbb{N}</math> to a subset of <math>\mathbb{R}</math>.</li> <li>▪ Recognize bounded, convergent, divergent, Cauchy and monotonic sequences and to calculate their limit superior, limit inferior, and the limit of a bounded sequence.</li> <li>▪ Apply the ratio, root, alternating series and limit comparison tests for convergence and absolute convergence of an infinite series of real numbers.</li> </ul>
UG B.Sc-H-CC-T-04	Differential Equations	6	75	<p>The course will enable the students to</p> <ul style="list-style-type: none"> <li>▪ Learn basics of differential equations and mathematical modelling</li> <li>▪ Formulate differential equations for various mathematical models.</li> <li>▪ Solve first order non-linear differential equations and linear differential equations of higher order using various techniques.</li> <li>▪ Apply these techniques to solve and analyse various mathematical models.</li> <li>▪ Formulate, classify and transform first order PDEs into canonical form.</li> <li>▪ Learn about method of characteristics and separation of variables to solve first order PDE's.</li> <li>▪ Classify and solve second order linear PDEs.</li> </ul>
UG B.Sc-H-GE-T-02	Calculus & Differential Equations	6	75	<p>This course will enable the students to</p> <ul style="list-style-type: none"> <li>▪ Learn first and second and higher derivative tests for relative extrema and apply the knowledge in problems in business, economics and life sciences.</li> <li>▪ Sketch curves in a plane using its mathematical properties in the different coordinate systems of reference over cross-sectional areas.</li> <li>▪ Learn basics of differential equations and mathematical modelling</li> <li>▪ Formulate differential equations for various mathematical models.</li> <li>▪ Solve first order non-linear differential equations and linear differential equations of higher order using various techniques.</li> <li>▪ Apply these techniques to solve and analyse various mathematical models.</li> </ul>
UG BCOM-H-AECC-T-02	MIL	2	50	

## SEMESTER-III

Course Code	Course Title	Course Credit	Full Marks	Course Outcome
UG B.Sc-H-CC-T-05	Theory of Real and Vector Functions	6	75	<p>This course will enable the students to</p> <ul style="list-style-type: none"> <li>▪ Have a rigorous understanding of the concept of limit of a function.</li> <li>▪ Learn about continuity and uniform continuity of functions defined on intervals.</li> <li>▪ Understand geometrical properties of continuous functions on closed and bounded intervals.</li> <li>▪ Learn extensively about the concept of differentiability using limits, leading to a better understanding for applications.</li> <li>▪ Know about applications of mean value theorems and Taylor's theorem.</li> </ul>
UG B.Sc-H-CC-T-06	Group Theory-I	6	75	<p>This course will enable the students to</p> <ul style="list-style-type: none"> <li>▪ Analyse the subgroups of cyclic groups and classify subgroups of cyclic groups.</li> <li>▪ Explain the significance of the notion of cosets, normal subgroups and factor groups.</li> <li>▪ Learn about Lagrange's theorem and Fermat's Little theorem.</li> <li>▪ Know about group homomorphisms and group isomorphisms.</li> </ul>
UG B.Sc-H-CC-T-07	Numerical Methods (Theory) & Numerical Methods Lab.	6	75	<p>The course will enable the students to</p> <ul style="list-style-type: none"> <li>▪ 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.</li> <li>▪ Know about methods to solve system of linear equations, such as Gauss-Jacobi, Gauss-Seidel and SOR methods.</li> <li>▪ Interpolation techniques to compute the values for a tabulated function at points not in the table.</li> <li>▪ Applications of numerical differentiation and integration to convert differential equations into difference equations for numerical solutions.</li> </ul>
UG B.Sc-H-GE-T-03	Algebra & Analytical Geometry	6	75	<p>This course will enable the students to</p> <ul style="list-style-type: none"> <li>▪ Employ De Moivre's theorem in a number of applications to solve numerical problems.</li> <li>▪ Learn about equivalent classes and cardinality of a set.</li> <li>▪ Use modular arithmetic and basic properties of congruences.</li> <li>▪ Recognize consistent and inconsistent systems of linear equations by the row echelon form of the augmented matrix. Find eigenvalues and corresponding eigenvectors for a square matrix.</li> <li>▪ Recognize the mathematical objects that are groups, and classify them as abelian and permutation groups, etc.</li> <li>▪ Link the fundamental concepts of groups and symmetrical figures.</li> <li>▪ Transform the co-ordinate system especially by Rotation of axes, thus reducing different second-degree equations to their corresponding simplest forms and also classify the conics using the discriminant.</li> <li>▪ Become familiar with the polar equations of conics &amp; their tangents and normal.</li> </ul>

UG B.Sc- H-SEC-T- 01A	Programming in C	2	50	<p>After completion of this paper, student will be able to</p> <ul style="list-style-type: none"> <li>▪ Understand and apply the programming concepts of C++ which is important to mathematical investigation and problem solving.</li> <li>▪ Learn about structured data-types in C++ and learn about applications in factorization of an integer and understanding Cartesian geometry and Pythagorean triples.</li> <li>▪ Use of containers and templates in various applications in algebra. Use mathematical libraries for computational objectives.</li> <li>▪ Represent the outputs of programs visually in terms of well formatted text and plots.</li> </ul>
UG B.Sc- H-SEC-T- 01B	Programming in Python	2	50	<p>After completion of this paper, student will be able to</p> <ul style="list-style-type: none"> <li>• Describe the basics of the Python programming language.</li> <li>• Install Python and write your first program.</li> <li>• Use variables to store, retrieve and calculate information.</li> <li>• Utilize core programming tools such as functions and loops.</li> </ul>

## SEMESTER-IV

Course Code	Course Title	Course Credit	Full Marks	Course Outcome
UG B.Sc-H-CC-T-08	Ring Theory and Linear Algebra	6	75	<p>The course will enable the students to</p> <ul style="list-style-type: none"> <li>▪ Learn about the fundamental concept of rings, integral domains and fields.</li> <li>▪ Know about ring homomorphisms and isomorphisms theorems of rings.</li> <li>▪ Learn about the concept of linear independence of vectors over a field, and the dimension of a vector space.</li> <li>▪ Basic concepts of linear transformations, dimension theorem, matrix representation of a linear transformation, and the change of coordinate matrix.</li> </ul>
UG B.Sc-H-CC-T-09	Multivariate Calculus and Tensor Analysis	6	75	<p>This course will enable the students to</p> <ul style="list-style-type: none"> <li>▪ Learn the conceptual variations when advancing in calculus from one variable to multivariable discussion.</li> <li>▪ Understand the maximization and minimization of multivariable functions subject to the given constraints on variables.</li> <li>▪ Learn about inter-relationship amongst the line integral, double and triple integral formulations.</li> <li>▪ Familiarize with Green's, Stokes' and Gauss divergence theorems.</li> </ul>
UG B.Sc-H-CC-T-10	Linear Programming Problem and Game Theory	6	75	<p>This course will enable the students to</p> <ul style="list-style-type: none"> <li>▪ Learn about the graphical solution of linear programming problem with two variables.</li> <li>▪ Learn about the relation between basic feasible solutions and extreme points. Understand the theory of the simplex method used to solve linear programming problems.</li> <li>▪ Learn about two-phase and big-M methods to deal with problems involving artificial variables.</li> <li>▪ Learn about the relationships between the primal and dual problems.</li> <li>▪ Solve transportation and assignment problems.</li> <li>▪ Apply linear programming method to solve two-person zero-sum game problems.</li> </ul>
UG B.Sc-H-GE-T-04	Calculus & Differential Equations	6	75	<p>This course will enable the students to</p> <ul style="list-style-type: none"> <li>▪ Learn first and second and higher derivative tests for relative extrema and apply the knowledge in problems in business, economics and life sciences.</li> <li>▪ Sketch curves in a plane using its mathematical properties in the different coordinate systems of reference over cross-sectional areas.</li> <li>▪ Learn basics of differential equations and mathematical modelling</li> <li>▪ Formulate differential equations for various mathematical models.</li> <li>▪ Solve first order non-linear differential equations and linear differential equations of higher order using various techniques.</li> <li>▪ Apply these techniques to solve and analyse various mathematical models.</li> </ul>

UG B.Sc- H-SEC-T- 02A or	Logic and Boolean Algebra	2	50	<p>This course will enable the students to</p> <ul style="list-style-type: none"> <li>▪ Explain and apply basic notions of symbolic logic.</li> <li>▪ Define proposition and argument.</li> <li>▪ Explain propositional connectives.</li> <li>▪ Explain and exemplify truth value status of a proposition.</li> <li>▪ Use truth tables and laws of identity, distributive, commutative, and domination.</li> <li>▪ Compute sum of products and product of sum expansions.</li> <li>▪ Convert Boolean expressions to logic gates and vice-versa.</li> </ul>
UG B.Sc- H-SEC-T- 02B	Graph Theory	2	50	<p>This course will enable the students to</p> <ul style="list-style-type: none"> <li>▪ Understand the basics of graph theory and learn about social networks, Eulerian and Hamiltonian graphs, diagram tracing puzzles and knight's tour problem.</li> <li>▪ Learn about the applications of graph theory in the study of shortest path algorithms.</li> </ul>

## SEMESTER-V

Course Code	Course Title	Course Credit	Full Marks	Course Outcome
UG B.Sc-H-CC-T-11	Riemann Integration and Series of Functions	6	75	<p>The course will enable the students to</p> <ul style="list-style-type: none"> <li>▪ Learn about some of the classes and properties of Riemann integrable functions, and the applications of the Fundamental theorems of integration.</li> <li>▪ Know about improper integrals including, beta and gamma functions.</li> <li>▪ Learn about Cauchy criterion for uniform convergence and Weierstrass M-test for uniform convergence.</li> <li>▪ Know about the constraints for the inter-changeability of differentiability and integrability with infinite sum.</li> <li>▪ Approximate transcendental functions in terms of power series as well as, differentiation and integration of power series.</li> </ul>
UG B.Sc-H-CC-T-12	Mechanics-I	6	75	<p>After completion of this course, the students will be able to learn and explain different concepts on Mechanics:</p> <ul style="list-style-type: none"> <li>• Coplanar forces in general, An arbitrary force system in space: Moment of a force about an axis, Varignon's theorem. Resultant force and resultant couple, Equilibrium in the presence of sliding Friction force, Virtual work, Stability of equilibrium: Conservative force field, Kinematics of a particle, Newton laws of motion and law of gravitation, Problems in particle dynamics, Motion of a projectile in a resisting medium.</li> </ul>
UG B.Sc-H-DSE-T-01A or	Group Theory-II	6	75	<p>The course shall enable students to</p> <ul style="list-style-type: none"> <li>▪ Learn about automorphisms for constructing new groups from the given group.</li> <li>▪ Learn about the fact that external direct product applies to data security and electric circuits.</li> <li>▪ Understand fundamental theorem of finite abelian groups.</li> <li>▪ Be familiar with group actions and conjugacy in <math>S_n</math></li> <li>▪ Understand Sylow theorems and their applications in checking non simplicity.</li> </ul>
UG B.Sc-H-DSE-T-01B	Partial Differential Equations & Laplace Transforms	6	75	<p>The course will enable the students to</p> <ul style="list-style-type: none"> <li>▪ Learn about Cauchy problem for second order PDE and homogeneous and nonhomogeneous wave equations.</li> <li>▪ Apply the method of separation of variables for solving many well-known second order PDEs.</li> <li>▪ Concept about Heat and Wave equations.</li> <li>▪ Know about power series solution of a differential equation and learn about Legendre's and Bessel's equations.</li> <li>▪ Use of Laplace transform and inverse transform for solving initial value problems.</li> </ul>
UG B.Sc-H-DSE-T-02A or	Number Theory	6	75	<p>This course will enable the students to</p> <ul style="list-style-type: none"> <li>▪ 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.</li> <li>▪ Know about number theoretic functions and modular arithmetic.</li> <li>▪ Solve linear, quadratic and system of linear congruence equations.</li> <li>▪ Learn about public key crypto systems, in particular, RSA.</li> </ul>
UG B.Sc-H-DSE-T-02B	Differential Geometry	6	75	<ul style="list-style-type: none"> <li>▪ After completing this course, a student will learn on Serret-Frenet formulae, relation between tangent, normal and binormals, first and second fundamental forms and ideas on various curvatures. He has scope to take more advanced courses in surface theory and geometry.</li> </ul>



## SEMESTER-VI

Course Code	Course Title	Course Credit	Full Mark	Course Outcome
UG B.Sc-H-CC-T-13	Metric Spaces & Complex Analysis	6	75	<p>The course will enable the students to</p> <ul style="list-style-type: none"> <li>▪ 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.</li> <li>▪ Analyse how a theory advances from a particular frame to a general frame.</li> <li>▪ Appreciate the mathematical understanding of various geometrical concepts, viz. balls or connected sets etc. in an abstract setting.</li> <li>▪ Learn about the two important topological properties, namely connectedness and compactness of metric spaces.</li> <li>▪ Learn the significance of differentiability of complex functions leading to the understanding of Cauchy–Riemann equations.</li> <li>▪ Learn some elementary functions and valuate the contour integrals.</li> <li>▪ Understand the role of Cauchy–Goursat theorem and the Cauchy integral formula.</li> <li>▪ 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.</li> </ul>
UG B.Sc-H-CC-T-14	Probability & Statistics	6	75	<p>This course will enable the students to</p> <ul style="list-style-type: none"> <li>▪ Learn about probability density and moment generating functions.</li> <li>▪ Know about various univariate distributions such as Bernoulli, Binomial, Poisson, gamma and exponential distributions.</li> <li>▪ Learn about distributions to study the joint behavior of two random variables. Measure the scale of association between two variables, and to establish a formulation helping to predict one variable in terms of the other, i.e., correlation and linear regression.</li> <li>▪ 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.</li> </ul>
UG B.Sc-H-DSE-T-03A <b>Or</b>	Fuzzy Set Theory	6	75	<p>This course will enable the students to</p> <ul style="list-style-type: none"> <li>▪ Gain the main subject of fuzzy sets</li> <li>▪ Learn crisp and fuzzy set theory</li> <li>▪ Decide the difference between crisp set and fuzzy set theory.</li> <li>▪ Make calculation on fuzzy set theory.</li> <li>▪ Gain the methods of fuzzy logic.</li> <li>▪ Recognize fuzzy logic membership function.</li> <li>▪ Recognize fuzzy logic fuzzy inference systems</li> <li>▪ Make applications on Fuzzy logic membership function and fuzzy inference systems.</li> <li>▪ Use the fuzzy set theory on the statistical method which is given.</li> <li>▪ Analyse statistical data by using fuzzy logic methods.</li> <li>▪ Compare statistical methods against fuzzy logic methods.</li> <li>▪ Get theory of the statistics fuzzy logic theory together</li> <li>▪ Evaluate fuzzy statistics applications.</li> </ul>

UG B.Sc- H-DSE-T- 03B	Bio- Mathematics	6	75	<p>Apropos conclusion of the course will empower the student to</p> <ul style="list-style-type: none"> <li>▪ Learn the development, analysis and interpretation of bio mathematical models such as population growth, cell division, and predator-prey models.</li> <li>▪ Learn about the mathematics behind heartbeat model and nerve impulse transmission model.</li> <li>▪ Appreciate the theory of bifurcation and chaos.</li> <li>▪ Learn to apply the basic concepts of probability to molecular evolution and genetics.</li> </ul>
UG BCOM-H- DSE-T- 04A <b>or</b>	Point Set Topology	6	75	<p>The course will enable the students to</p> <ul style="list-style-type: none"> <li>▪ Demonstrate an understanding of the concepts of metric spaces and topological spaces, and their role in mathematics.</li> <li>▪ Demonstrate familiarity with a range of examples of these structures. Prove basic results about completeness, compactness, connectedness and convergence within these structures.</li> </ul>
UG BCOM-H- DSE-T- 04B	Mechanics-II	6	75	<p>The course will enable the students to</p> <ul style="list-style-type: none"> <li>▪ Know about the concepts in statics such as moments, couples, equilibrium in both two and three dimensions.</li> <li>▪ Understand the theory behind friction and centre of gravity.</li> <li>▪ Calculate moments of inertia of areas and rigid bodies.</li> <li>▪ Know about conservation of mechanical energy and work-energy equations. Learn about translational and rotational motion of rigid bodies.</li> </ul>