Department of Mathematics

UNDERGRADUATE SECTION

Model Reference: University of Calcutta, Syllabus for three-year B.Sc. in Mathematics (Honours) under CBCS system 2018 (Notification No. CSR/12/18)

Programme Outcomes Nos	Programme Outcomes (PO)
PO A	To acquire in-depth knowledge of algebra, calculus, geometry, differential equations and several other branches of Mathematics. This also leads to study of associated areas like computer science and physical science. Therefore, this Program helps learners in building a solid groundwork for higher studies in mathematics.
PO B	The skills and knowledge gained has intrinsic beauty, which also leads to proficiency in analytical reasoning. This can be utilized in modelling and solving real life problems.
PO C	Apply mathematical intuition to solve theoretical as well as applied problems by critical understanding, analysis and synthesis
PO D	Ability to interconnect mathematics efficiently by written, computational and graphic means.
PO E	Create mathematical concepts from basic axioms.
PO F	Skill to apply multivariable calculus tools in physics, economics, optimization, and understanding the architecture of curves and surfaces in plane and space etc.
PO G	Accomplished to present mathematics undoubtedly and precisely as well as describe mathematical ideas from multiple perspectives and explain fundamental concepts of mathematics to non-mathematicians.
PO H	To develop disciplined approach through several mathematical courses which can help their path more seamlessly in the entire lifespan.
PO I	This benefits them to learn behave responsibly in a rapidly changing interdependent society.
PO J	Current Program will also benefit students to enhance their employability in numerous sectors like banking, insurance and investment sectors, data analyst and in various other public and private enterprises.

Programme Specific Outcomes Nos	Programme Specific Outcomes (PSO)
PSO 1	**Calculus:** This course will enable the students to: i) Assimilate the notions of limit of a sequence and convergence of a series of real numbers. ii) Calculate the limit and examine the continuity of a function at a point. iii) Understand the consequences of various mean value theorems for differentiable functions. iv) Sketch curves in Cartesian and polar coordinate systems. v) Apply derivative tests in optimization problems appearing in social sciences, physical sciences, life sciences and a host of other disciplines.
PSO 2	**Ordinary Differential Equations:** This course will enable the students to: i) Understand the genesis of ordinary differential equations. ii) Learn various techniques of getting exact solutions of solvable first order differential equations and linear differential equations of higher order. iii) Know Power series solution for higher order linear differential equations in the neighbourhood of a certain point. iv) Grasp the concept of a general solution of a linear differential equation of an arbitrary order and also learn a few methods to obtain the general solution of such equations. v) Formulate mathematical models in the form of ordinary differential equations to suggest possible solutions of the day-to-day problems arising in physical, chemical and biomedical fields.
PSO 3	**Real Analysis:** This course will enable the students to: i) Understand many properties of the real line $\mathbb{R}$ and learn to define sequence in terms of functions from $\mathbb{R}$ to a subset of $\mathbb{R}$. ii) Recognize bounded, convergent, divergent, Cauchy and monotonic sequences and to calculate their limit superior, limit inferior, and the limit of a bounded sequence. iii) Apply several tests for convergence on series with positive terms, test for alternating series as well as absolute convergence of an infinite series of real numbers. iv) Learn some of the properties of Riemann integrable functions, and the applications of the fundamental theorems of integration.
PSO 4	**Group Theory:** The course will enable the students to: i) Recognize the mathematical objects called groups. ii) Link the fundamental concepts of groups and symmetries of geometrical objects. iii) Explain the significance of the notions of cosets, normal subgroups, and factor groups. iv) Analyse consequences of Lagrange's theorem. v) Learn about structure preserving maps between groups and their consequences.
PSO 5	**Linear Algebra:** This course will enable the students to: i) Understand the concepts of vector spaces, subspaces, bases, dimension and their properties. ii) Relate matrices and linear transformations, compute eigen values and eigen vectors of linear transformations. iii) Learn properties of inner product spaces and determine orthogonality in inner product spaces. iv) Realise importance of adjoint of a linear transformation and its canonical form.
PSO 6	**Partial Differential Equations:** This course will enable the students to: i) Apply a range of techniques to solve first & second order partial differential equations. ii) Model physical phenomena using partial differential equations such as the heat and wave equations and their solution techniques.

PSO 7	**Multivariable Calculus:** This course will enable the students to: i) Learn conceptual variations while advancing from one variable to several variables in calculus. ii) Apply multivariable calculus in optimization problems. iii) Inter-relationship amongst the line integral, double and triple integral formulations. iv) Applications of multivariable calculus tools in physics, economics, optimization, and understanding the architecture of curves and surfaces in plane and space etc. v) Realize importance of Green, Gauss and Stokes' theorems in other branches of mathematics.
PSO 8	**Metric Spaces:** This course will enable the students to: i) Learn basic facts about the cardinality of a set. ii) Understand several standard concepts of metric spaces and their properties like openness, closedness, completeness, Bolzano-Weierstrass property, compactness, and connectedness. iii) Identify the continuity of a function defined on metric spaces.
PSO 9	**Ring Theory:** This course will enable the students to: i) Understand the basic concepts of group actions and their applications. ii) Recognize and use the Sylow theorems to characterize certain finite groups. iii) Know the fundamental concepts in ring theory such as the concepts of ideals, quotient rings, integral domains, and fields. iv) Learn in detail about polynomial rings, fundamental properties of finite field extensions, and classification of finite fields.
PSO 10	**Linear Programming:** This course will enable the students to: i) Analyze and solve linear programming models of real-life situations. ii) Provide graphical solutions of linear programming problems with two variables, and illustrate the concept of convex set and extreme points. iii) Understand the theory of the simplex method. iv) Know about the relationships between the primal and dual problems, and to understand sensitivity analysis. v) Learn about the applications to transportation, assignment and two-person zero-sum game problems.
PSO 11	**Numerical Analysis:** This course will enable the students to: i) Obtain numerical solutions of algebraic and transcendental equations. ii) Find numerical solutions of system of linear equations and check the accuracy of the solutions. iii) Learn about various interpolating and extrapolating methods. iv) Solve initial and boundary value problems in differential equations using numerical methods. v) Apply various numerical methods in real life problems.
PSO 12	**C Programming for Mathematics:** This course will enable the students to: i) Understand and apply the programming concepts of C programming language which is important for mathematical investigation and problem solving. ii) Use mathematical libraries for computational objectives. iii) Represent the outputs of programs visually in terms of well formatted text and plots.
PSO 13	**Complex Analysis:** This course will enable the students to: i) Visualize complex numbers as points of $\mathbb{R}$ and stereographic projection of complex plane on the Riemann sphere. ii) Understand the significance of differentiability and analyticity of complex functions leading to the Cauchy Riemann equations. iii) Learn the role of Cauchy Goursat theorem and Cauchy integral formula in evaluation of contour integrals. iv) Apply Liouville's theorem in fundamental theorem of

	algebra. v) Understand the convergence, term by term integration and differentiation of a power series. vi) Learn Taylor and Laurent series expansions of analytic functions, classify the nature of singularity, poles and residues and application of Cauchy Residue theorem.
PSO 14	**Mechanics**: This course will enable the students to: i) Learn about virtual displacements and virtual work, stability of equilibrium. ii) Kinematics of a particle and problems in particle dynamics and their applications. iii) Planar motion of a particle, motion of a particle in three dimensions. iv) The linear momentum principle, The angular momentum principle and The energy principle.

Mapping of PO & PSO for B.Sc. in Mathematics (Honours) Syllabus of University of Calcutta

Programme Specific Outcomes (PSO) Nos	**Programme Outcomes (PO)**									
	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**
PSO 1	√	√	√		√	√	√			
PSO 2	√			√			√		√	√
PSO 3	√	√	√	√	√	√		√		
PSO 4	√	√	√	√	√			√		
PSO 5	√	√	√	√	√	√	√			
PSO 6	√	√	√	√	√	√	√	√	√	√
PSO 7	√	√	√	√	√	√	√		√	√
PSO 8	√	√	√	√	√	√	√			
PSO 9	√	√	√	√	√	√	√			
PSO 10	√		√	√	√	√	√	√	√	√
PSO 11	√			√	√	√	√	√	√	√
PSO 12	√			√	√	√	√	√	√	√
PSO 13	√	√	√		√		√			
PSO 14	√						√	√	√	√

Programme Outcome mapping for Semester wise Courses in Three-year B.Sc. in Mathematics (Honours) under University of Calcutta

TABLE I

COURSE DURATION	COURSE DETAIL	PROGRAMME OUTCOME (PO)									
		A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**
SEMESTER-I Papers:	MTM-A-CC-1-1-TH, Calculus, Geometry & Vector Analysis (Theory)	√	√	√	√	√	√	√	√	√	√
	MTM-A-CC-1-2-TH, Algebra (Theory)	√	√	√	√	√	√	√	√	√	√

TABLE II

COURSE DURATION	COURSE DETAIL	PROGRAMME OUTCOME (PO)									
		A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**
SEMESTER-2	MTM-A-CC-2-3-TH, Real Analysis (Theory)	√	√	√	√	√	√	√		√	√
Papers:	MTM-A-CC-2-4-TH, Group Theory-I (Theory)	√	√		√	√		√		√	√

TABLE III

COURSE DURATION	COURSE DETAIL	PROGRAMME OUTCOME (PO)									
		A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**
SEMESTER- 3 **Papers:**	MTM-A-CC-3-5-TH, Theory of Real Functions (Theory)	√	√	√		√	√		√	√	√
	MTM-A-CC-3-6-TH, Ring Theory & Linear Algebra-I (Theory)	√	√	√	√	√	√			√	
	MTM-A-CC-3-7-TH, Ordinary Differential Equation & Multivariate Calculus-I (Theory)	√	√	√	√	√	√	√	√	√	√
	MTM-A-SEC-A-TH, C Programming Language (Theory)	√	√	√	√	√	√	√	√	√	√

TABLE IV

COURSE DURATION	COURSE DETAIL	PROGRAMME OUTCOME (PO)									
		A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**
SEMESTER- 4 **Papers:**	MTM-A-CC-4-8-TH, Riemann Integration & Series of Functions (Theory)	√	√	√		√	√		√	√	√
	MTM-A-CC-4-9-TH, Partial differential equation & Multivariate Calculus-II (Theory)	√	√	√	√	√	√	√	√	√	√
	MTM-A-CC-4-10-TH, Mechanics (Theory)	√	√	√	√	√	√	√	√	√	√
	MTM-A-SEC-B-TH, Mathematical Logic (Theory)	√			√	√		√		√	√
	MTM-A-SEC-B-TH, Scientific computing with Sage Math & R (Theory)	√	√	√	√	√		√		√	√

TABLE V

COURSE DURATION	COURSE DETAIL	PROGRAMME OUTCOME (PO)									
		A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**
SEMESTER- 5 **Papers:**	MTM-A-CC-5-11-TH, Probability & Statistics (Theory)	√	√	√			√		√	√	√
	MTM-A-CC-5-12-TH, Group Theory-II & Linear Algebra-II (Theory)	√	√	√		√	√			√	
	MTM-A-DSE-A-5-1-TH, Advanced Algebra (Theory)	√	√	√	√	√	√	√	√		√
	MTM-A-DSE-A-5-1-TH, Bio Mathematics (Theory)	√	√	√	√	√	√			√	√
	MTM-A-DSE-B-5-1-TH, Linear Programming & Game Theory (Theory)	√	√	√	√	√	√	√	√	√	√

TABLE VI

COURSE DURATION	COURSE DETAIL	PROGRAMME OUTCOME (PO)									
		A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**
SEMESTER- 6 **Papers:**	MTM-A-CC-6-13-TH, Metric Space & Complex Analysis (Theory)	√	√	√	√	√	√	√	√	√	
	MTM-A-CC-6-14-TH, Numerical Methods (Theory)	√	√	√	√	√	√	√	√	√	√
	MTM-A-CC-6-14-P, Numerical Methods Lab (Practical)	√	√	√			√		√		
	MTM-A-DSE-A-6-2-TH, Mathematical Modelling (Theory)	√	√	√	√		√	√	√		√
	MTM-A-DSE-A-6-2-TH, Fluid Statics & Elementary Fluid Dynamics (Theory)	√	√	√	√		√	√	√		√
	MTM-A-DSE-A-6-2-TH, Differential Geometry (Theory)	√	√	√	√	√	√	√	√	√	√
	MTM-A-DSE-B-6-2-TH, Point Set Topology (Theory)	√	√	√	√	√	√	√			
	MTM-A-DSE-B-6-2-TH, Advanced Mechanics (Theory)	√	√	√	√	√	√	√	√	√	√