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UNIVERSITY OF CALCUTTA

NOTICE

Program Outcome (PO)/ Program Specific Outcome (PSO)/ Course Outcome (CO) for the following Subjects, offered by the University of Calcutta pertaining to the U.G. (4-Year Honours & Honours with Research/ 3-Year MDC) Courses of Studies under CCF , as laid down in the accompanying pamphlets:-

1. Bio-Chemistry
2. French
3. Human Development
4. Political Science
5. Economics
- ✓ 6. Mathematics
7. Philosophy
8. Women's Studies


Secretary
20/06/2025
U.G. Councils

Name of the Programme: B.Sc. Mathematics(Major/Minor)(CCF 2022)

Year of Introduction: 2023

Program Specific Outcome:

PSO1: The basic objective of studying Mathematics Major/ Minor course is to develop the mathematical reasoning power of the students and logical support behind an assumption. Throughout the entire course the students learn different branches of mathematics through which they are not only equipped with solution of different types of problems by framing a proper mathematical model but they can logically justify the model and the computational procedures with proper mathematical reasoning.

PSO2: Another objective of cultivating Mathematics Major/ Minor course is to enhance the power of critical thinking of the students by solving varieties of Mathematical problems and this programme will provide a very strong foundation in Mathematical concepts, problem-solving skills and the ability to apply mathematical knowledge in various fields.

PSO3: The entire syllabus for Undergraduate Course is framed in such a way that after successful completion of three year / four year courses phase by phase the students will be able to solve the mathematical problems with minimum error and the students will be equipped with mathematical skills and techniques which they can apply in both academic and non-academic areas in work. The students will be able to translate real-world problems into mathematical models and analyze these models to draw conclusions by developing critical thinking skills to evaluate mathematical arguments.

PSO4: The students will develop strong understanding and good grasp over the areas of Algebra, Analysis, Metric spaces and Complex analysis, Topology, Calculus and its applications, Ordinary and Partial differential equations, Mechanics, Probability and Statistics, Mathematical methods and computational skill using different computer languages. The theory and its applications will motivate the students for critical thinking towards further specialisation and to pursue research in mathematics in India and abroad including literature searches, data analysis, and formulating research problems.

PSO5: The students get a strong foundation in the subject and develop a comprehensive knowledge of all the classical and applied fields of mathematics. They will be able to apply mathematical knowledge to problems of engineering sciences, information technology, computer science and social sciences.

PSO6: The students will acquire numerical skill, logical thinking and analysing capability which they can apply in competitive examinations to come out successful. Problem solving skills will be enhanced that will help to resolve day to day problems. They will be able to teach in Educational and Research Institutions and to impart their knowledge in different service sectors as erudite consultants.

The National Education Policy, 2020 aims to nurture well-rounded individuals who can contribute to society by fostering critical thinking, creativity, and problem-solving skills. With a focus on reducing the burden of examinations and rote learning, NEP 2020 aims to create a learning environment that fosters curiosity, innovation, and lifelong learning. It also provides quality education to all by enabling an individual to study one or more specialized areas of interest at a deep level, and also to develop character, ethics and moral values. Its educational program includes the importance of informal education and traditional value systems of an Indian society in addition to the academic life. The policy aims to foster the holistic development of students, encompassing their intellectual, social, physical, emotional and moral capacities. In the context of the New Education Policy (NEP) 2020, Course Outcomes (COs) are specific, measurable learning objectives that students are expected to achieve by the end of a course, while Programme Outcomes (POs) are the broader, expected outcomes that students should demonstrate upon completion of a program. COs are the building blocks of POs, meaning that achieving the individual COs within a course contributes to the overall attainment of the program's POs. The syllabus of Mathematics Major and Minor has been designed in a way the student gets a strong foundation in the subject and gains an in-depth knowledge. Program wise outcomes are detailed below:-

Program	One year Certificate course with Mathematics Major
Participants	Students of Semester one and semester two
Program details	To complete a Certificate course with Mathematics major the students should study two semester courses each of 21 credits. In each of the semesters they study one core course of Mathematics Major having credit 4, One Skill enhancement course of Mathematics Major having credit 4, one core course of one Minor paper having credit 4, one interdisciplinary course of credit 3, one language course of credit 2 and two value added course each of credit 2.
Courses taught in Mathematics Major	Semester 1:: (a)Core course:- Calculus, Geometry, Vector analysis; (b) SEC: C language with Mathematical Application Semester 2:: (a)Core course:- Basic Algebra; (b) SEC: Python Programming and Introduction to Latex
Program Outcome	PO1:-The students will be familiar with the basic knowledge Calculus, Geometry, Vector algebra and Basic Algebra. They will learn different applications of calculus, broad ideas of two and three dimensional geometry application of vector geometry and basics of Algebra which will help them to develop a good grasp over the basic premise of the subject. PO2:- The student will also learn two computer languages C and Python as Skill Enhancement Courses and will help them to apply in different mathematical problems. It will enhance their computational skills and develop their skill for logic management. Also by learning the basic programming constructions, they can easily switch over to any other language in future.

Program	Two year Diploma course with Mathematics Major
Participants	Students of Semester Three and Semester Four after successful completion of one year certificate course
Program details	<p>To complete a Diploma course with Mathematics major the students should study four semester courses with following specification:-</p> <p>i) In each of the first two semesters (each of credit 21) they study one core course of Mathematics Major having credit 4, one Skill enhancement course of Mathematics Major having credit 4, one core course of first Minor paper having credit 4, one interdisciplinary course of credit 3, one language course of credit 2 and two value added course each of credit 2. ii) In the third semester(credit 21) they should study two core courses of Mathematics Major having credit 4, one Skill enhancement course of Mathematics Major having credit 4, one core course of the second Minor paper having credit 4, one interdisciplinary course of credit 3 and one language course of credit 2. (iii) In the fourth semester (credit 22) they should study four core courses each of credit 4, one core course of the second Minor paper having credit 4 and one language course of credit 2.</p>
Courses taught in Mathematics Major	<p>Semester 1:: (a)Core course:- Calculus, Geometry, Vector analysis; (b) SEC: C language with Mathematical Application</p> <p>Semester 2:: (a)Core course:- Basic Algebra; (b) SEC: Python Programming and Introduction to Latex</p> <p>Semester 3:- (a) Core course:- Real analysis, (b)Core course: Ordinary Differential equations-I and Group Theory-I. (c) SEC:- Linear Programming and Rectangular Games;</p> <p>Semester 4:- (a) Core course:- Theory of Real Functions, (b)Core course: Mechanics-I (c)Core course: Partial Differential Equations-I and Multivariate Calculus-I; (d) Core course: Group Theory-II and Ring Theory-I</p>
Program Outcome	<p>PO1:-The students will acquire basic knowledge of Calculus, Geometry, Vector algebra, Algebra, Real analysis, Theory of real functions, Ordinary and Partial differential equations, Mechanics and two computer languages. Thus they will be familiar with the basic branches of Mathematics.</p> <p>PO2: They will be conversant with the basic branches of mathematics which will help in their future study. Moreover they will be able to analyze problems in the light of Algebra, real analysis and theory of</p>

	<p>function which in turn develop their inner sight and a good grasp over the subject.</p> <p>PO3:- During the course of study the students will learn a course of Ordinary Differential Equations, Partial Differential Equations; Multivariate Calculus and Mechanics which will help them to solve different real life problems and mathematical models.</p> <p>PO4:- The student will also learn two computer languages C and Python as Skill Enhancement Courses, one of which is compiler based and the other is interpreter based. It will enhance their computational and analytical skills and will develop proficiency to write proper algorithm for management of a problem. Also by learning the basic programming constructs, they can easily switch over to any other language in future.</p>
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Program	Three year Degree course with Mathematics Major
Participants	Students of Semester Five and Six after successful completion of two year diploma course
Program details	<p>To complete a Degree course with Mathematics major the students should study six semester courses with following specification:-</p> <p>i) In the first semester there are one core course of Mathematics Major having credit 4, one Skill enhancement course of Mathematics Major having credit 4, one core course of first Minor paper having credit 4, one interdisciplinary course of credit 3, one language course of credit 2 and two value added courses each of credit 2.</p> <p>(ii) In the second semester there is one core course of Mathematics Major having credit 4, one Skill enhancement course of Mathematics Major having credit 4, one core course of first Minor paper having credit 4, one interdisciplinary course of credit 3, one language course of credit 2 and two value added courses each of credit</p> <p>iii) In the third semester there are two core courses of Mathematics Major having credit4, one Skill enhancement course of Mathematics Major having credit 4, one core course of the second Minor paper having credit 4, one interdisciplinary course of credit 3 and one language course of credit 2.</p>

	<p>(iv) In the fourth semester there are four core courses each of credit 4, one core course of the second Minor paper having credit 4 and one language course of credit 2.</p> <p>(iv) In the fifth semester there are four core courses each of credit 4, one core course of the first Minor paper having credit 4 and one core course of the second Minor paper having credit 4.</p> <p>(v) In the sixth semester there are three core courses each of credit 4, one core course of the first Minor paper having credit 4 and one core course of the second Minor paper having credit 4 and summer internship programme of credit 3.</p>
<p>Courses taught in Mathematics Major</p>	<p>Semester 1:: (a)Core course:- Calculus, Geometry, Vector analysis; (b) SEC: C language with Mathematical Application</p> <p>Semester 2:: (a)Core course:- Basic Algebra; (b) SEC: Python Programming and Introduction to Latex</p> <p>Semester 3:- (a) Core course:- Real analysis, (b)Core course: Ordinary Differential equations-I and Group Theory-I. (c) SEC:- Linear Programming and Rectangular Games;</p> <p>Semester 4:- (a) Core course:- Theory of Real Functions, (b)Core course: Mechanics-I (c)Core course: Partial Differential Equations-I and Multivariate Calculus-I; (d) Core course: Group Theory-II and Ring Theory-I</p> <p>Semester 5:- (a) Core course:- Probability and Statistics (b)Core course: Ring Theory-II and Linear Algebra-I (c)Core course: Riemann Integration and Series of function; (d) Core course: Mechanics-II</p> <p>Semester 6:- (a) Core course:- Metric Space & Complex Analysis-I, (b)Core course: Multivariate Calculus-II and Application of Calculus (c) Core course: Numerical analysis;</p>
<p>Program Outcome</p>	<p>PO1:-In three years of study the students will gain a thorough knowledge in Mathematics by enhancing problem-solving skills to resolve day to day problems.</p> <p>PO2:-Three years Graduates will be able to apply their knowledge and skills in a professional setting, to communicate effectively and collaborate with others and also will be able to engage in lifelong learning and adapt to changing circumstances."</p>

PO3:- Acquire deep understanding about scientific methods and apply these in solving scientific problems by analysing practical data using qualitative and quantitative methods.

PO4:- Develop scientific, communicative and numerical skills and make rewarding careers in Information technology, Machine learning, Industrial Mathematics and AI.

PO 5:- Can develop scientific models to solve problems in the fields of Engineering and social sciences and can carry out research projects independently or in collaboration with other institutions or industries.

PO 6:- In the course of six semesters the students will acquire knowledge of Calculus of single and multiple variables, Geometry of two and three dimensions, Vector algebra and calculus, Linear Modern and Classical algebra, Real and Complex analysis, Concepts of Riemann integration, Sequence and Series and functions, Probability and Statistics, Metric spaces, Ordinary and Partial differential equations, Mechanics of particle and rigid bodies, Statics, Numerical Analysis and two computer languages. Thus their course curriculum gives them a flavour of almost all the important branches of Mathematics and as such they can pursue their higher studies and research in their chosen branch so as to contribute significantly in the subject.

PO7:- During these three years of study the students also learn two computer languages C and Python, one of which is compiler based and the other is interpreter based. In Numerical analysis practical they apply those languages to run a problem and find a solution. It will enhance their computational and analytical skills and will develop proficiency to write proper algorithm for management of a problem. Also by learning the basic programming constructs, they can easily switch over to any other language in future.

PO8: After getting the flavour of all the basic branches of Mathematics the students will gain scientific knowledge and skills of different branches, which enable them to undertake further studies in Mathematics, Statistics or its allied areas. They will be able to analyze problems in the light of respective branch of mathematics and will be able to predict the solution of real life problems with the help of models. Thus the course will help them to develop a logical vision, a computational skill, a critical thinking power and as a whole a good grasp over the subject with which they will be able to proceed further in future life.

Course Outcome

Course: MATH-H-CC1-1-TH: Calculus, Geometry & Vector Analysis

CO1: To learn to find out higher order derivatives, Leibnitz rule and its applications, L'Hospital's rule.

CO2: To learn reduction formulae. They learn to find out arc length of a curve, area under a curve, area and volume of surface of revolution.

CO3: To learn classification of conics, reduction to canonical form, tangent, normal and polar equations of conics.

CO4: To acquire detail knowledge of spheres, cylindrical surfaces, central conicoids, different quadric surfaces.

CO5: To learn application of vector equations to geometry and mechanics, differentiation and integration of vector functions.

Course: MATH-H-CC2-2-TH: Basic Algebra

CO1: To learn about exponential, logarithmic, trigonometric and hyperbolic functions of complex variable.

CO2: To learn to solve cubic and biquadratic equation.

CO3: To acquire knowledge of equivalence relation, partial order relation, linear order relation, composition of mappings.

CO4: To learn well-ordering property of positive integers, division algorithm, congruence relation between integers.

CO5: To learn about existence and uniqueness of a system of linear equations, row reduction and echelon forms.

CO6: To learn about algebraic and geometric properties of vectors in n-dimensional space, linear independence of vectors, algebraic and geometric characterizations of linearly independent subsets.

Course: MATH-H-SEC1-1-TH: C Language with Mathematical Applications

CO1: To learn C language in detail.

CO2: To learn to use different types of control statements and arrays.

CO3: To learn to write different types of computer programs using C language.

Course: MATH-H-SEC 2.1-2-TH: Python Programming and Introduction to Latex

CO1: To learn Python programming language in detail.

CO2: To write programs using Python language and also plot functions.

CO3: To learn Latex which enables them typing scientific documents precisely.

Course: MATH-H-SEC3-3-TH: Linear Programming and Rectangular Games

CO1: To learn formulating real life problems into mathematical models.

CO2: To learn simplex method to solve linear programming problems.

CO3: To learn duality theory and post optimal analysis.

CO4: To learn to solve transportation problems and assignment problems.

CO4: To learn different techniques to solve rectangular games.

Course: MATH-H-IDC-1-TH: Mathematics in Daily Life

CO1: To learn basics of set theory.

CO2: To learn mathematics of integers behind ISBN, UPC, VISA, MASTER card nos.

CO3: To get idea of propositional logic, logical connectives,

CO4: To learn basics of linear programming problems.

CO5: To learn financial mathematics at elementary level.

Course: MATH-H-CC 3-3-TH: Real Analysis

CO1: To get idea of countable sets, uncountable sets, bounded and unbounded sets.

CO2: To learn concept of interior point, open set, limit point, closed set, dense set etc.

CO3: To study real sequence and its convergence and concept of subsequence.

CO4: To study infinite series and different tests for convergence.

**Course: MATH-H-CC 4-3-TH: Ordinary Differential Equations – I
and Group Theory – I**

CO1: To learn formation of differential equations and solution of differential equations.

CO2: To learn methods for solving first order first degree and higher degree differential equations.

CO3: To learn methods for solving higher order linear and nonlinear differential equations.

CO4: To study algebraic structure 'Group', elementary properties of groups, subgroups, order of a group, cyclic group, alternating groups etc.

Course: MATH-H-CC 5-4-TH: Theory of Real Functions

CO1: To learn about limit and continuity of function in detail.

CO2: To acquire knowledge of bounded function, discontinuity of a function, uniform continuity.

CO3: To learn Rolle's theorem, mean value theorems, Taylor's theorem, its application, existence of local extremum of a function in an interval.

Course: MATH-H-CC 6-4-TH: Mechanics-I

CO1: To learn about principle of forces, resultant forces, resultant couple and coplanar forces.

CO2: To study rectilinear motion and simple harmonic motion.

CO3: To learn to solve problems on work, power, energy.

CO4: To study on impulsive forces and collision of elastic bodies.

CO5: To learn to solve problems of motion of a particle in two-dimension.

Course: MATH-H-CC7-4-TH: Multivariate Calculus-I and Partial Differential Equations-I

CO1: To become familiar with the concept of limit, continuity, differentiability, partial derivatives of functions of two or more variables.

CO2: To learn to find out directional derivatives, gradient and tangent planes, partial derivatives of higher order.

CO3: To learn about homogeneous functions, implicit functions.

CO4: To learn to find out extrema of functions of two variables, multiple integral, repeated integral.

CO5: To learn classification of PDE, solution of quasilinear equations, solution of semilinear equations, Charpit's general method of solution of nonlinear first order PDEs.

Course: MATH-H-CC 8-4-TH: Group Theory – II and Ring Theory – I

CO1: To learn about normal subgroup, quotient group, group homomorphism, properties of isomorphism.

CO2: To learn about automorphism, external direct product, internal direct product, Abelian group.

CO3: To acquire knowledge of ring theory, subrings, integral domain and fields, subfield, ideal, ring homomorphism, congruence on rings.

Course: MATH-H-CC 9-5-TH: Probability and Statistics

CO1: To learn about random experiment, probability axioms, conditional probability, joint probability.

CO2: To learn distribution function of a random variable, properties of distribution function, probability mass / density functions etc.

CO3: To learn joint distribution of discrete and continuous random variables and their properties.

CO4: To learn about populations and samples and sampling distributions, sample characteristics.

CO5: To learn to find out estimation of parameters, method of maximum likelihood .

CO6: To acquire knowledge of bivariate frequency distribution and confidence intervals.

CO7: To learn testing of hypothesis, type I and type II error.

Course: MATH-H-CC 10-5-TH: Ring Theory - II and Linear Algebra – I

CO1: To learn about principal ideal domain, principal ideal ring, Euclidean domain.

CO2: To acquire knowledge of polynomial rings, factorization domain, ring embedding and quotient field, regular rings, ideals in regular rings.

CO3: To learn vector space, subspaces, quotient spaces, linear span, basis and dimension, full rank factorization, rank inequalities.

CO4: To learn about linear transformations, algebra of linear transformations, isomorphisms, eigen values and eigen vectors.

Course: MATH-H-CC11-5-TH: Riemann Integration and Series of Functions

CO1: To learn Riemann's definition of integrability, necessary and sufficient condition for Riemann integrability, properties of Riemann integrable functions.

CO2: To learn about improper integrals, Cauchy's principal value of improper integral, tests of convergence.

CO3: To learn about sequence of functions, pointwise and uniform convergence, boundedness, continuity, integrability and differentiability of the limit function of a sequence of functions in case of uniform convergence.

CO4: To learn about series of functions, pointwise and uniform convergence, boundedness, continuity, integrability and differentiability of a series of a series of functions in case of uniform convergence.

CO5: To learn about power series and Fourier series.

Course: MATH-H-CC 12-5-TH: Mechanics-II

CO1: To learn to solve problems of friction and problems of virtual work.

CO2: To become familiar with the concept of stable, unstable and neutral equilibrium.

CO3: To learn to find out equations of equilibrium for an arbitrary system of forces in three-dimension.

CO4: To learn to solve problems of motion of a particle on rough curve, problems of motion of a particle of varying mass etc.

CO5: To learn dynamics of a system of particles and dynamics of rigid body in detail.

Course: MATH-H-CC 13-6-TH: Metric Space and Complex Analysis – I

CO1: To learn about open ball, open set, closed set, bounded set, uniform continuity, isometry etc.

CO2: To learn convergent sequence, completeness etc.

CO3: To learn compactness, connectedness, contraction mapping etc.

CO4: To learn limit, continuity and differentiability of complex functions of complex variable.

CO5: To learn analytic functions and elementary functions of complex variable.

CO6: To learn bilinear transformation and its properties.

CO7: To learn Power series- its convergence, representation of analytic functions by power series.

CO8: To learn properties of harmonic functions, Milne Thompson method.

Course: MATH-H-CC 14-6-TH: Multivariate Calculus – II and Application of Calculus

CO1: To learn about continuity and differentiability of functions of several variables.

CO2: To learn computation of double integrals and triple integrals.

CO3: To learn divergence and curl of vector field and application of line integrals.

CO4: To learn Green's theorem, Stokes theorem, Divergence theorem.

CO5: To learn Curvature, concavity, points of inflection, envelopes, rectilinear asymptotes, curve tracing.

Course: MATH-H-CC 15-6-TH: Numerical Analysis

CO1: To learn polynomial approximation, interpolation, numerical differentiation and integration.

CO2: To learn different methods for solving transcendental and polynomial equations.

CO3: To learn solving system of linear algebraic equations.

CO4: To learn some methods for matrix inversion and Power method for obtaining dominant eigenpair.

CO5: To learn some methods for solving ordinary differential equations.

Course: MATH-MD-CC 5-4-TH: Advanced Calculus

CO1: To learn sequence of real numbers and infinite series of constant terms.

CO2: To learn limit, continuity of real valued functions, properties of continuous functions.

CO3: To learn Rolle's theorem, mean value theorems, Taylor's and Maclaurin's infinite series.

CO4: To learn limit, continuity, differentiability, partial derivatives of real valued functions of two or three variables, chain rule of partial derivatives, Euler's theorem on homogeneous functions.

Course: MATH-MD-CC 6-4-TH: Statistics and Numerical Analysis

CO1: To learn probability theory, discrete and continuous distribution, mathematical expectations.

CO2: To learn measures of central tendency, measures of dispersion, correlation and regression.

CO3: To learn sampling theory, basic idea of some distributions used in sampling theory.

CO4: To learn estimation of parameters, point estimation, interval estimation, testing of hypothesis, type I and type II error.

CO5: To learn interpolation and numerical integration.

CO6: To learn methods for solving transcendental equations and Gauss elimination method for solving system of linear equations.

Course: MATH-MD-CC 7-5-TH: Mathematical Methods

CO1: To learn sequence and series of functions in detail.

CO2: To learn application of differential calculus and maxima and minima of functions.

CO3: To learn Fourier series of periodic functions.

CO4: To learn Laplace transform and its application to the solution of ordinary differential of second order with constant coefficients.

Course: MATH-MD-CC 8-6-TH: Discrete Mathematics

CO1: To learn Graph theory in detail.

CO2: To learn application of congruences.

CO3: To learn combinatorics, recurrence relations, generating functions.

CO4: To learn Boolean functions, Boolean polynomials, Minimal forms of Boolean polynomials, switching circuits, Logic gates.