Government of West Bengal
Government General Degree College Nakashipara
Department of Mathematics
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Phone No.: 03474-268008 web: www.muragachhagovtcollege.org e-mail: mgcnadia2015@gmail.com

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PROGRAMME OUTCOME AND COURSE OUTCOME FOR THE ACADEMIC SESSION 2022-23 OFFERED BY DEPARTMENT OF MATHEMATICS

B.Sc. (Hons.) in Mathematics

Programme Objectives:

A. Students who choose B.Sc. (Hons.) Mathematics Programme, develop the ability to think critically, logically and analytically and hence use mathematical reasoning in everyday life.
B. 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.
C. 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, Mathematical Finance, Coding Theory, Mechanics and Biomathematics cater to varied interests and ambitions and helps to widen the horizon of students' self-experience.
D. To broaden the interest for interconnectedness between formerly separate disciplines one can choose from the list of Generic electives for example one can opt for economics as one of the GE papers.
E. Skill enhancement Courses enable the student acquire the skill relevant to the main subject.
F. Choices from Discipline Specific Electives provides the student with liberty of exploring his interests within the main subject.
G. The well-structured program empowers the student with the skills and knowledge leading to enhanced career opportunities in industry, commerce, education, finance and research.

Programme Learning Outcomes:

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

PO1: **Critical Thinking:** Think in a critical manner.
PO2: **Familiarization with Mathematical Analysis:** Familiarize the students with suitable tools of mathematical analysis to handle issues and problems in mathematics and related sciences.
PO3: **Visualization and Communication of Abstract Idea:** Communicate mathematics effectively by written, computational and graphic means.
PO4: **Development of Understanding of Core Concepts:** Create mathematical ideas about basic axioms.

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PO5: **Development of Understanding of Mathematical Techniques:** Gauge the hypothesis, theories, techniques and proofs provisionally.

PO6: **Utilization of Mathematical Idea:** Utilize mathematics to solve theoretical and applied problems by critical understanding, analysis and synthesis.

PO7: **Application in Other Branches of Science:** 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.

Course Outcomes:

Honours Course Offered by Department of Mathematics

Semester-I

Paper Name: Calculus & Analytical Geometry (MATH-H-CC-T-01)

Course Objectives: The primary objective of this course is to introduce the basic tools of calculus and geometric properties of different conic sections which are helpful in understanding their applications in planetary motion, design of telescope and to the real-world problems. Also, to carry out the hand on sessions in computer lab to have a deep conceptual understanding of the above tools to widen the horizon of students' self-experience.

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

1. Sketch curves in a plane using its mathematical properties in the different coordinate systems of reference.
2. Apply derivatives in Optimization, Social sciences, Physics and Life sciences etc.
3. Compute area of surfaces of revolution and the volume of solids by integrating over cross-sectional areas.

Paper Name: Algebra (MATH-H-CC-T-02)

Course Objectives: The primary objective of this course is to introduce the basic tools of theory of equations, complex numbers, number theory and matrices to understand their linkage to the real-world problems. Perform matrix algebra with applications to Computer Graphics.

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

1. Employ De Moivre's theorem in a number of applications to solve numerical problems.
2. Apply Euclid's algorithm and backwards substitution to find greatest common divisor.
3. Recognize consistent and inconsistent systems of linear equations by the row echelon form of the augmented matrix, using rank.
4. Find eigenvalues and corresponding eigenvectors for a square matrix.

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Semester-II

Paper Name: Real Analysis (MATH-H-CC-T-03)

Course Objectives: The course will develop a deep and rigorous understanding of real line and of defining terms to prove the results about convergence and divergence of sequences and series of real numbers. These concepts have wide range of applications in real life scenario.

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

1. Understand many properties of the real line and learn to define sequence in terms of functions from to a subset of Real Numbers.
2. Recognize bounded, convergent, divergent, Cauchy and monotonic sequences and to calculate their limit superior, limit inferior, and the limit of a bounded sequence.
3. Apply the ratio, root, and alternating series and limit comparison tests for convergence and absolute convergence of an infinite series of real numbers.

Paper Name: Differential Equations (MATH-H-CC-T-04)

Course Objectives: The main objectives of this course are to introduce the students to the exciting world of Differential Equations, Mathematical Modelling and their applications.

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

1. Formulate Differential Equations for various Mathematical models.
2. Solve first order non-linear differential equation and linear differential equations of higher order using various techniques.
3. Apply these techniques to solve and analyse various mathematical models.

Semester- III

Paper Name: Theory of Real & Vector Functions (MATH-H-CC-T-05)

Course Objectives: It is a basic course on the study of real valued functions that would develop an analytical ability to have a more matured perspective of the key concepts of calculus, namely, limits, continuity, differentiability and their applications.

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

1. To have a rigorous understanding of the concept of limit of a function.
2. The geometrical properties of continuous functions on closed and bounded intervals.
3. The applications of mean value theorem and Taylor's theorem.

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Paper Name: Group Theory-I (MATH-H-CC-T-06)

Course Objectives: The objective of the course is to introduce the fundamental theory of groups and their homomorphisms. Symmetric groups and group of symmetries are also studied in detail. Fermat's Little theorem as a consequence of the Lagrange's theorem on finite groups.

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

1. Recognize the mathematical objects that are groups, and classify them as abelian, cyclic and permutation groups, etc.
2. Link the fundamental concepts of Groups and symmetrical figures.
3. Analyse the subgroups of cyclic groups.
4. Explain the significance of the notion of cosets, normal subgroups, and factor groups.

Paper Name: Numerical Methods & Numerical Methods Lab (MATH-H-CC-T-07)

Course Objectives: To comprehend various computational techniques to find approximate value for possible root(s) of non-algebraic equations, to find the approximate solutions of system of linear equations and ordinary differential equations. Also, the use of Computer programs by which the numerical problems can be solved both numerically and analytically, and to enhance the problem-solving skills.

Course Learning Outcomes: The course will enable the students to learn the following:

1. 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.
2. Interpolation techniques to compute the values for a tabulated function at points not in the table.
3. Applications of numerical differentiation and integration to convert differential equations into difference equations for numerical solutions.

Paper Name: Programming in "C" (MATH-H-SEC-T-01)

Course Objectives: The objective of this course is to introduce the concepts of Programming and the fundamentals of "C" programming language to the student.

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

1. Develop ideas with regard to "Program Design".
2. Develop a "C" program that give logical outputs.
3. Manage I/O and String operations.
4. Understand key concepts like "Array", "Loop" etc.

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Semester-IV

Paper Name: Ring Theory & Linear Algebra-I (MATH-H-CC-T-08)

Course Objectives: The objective of this course is to introduce the fundamental theory of two objects, namely- rings and vector spaces, and their corresponding homomorphisms.

Course Learning Outcomes: The course will enable the students to learn about:

1. The fundamental concept of Rings, Fields, subrings, integral domains and the corresponding morphisms.
2. The concept of linear independence of vectors over a field, the idea of a finite dimensional vector space, basis of a vector space and the dimension of a vector space.
3. Basic concepts of linear transformations, the Rank-Nullity Theorem, matrix of a linear transformation, algebra of transformations and the change of basis.

Paper Name: Multivariate Calculus & Tensor Analysis (MATH-H-CC-T-09)

Course Objectives: To understand the extension of the studies of single variable differential and integral calculus to functions of two or more independent variables.

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

1. The conceptual variations when advancing in calculus from one variable to multivariable discussions.
2. Inter-relationship amongst the line integral, double and triple integral formulations.
3. Applications of multi variable calculus tools in physics, economics, optimization, and understanding the architecture of curves and surfaces in plane and space etc.
4. Applications of tensor in physics and other related fields.

Paper Name: Linear Programming Problems & Game Theory (MATH-H-CC-T-10)

Course Objectives: This course develops the ideas underlying the Simplex Method for Linear Programming problem, as an important branch of Operations Research. The course covers Linear Programming with applications to Transportation, Assignment and Game Problem. Such problems arise in manufacturing resource planning and financial sectors.

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

1. Analyse and solve linear programming models of real-life situations.

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2. The graphical solution of LPP with only two variables, and illustrate the concept of convex set and extreme points. The theory of the simplex method is developed.
3. The relationships between the primal and dual problems and their solutions with applications to transportation, assignment and two-person zero-sum game problem.

Paper Name: Graph Theory (MATH-H-SEC-T-02)

Course Objectives: To understand the core concepts of "Graph Theory" and to apply those tools in solving real world problems.

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

1. Understand the basics of graph theory and their various properties.
2. Model problems using graphs and to solve these problems algorithmically.
3. Apply graph theory concepts to optimize and solve real world applications like routing, TSP/traffic control, etc.

Semester V

Paper Name: Riemann Integration & Series of Functions (MATH-H-CC-T-11)

Course Objectives: To understand the integration of bounded functions on a closed and bounded interval and its extension to the cases where either the interval of integration is infinite, or the integrand has infinite limits at a finite number of points on the interval of integration. The sequence and series of real valued functions, and an important class of series of functions (i.e., power series).

Course Learning Outcomes: The course will enable the students to learn about:

1. Some of the families and properties of Riemann integrable functions, and the applications of the fundamental theorems of integration.
2. Beta and Gamma functions and their properties.
3. The valid situations for the inter-changeability of differentiability and integrability with infinite sum, and approximation of transcendental functions in terms of power series.

Paper Name: Mechanics - I (MATH-H-CC-T-12)

Course Objectives: To understand the basic concepts of Classical Mechanics, i.e., concepts with regard to Particle Dynamics and Rigid Body Dynamics in 2D and 3D space.

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

1. Understand and use basic terms for the description of the motion of particles, vector functions and the fundamental laws of Newtonian mechanics.
2. Solve mechanics problems in one dimension that involve one or more of the forces of gravity, friction and air resistance.
3. Solve problems relating to the motion of a projectile and artificial satellites.
4. Identify, formulate and solve engineering problems in rigid body dynamics.

Paper Name: Partial Differential Equations & Laplace Transform(MATH-H-DSE-T-01)

Course Objectives: The main objectives of this course are to teach students to form and solve partial differential equations and use them in solving some physical problems.

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

1. Formulate, classify and transform partial differential equations into canonical form.
2. Solve linear and non-linear partial differential equations using various methods; and apply these methods in solving some physical problems.

Paper Name: Number theory (MATH-H-DSE-T-02)

Course Objectives: The main objectives of this course are to teach students to learn about some important results in the theory of numbers including the prime number theorem, Chinese remainder theorem, Wilson's theorem and their consequences.

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

1. Learn about number theoretic functions, modular arithmetic and their applications.
2. Familiarize with modular arithmetic and find primitive roots of prime and composite numbers.
3. Know about open problems in number theory, namely, the Goldbach conjecture and twin-prime conjecture.

Semester VI

Paper Name: Metric Spaces & Complex Analysis (MATH-H-CC-T-13)

Course Objectives: The course aims at providing the basic knowledge pertaining to metric spaces such as open and closed balls, neighbourhood, interior, closure, subspace, continuity, compactness, connectedness etc. This course aims to introduce the basic ideas of analysis for

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complex functions in complex variables with visualization through relevant practical. Particular emphasis has been laid on Cauchy's theorems, series expansions and calculation of residues.

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

1. Understand the basic concepts of metric spaces. Correlate these concepts to their counter parts in real analysis. Appreciate the abstractness of the concepts such as open balls, closed balls, compactness, connectedness etc. beyond their geometrical imaginations.
2. Understand the significance of differentiability of complex functions leading to the understanding of Cauchy-Riemann equations.
3. Evaluate the contour integrals and understand the role of Cauchy-Goursat theorem and the Cauchy integral formula. 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.

Paper Name: Probability & Statistics (MATH-H-CC-T-14)

Course Objectives: To make the students familiar with the basic statistical concepts and tools which are needed to study situations involving uncertainty or randomness. The course intends to render the students to several examples and exercises that blend their everyday experiences with their scientific interests.

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

1. Distributions to study the joint behaviour of two random variables.
2. To establish a formulation helping to predict one variable in terms of the other, i.e., correlation and linear regression.
3. Central limit theorem, which helps to understand the remarkable fact that: the empirical frequencies of so many natural populations, exhibit a bell-shaped curve.

Paper Name: Bio-Mathematics (MATH-H-DSE-T-03)

Course Objectives: The focus of the course is on scientific study of normal functions in living systems. The emphasis is on exposure to nonlinear differential equations with examples such as heartbeat, chemical reactions and nerve impulse transmission. The basic concepts of the probability to understand molecular evolution and genetics have also been applied.

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

1. Learn the development, analysis and interpretation of bio mathematical models.
2. Reinforce the skills in mathematical modelling.
3. Appreciate the theory of bifurcation and chaos.
4. Learn to apply the basic concepts of probability to molecular evolution and genetics.

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Paper Name: Mechanics - II (MATH-H-DSE-T-04)

Course Objectives: The course aims at understanding the various concepts of physical quantities and the related effects on different bodies using mathematical techniques. It emphasizes knowledge building for applying mathematics in physical world.

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

1. Analyse the properties of a force system (in both 2D & 3D).
2. Solve equilibrium problems of various types including friction, using analytical models.
3. Understand the basic properties of fluids and the significance of basic principles of fluid statics and application of hydrostatic law in determining forces on surfaces and hydraulic structures, floatation and stability of floating bodies.

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GENERIC ELECTIVE COURSES OFFERED BY DEPARTMENT OF MATHEMATICS

FOR THE ACADEMIC SESSION 2022-23

(For students Other than B.Sc.(H) Mathematics)

Semester-I or Semester-III

Paper Name: Algebra & Analytical Geometry (MATH-H-GE-T-01)

(This course is again repeated in 3rd semester for students who have not studied Mathematics in 1st Semester.)

Course Objectives: The primary objective of this course is to introduce the basic tools of theory of equations, complex numbers and matrices to understand their linkage to the real-world problems. They are also supposed to understand geometric properties of different conic sections which are helpful in other areas of learning.

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

1. Sketch curves in a plane using its mathematical properties in the different coordinate systems of reference.
2. Compute area of surfaces of revolution and the volume of solids by integrating over cross-sectional areas.
3. Employ De Moivre's theorem in a number of applications to solve numerical problems.
4. Recognize consistent and inconsistent systems of linear equations by the row echelon form of the augmented matrix, using rank.
5. Find eigenvalues and corresponding eigenvectors for a square matrix.

Semester-II or Semester-IV

Paper Name: Calculus & Differential Equations (MATH-H-GE-T-02)

(This course is again repeated in 4th semester for students who have not studied Mathematics in 2nd Semester.)

Course Objectives: The main aim of this course is to introduce the concept of differentiation of functions, points of inflection, curve sketching etc. Concepts of functions of several variables, their partial derivatives and saddle points is also discussed. The students are also encouraged to use Differential Equations in Mathematical Modelling and other applications.

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

1. Understand Limits, continuity and partial derivatives of functions of several variables.
2. Get acquainted with Leibnitz's theorem and its applications.
3. Apply principle of maxima and minima for a function of a single variable.
4. Understand Method of Variation of Parameters and Method of Undetermined Coefficients.

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MATHEMATICS COURSE FOR B.SC. PROGRAMME OFFERED BY

DEPARTMENT OF MATHEMATICS FOR THE ACADEMIC SESSION 2022-23

Semester-I

Paper Name: Algebra & Analytical Geometry (MATH-G-CC-T-01)

Course Objectives: The primary objective of this course is to introduce the basic tools of theory of equations, complex numbers and matrices to understand their linkage to the real-world problems. They are also supposed to understand geometric properties of different conic sections which are helpful in other areas of learning.

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

1. Sketch curves in a plane using its mathematical properties in the different coordinate systems of reference.
2. Compute area of surfaces of revolution and the volume of solids by integrating over cross sectional areas.
3. Employ De Moivre's theorem in a number of applications to solve numerical problems.
4. Recognize consistent and inconsistent systems of linear equations by the row echelon form of the augmented matrix, using rank.
5. Find eigenvalues and corresponding eigenvectors for a square matrix.

Semester-II

Paper Name: Calculus & Differential Equations (MATH-G-CC-T-02)

Course Objectives: The main aim of this course is to introduce the concept of differentiation of functions, points of inflection, curve sketching etc. Concepts of functions of several variables, their partial derivatives and saddle points is also discussed. The students are also encouraged to use Differential Equations in Mathematical Modelling and other applications.

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

1. Understand Limits, continuity and partial derivatives of functions of several variables.
2. Get acquainted with Leibnitz's theorem and its applications.
3. Apply principle of maxima and minima for a function of a single variable.
4. Understand Method of Variation of Parameters and Method of Undetermined Coefficients.

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Semester-III

Paper Name: Real Analysis (MATH-G-CC-T-03)

Course Objectives: The course aims at building an understanding of convergence of sequence and series of real numbers and various methods/tools to test their convergence. The course also aims at building understanding of the theory of Riemann integration.

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

1. Understand basic properties of the field of real numbers.
2. To test convergence of sequence and series of real numbers.
3. Distinguish between the notion of integral as anti-derivative and Riemann integral.

Paper Name: Vector Calculus (MATH-G-SEC-T-01)

Course Objectives: The course provides an introduction to functions of several real variables and classical vector analysis. Topics discussed are: partial derivatives; directional derivatives; gradients; extremal problems and the Lagrange multiplier method; multiple integrals, line and surface integrals; vector valued functions; divergence, curl and flux of vector fields; the theorems of Green and Stokes; the divergence theorem; and applications.

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

1. To apply techniques from multivariable analysis to set up and solve mathematical models.
2. Deduce simple mathematical results, and to calculate integrals.
3. Set up and solve simple optimization problems, including problems with constraints.

Semester-IV

Paper Name: Linear Programming Problems & Game Theory (MATH-G-CC-T-04)

Course Objectives: This course develops the ideas underlying the Simplex Method for Linear Programming Problem, as an important branch of Operations Research. The course covers Linear Programming with applications to Transportation, Assignment and Game Problem. Such problems arise in manufacturing resource planning and financial sectors.

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

1. Analyse and solve linear programming models of real-life situations.

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2. The graphical solution of LPP with only two variables, and illustrate the concept of convex set and extreme points. The theory of the simplex method is developed.
3. The relationships between the primal and dual problems and their solutions with applications to transportation, assignment and two-person zero-sum game problem.

Paper Name: Graph Theory (MATH-G-SEC-T-02)

Course Objectives: To understand the core concepts of "Graph Theory" and to apply those tools in solving real world problems.

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

1. Understand the basics of graph theory and their various properties.
2. Model problems using graphs and to solve these problems algorithmically.
3. Apply graph theory concepts to optimize and solve real world applications like routing, TSP/traffic control, etc.

Semester-V

Paper Name: Complex Analysis (MATH-G-DSE-T-01)

Course Objectives: The course aims at providing the basic knowledge pertaining to metric spaces such as open and closed balls, neighbourhood, interior, closure, subspace, continuity, compactness, connectedness etc. This course aims to introduce the basic ideas of analysis for complex functions in complex variables with visualization through relevant practical. Particular emphasis has been laid on Cauchy's theorems, series expansions and calculation of residues.

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

1. Understand the basic concepts of metric spaces. Correlate these concepts to their counter parts in real analysis. Appreciate the abstractness of the concepts such as open balls, closed balls, compactness, connectedness etc. beyond their geometrical imaginations.
2. Understand the significance of differentiability of complex functions leading to the understanding of Cauchy-Riemann equations.
3. Evaluate the contour integrals and understand the role of Cauchy-Goursat theorem and the Cauchy integral formula.
4. Expand some simple functions as their Taylor series.

Paper Name: Theory of Probability (MATH-G-SEC-T-03)

Course Objectives: To make the students familiar with the basic statistical concepts and tools which are needed to study situations involving uncertainty or randomness. The course intends

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to render the students to several examples and exercises that blend their everyday experiences with their scientific interests.

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

1. Distributions such as Binomial, Poisson etc.
2. Mathematical Expectations, Moment Generating Function etc.
3. Distributions to study the joint behaviour of two random variables.

Semester-VI

Paper Name: Dynamics of a Particle (MATH-G-DSE-T-02)

Course Objectives: To understand the basic concepts of Classical Mechanics, i.e., concepts with regard to Particle Dynamics

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

1. Understand and use basic terms for the description of the motion of particles, vector functions and the fundamental laws of Newtonian mechanics.
2. Solve problems relating to the motion of a projectile and artificial satellites.
3. Identify, formulate and solve engineering problems in rigid body dynamics.

Paper Name: Programming in "C" (MATH-G-SEC-T-04)

Course Objectives: The objective of this course is to introduce the concepts of Programming and the fundamentals of "C" programming language to the student.

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

1. Develop ideas with regard to "Program Design".
2. Develop a "C" program that give logical outputs.
3. Manage I/O and String operations.
4. Understand key concepts like "Array", "Loop" etc.

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