VIDYANAGAR COLLEGE
P.O. - CHARASHYAMDAS, SOUTH 24 PARGANAS, PIN-743503

DEPARTMENT OF MATHEMATICS
Program Outcomes, Program Specific Outcomes and Course Outcomes

On successful completion of the undergraduate Mathematics program (CCF): Students will have acquired sufficient knowledge and skills to pursue further studies in Mathematics and its allied disciplines. They will develop a deep understanding of various branches of Pure and Applied Mathematics, including Geometry, Algebra, Mathematical Analysis, Discrete Mathematics, Statistics, Operational Research, and Differential Equations. The introduction of Skill Enhancement Courses (SECs) and Discipline-Specific Core Courses (DSCCs), or Major courses, will strengthen students' understanding not only of core Mathematics but also of related multidisciplinary subjects. These courses will also provide proper training in mathematics-based software tools, enabling students to become proficient in their use. Students will be exposed to specialized areas of advanced mathematics and their practical applications. Graduates will be capable of analysing mathematical results and applying them to problems across various branches of Mathematics. They will develop the ability to comprehend and communicate mathematical statements, ideas, and results effectively—both verbally and in writing—using appropriate definitions, terminology, and symbols. Students will learn to convey mathematical concepts clearly through relevant examples and geometrical visualizations. They will also be prepared to work collaboratively with peers and instructors to deepen their understanding, formulate and solve problems, and present well-reasoned solutions. Furthermore, they will be proficient in using mathematical software and computer packages to explore and solve complex problems where appropriate.

Programme outcome (PO)

PO	Description
PO1	**Gain a depth knowledge in the discipline of science by exchanging problem solving skills.**
PO2	**Acquire through understanding about scientific methods and apply these in solving scientific problems by analyzing practical data using qualitative and quantitative methods**
PO3	**Solve problems in different fields like health, industries etc. and can carry out research projects independently in various kind of industries.**
PO4	**Develop strong scientific, communicative, and numerical skills to build rewarding careers in science and education by successfully tackling challenging competitive examinations.**
PO5	**Acquire innovative ideas through practical experiments**
PO6	**Demonstrate the ability to communicate mathematical ideas clearly. They will use correct mathematical terminology and proper mathematical notations.**
PO7	**Develop and maintain problem solving skills.**
PO8	**Write and understand basic proof of mathematics.**

PROGRAMME SPECIFIC OUTCOMES

PO	Description
PSO1	**Gain a strong knowledge in different areas of mathematics and solve real life problems by mathematical models.**
PSO2	**Gain numerical skills and exploring these ideas in competitive examinations, internships with confidence.**
PSO3	**Developing problem solving skills to solve day to day problems**
PSO4	**Apply knowledge of principles, concepts and results in specific subject area to analyze their impact both locally and globally.**
PSO5	**Doing research in the field of mathematics, Engineering, information technology, computer science and social science.**
PSO6	**Gain scientific knowledge and skills in mathematics, statistics or its allied areas.**
PSO7	**Develop and maintain problem solving skills in mathematics.**
PSO8	**Write and understand basic proof of mathematics in lower to higher level.**

Course Outcomes:

Semester	Course Code	Course Outcomes
SEM-I	**MATH-H-CC1-1-Th & MATH-MC-MN1-1-Th & MATH- MC-MN3-3-Th** **&** **MATH- MD-CC1-1-Th** **&** **MATH- MD-MN1-3-Th** **Calculus, Geometry & Vector analysis**	Upon successful completion of this course, students will be able to: **CO 1.** Compute limits, derivatives, and integrals. **CO 2.** Analyse functions using limits, derivatives, and integrals. **CO 3.** Recognize the appropriate tools of calculus to solve applied problems. **CO 4.** Describe the various forms of equation of a plane, straight line, Sphere, Cone and Cylinder. **CO 5.** Find the angle between planes, Bisector planes, Perpendicular distance from a point to a plane, Image of a line on a plane, Intersection of two lines. **CO 6.** Define coplanar lines and illustrate. **CO 7.** Compute the angle between a line and a plane, length of perpendicular from a point to a line. **CO 8.** Define skew lines, calculate the shortest distance between two skew lines. **CO 9.** Find and interpret the gradient curl, divergence for a function at a given point. **CO 10.** Interpret line, surface and volume integrals, evaluate integrals by using Green's Theorem, Stokes theorem & Gauss's Theorem.
SEM-I	**MATH-H-SEC1-1-Th & MATH-MD-SEC-1-TH & MATH-MD-SEC-2-TH & MATH-MD-SEC-3-TH** **C Language with Mathematical Application**	**CO 1.** This course is very effective to the students because it includes from algorithms, flowcharts, basic programming in C. **CO 2**. Understand C programming language and can solve problems using C-programming software. **CO 3**. Understand the necessity of using numerical methods apply these to solve various types of problems. **CO 4.** Find roots of transcendental and polynomial equations using numerical technique. **CO 5.** Solve mathematical models using appropriate numerical methods and pursue research in the field of mathematics, engineering, computer science. **CO 6.** Constructs polynomials employing different methods and understand numerical differentiation and integration which enables them to undertake further studies in Mathematics, or its allied areas. **CO 7.** Compare the rate of convergence of different numerical formula
		Students will be able to **CO 1.** Learn basics of set theory, Venn diagram, First Principle of Mathematical Induction.

SEM-I, II & III	**MATH-H-IDC-1-Th** **Mathematics in Daily Life**	**CO 2.** Know Division Algorithm, Fundamental theorem of Arithmetic, Algorithm for Primality test. **CO 3.** Understand logical connectives: NOT, OR, AND and their truth tables, Tautology, logical consequence etc. **CO 4.** Formulate daily life problems as an LPP **CO 5.** Solve an LPP by graphical method **CO 6.** Know definition of Game, Examples from daily life Two person zero sum game. **CO 7.** Learn Simple interest and Compound interest, Idea of repayment of loans. **CO 8.** Know dividend calculation and calculation of income tax on taxable income (old and new regime)

Semester	Course Code	Course Outcomes
SEM-II	**MATH-H-CC2-2-Th & MATH-MD-CC-2-2-Th & MATH-MC-MN-2-2-Th & MATH-MC-MN-4-4-Th & MATH-MD-MN-2-4-Th** **Basic Algebra**	students will be able to **CO 1.** Employ De Moivre's theorem in a number of applications to solve numerical problems. **CO 2.** Apply Cardons method (solve cubic equation) and Ferrari's method (solve Bi-quadratic equation). **CO 3.** Apply the inequality to the problems of maxima and minimum. **CO 4.** Complex functions are really helpful for understand the complex analysis. **CO 5.** Complex numbers are used in real life applications such as electricity, and also to signal processing, which is use full in cellular technology and wireless technologies, as well as radar and even biology (brain waves). **CO 6.** Anyone can judge about dependency between two rows and two columns of a matrix with the help of rank. **CO 7.** In our real life we use system of linear equations in the regards of age problem, speed related problems, wages and hourly rate problems.
		Knowledge gained: **CO 1.** To understand why Python is a useful scripting language for developers. **CO 2.** To learn how to use lists, tuples, and dictionaries in Python programs. **CO 3.** To learn how to identify Python object types. **CO 4.** To learn how to use indexing and slicing to access data in Python programs.

SEM-II	**MATH-H-SEC2.1-2-Th** **Python programming and Introduction to Latex**	**CO 5.** To define the structure and components of a Python program. **CO 6.** To learn how to write loops and decision statements in Python. **CO 7.** To learn how to write functions and pass arguments in Python. **CO 8.** To learn how to build and package Python modules for reusability. **CO 9.** To learn how to read and write files in Python. **CO 10.** To learn how to design object-oriented programs with Python classes. **CO 11.** To learn how to use class inheritance in Python for reusability. **CO 12.** To learn how to use exception handling in Python applications for error handling. **CO 13.** To acquire programming skills in core Python. **CO 14.** To acquire Object Oriented Skills in Python Skills gained: **CO 15.** To learn how to design and program Python applications. Competency developed: **CO 16.** To develop the ability to write database applications in Python **CO 17.** To develop the skill of designing Graphical user Interfaces in Python. **CO 18.** This course is very effective to the students because it includes introduction to LaTeX word processor, equation representation, picture environment etc.
SEM-III	**MATH-H-CC3-3-Th** **Real Analysis**	This course will enable the students to: **CO 1.** Understand many properties of the real line R and learn to define sequence in terms of functions from R to subset of R. **CO 2.** Recognize bounded, convergent, divergent, Cauchy and monotonic sequences and to calculate their limit superior, limit inferior, and the limit of a bounded sequence. **CO 3.** Enumerate the limits of functions, infinite limits and limit at infinity **CO 4.** Demonstrate, describe, and recognize ways in which limit do not exit. **CO 5.** Evaluate one sided limits and describe relationship between limits and one sided limits. **CO 6.** Develop solutions for tangent and area problems using the concepts of limits, derivatives. **CO 7.** Draw graphs of algebraic and transcendental functions considering limits continuity and differentiability at a point. **CO 8.** Articulate the relationship between derivatives and integrals using the fundamental theorems of calculus.

		CO 9. Predict in various cases, like where the speed in a given curve was maximum without differentiation by Rolle's theorem.

Semester	Course Code	Course Outcomes
SEM-III	**MATH-H-CC4-3-Th & MATH-MC-MN5-5-TH & MATH-MD-CC3-3-TH & MATH-MD-MN3-5-TH** **Ordinary Differential Equation-I & Group Theory -I**	The course will enable the students to: **CO 1.** Explain the concept of differential equation. **CO 2.** Solve first-order ordinary differential equations. **CO 3.** Find solution of higher order linear differential equations. **CO 4.** Solve systems of linear differential equations. **CO 5.** Recognize the mathematical objects called groups. **CO 6.** Link the fundamental concepts of groups and symmetries of geometrical objects.
SEM-III	**MATH-H-SEC3-3-Th** **Linear Programming & Rectangular Games**	Students will have the knowledge and skills to **CO 1.** formulate a given simplified description of a suitable real-world problem as a linear programming model in general, standard and canonical forms. **CO 2.** sketch a graphical representation of a two-dimensional linear programming model given in general, standard or canonical form. **CO 3.** classify a two-dimensional linear programming model by the type of its solution. **CO 4.** solve a two-dimensional linear programming problem graphically **CO 5.** use the simplex method to solve small linear programming models by hand, given a basic feasible point. **CO 6.** The transportation model can be defined as the determination of only one commodity that is being transported from one destination to various locations. **CO 7.** to distinguish a game situation from a pure individual's decision problem, **CO 8.** to explain concepts of players, strategies, payoffs, rationality, equilibrium, **CO 9.** to describe sequential games using game trees, and to use the backward induction to solve such games.

SEM-IV	**MATH-H-CC5-4-Th** **Theory of Real Functions**	Students will be able **CO 1.** To enumerate the limits of functions, infinite limits and limit at infinity **CO 2.** To demonstrate, describe and recognize ways in which limit do not exit. **CO 3.** To evaluate one sided limit and describe relationship between limits and one sided limits. **CO 4.** To develop solutions for tangent and area problems using the concepts of limits, derivatives. **CO 5.** To draw graphs of algebraic and transcendental functions considering limits continuity and differentiability at a point. **CO 6.** To articulate the relationship between derivatives and integrals using the fundamental theorems of calculus. **CO 7.** To predict in various cases, like where the speed in a given curve was maximum without differentiation by Rolle's theorem.
	MATH-H-CC6-4-Th & MATH-MC-MN6-6-TH & MATH-MD-CC4-4-TH & MATH-MD-MN 4-5-TH **Mechanics-I**	Students will be able **CO 1.** To understand the resultant forces and resultant couple, Coplanar forces: Its reduction and conditions of equilibrium. **CO 2.** To know Newton's laws of motion, work, power & energy. **CO 3.** To learn Conservative field and Principle of conservation of energy. **CO 4.** To understand the Principle of conservation of linear momentum, Collision of elastic bodies: Coefficient of restitution, Newton's law of collision **CO 5.** To study the concept of Equations of motion and the equivalent one dimensional problem. **CO 6.** To understand the Kepler problem and inverse square law of force, Motion of artificial satellites
	MATH-H-CC7-4-Th **Partial Differential Equations-I** **& Multi-variate Calculus-I**	students will have the knowledge and skills to: **CO 1.** Apply a range of techniques to find solutions of standard Partial Differential Equations (PDE) **CO 2.** Understand basic properties of standard PDE's. **CO 3.** Demonstrate accurate and efficient use of Fourier analysis techniques and their applications in the theory of PDE's. **CO 4.** Demonstrate capacity to model physical phenomena using PDE's (in particular using the heat and wave equations). **CO 5.** Apply problem-solving using concepts and techniques from PDE's and Fourier analysis applied to diverse situations in physics, engineering, financial mathematics and in other mathematical contexts. **CO 6.** Maxima and minima, Lagrange multiplier, directional derivatives, level sets. **CO 7.** Any of the operations of vector calculus including gradient, divergence, and curl.

		CO 8. Multivariate calculus can be applied to analyse deterministic systems that have multiple degrees of freedom. **CO 9.** It is used in many fields of natural and social science and engineering to model and study high dimensional systems that exhibit deterministic behaviour.
	MATH-H-CC8-4-Th **Group Theory-II & Ring Theory- I**	Students will be capable **CO 1.** To know Group homomorphisms, properties of homomorphisms. **CO 2.** To understand automorphism groups of finite and infinite cyclic groups. **CO 3.** To learn converse of Lagrange's theorem for finite abelian group, Cauchy's theorem for finite abelian group. **CO 4.** To know the fundamental concepts in ring theory such as the concepts of ideals, quotient rings, integral domains, and fields. **CO 5.** To learn in detail about polynomial rings, fundamental properties of finite field extensions, and classification of finite fields. **CO 6.** Ring theory has many applications to the study of geometric objects, to topology and in many cases their links to other branches of algebra are quite well understood. **CO 7.** The polynomial ring, Homomorphism, Ideal, Integral Domain all are very important for higher study and interview.
SEM-V	**MATH-H-CC9-5-TH** **Probability and Statistics**	Students will be capable **CO 1.** To know probability as set function, conditional probability. **CO 2.** To know distribution function of random variables. **CO. 3**. To learn in details about chebyshev's enquality, binomial distribution.
	MATH-H-CC10-5-TH **Ring Theory-II and Linear Algebra -I**	Students will be capable **CO 1.** To know principal ideal domain, principal ideal ring. **CO 2.** To know polynomial ring, unique factorization domain. **CO 3.** To know vector spaces, subspaces. **CO 4.** To know rank and nullity of linear transformation. **CO 5.** To know isomorphisms theorems, Cayley-Hamilton theorem.
	MATH-H-CC11-5-TH **Riemann Integration and Series of Functions**	Students will be capable **CO 1.** To know partition of closed and bounded interval and refinement of partitions. **CO 2.** To know concept of negligible set, integrability of sum. **CO 3.** To know uniform convergence, fourier series.

	MATH-H-CC12-5-TH **Mechanics-II**	Students will be capable **CO 1.** To know friction, virtual work, stable and unstable equilibrium. **CO 2.** To know dynamics of system of particles, moment of inertia. **CO 2.** To know general motion, motion of rigid body, impulsive force.
	MATH-MD-CC6-5-TH **&** **MATH-MD-MC6-6-TH** **Statistics and Numerical Analysis**	Students will be capable **CO 1.** To know probability theory, Binomial law. **CO 2.** To know probability distribution, moments, covariance, correlation coefficient. **CO 3.** To know sampling theory, statistical inference. **CO 4.** To know operators, interpolation. **CO 5.** To know numerical integration, numerical solutions of linear and non-linear equations.
	MATH-MD-CC7-5-TH **Mathematical Methods**	Students will be capable **CO 1.** To know sequence and series of functions. **CO 2.** To know convergence of power series, radius of convergence. **CO 3.** To know application of differential calculus, maxima and minima of functions. **CO 4.** To know Fourier coefficients, Laplace transform.

SEMESTER	COURSE CODE	COURSE OUTCOME
SEM-VI	**MATH-H-CC13-6-TH** **Complex Analysis**	Students will be capable **CO 1.** To know definition and examples of metric spaces. **CO 2.** To know compactness, Lebesgue number, connectedness, contraction mapping. **CO 3.** To know stereographic projections, Cauchy-Riemann equations, Mobius transformation. **CO 4.** To know harmonic functions and its properties.

	MATH-H-CC14-6-TH **Multivariate Calculus-II and Application of calculus**	Students will be capable **CO 1.** To know inverse function theorem, implicit function. **CO 2.** To know level sets, tangent spaces. **CO 3.** To know divergence and curl, Green's theorem. **CO 4.** To know curvature, concavity.
	MATH-H-CC15-6-TH **Numerical Analysis**	Students will be capable **CO 1.** To know machine number, floating point, rounding of numbers. **CO 2.** To know interpolation, numerical integration, bisection method. **CO 3.** To know matrix inversion by Gaussian elimination. **CO 4.** To know algebraic Eigen value problem, Runge-Kutta method, Picard's method.