Program Outcomes, Program Specific Outcomes

and

Course Outcomes

Department of Mathematics

Bidhan Chandra College , Asansol-4

Program Outcomes .

➢ B.Sc. Honours in Mathematics :

After successful completion of three year honours degree program in Mathematics –

PO1: A student should be able to recall major facts about mathematics and should be able to display knowledge of conventions such as notations, terminology and recognize basic geometrical figures and graphical displays, state important facts resulting from their studies.

PO2: A student should get a relational understanding of mathematical concepts and concerned structures, and should be able to follow the patterns involved, mathematical reasoning.

PO3: A student should get adequate exposure to global and local concerns that explore them many aspects of Mathematical Sciences .

PO4: A student be able to apply their skills and knowledge that is, translate information presented verbally into mathematical form, select and use appropriate mathematical formulae or techniques in order to process the information and draw the relevant conclusion.

PO5: A student should be made aware of history of mathematics and hence of its past, present and future role as part of our culture.

PO6: A student should be able to create an awareness of the impact of Mathematics on the environment, society, and development outside the scientific community.

PO7: A should be aware of the uses modern techniques, decent equipment's and Mathematical software's .

➢ B.Sc. Program in Mathematics :

After successful completion of three year degree program in Chemistry a student should be able to –

PO1: Demonstrate, solve and an understanding of basic concepts in all disciplines of Mathematics.

PO2: Solve the problem and also think methodically, independently and draw a logical conclusion

PO3: Employ critical thinking and the scientific knowledge to design, carry out, record and analyze the results of Mathematical problems.

PO4: Create an awareness of the impact of Mathematics on the environment, society, and development outside the scientific community .

PO5: To inculcate the scientific temperament in the students and outside the scientific community.

PO6: Use modern techniques, decent equipment's and Mathematical software's .

Program Specific Outcomes .

> ### B.Sc. Honours in Mathematics :

PSO1 : Bachelor's degree in mathematics is the culmination of in-depth knowledge of algebra, analysis, calculus, geometry, differential equations and several other branches of mathematics. This also leads to study of related areas like computer science and statistics. Thus, this programme helps learners in building a solid foundation for higher studies in mathematics.

PSO2: The skills and knowledge gained has intrinsic beauty, which also leads to proficiency in analytical reasoning. This can be utilized in modeling and solving real life problems.

PSO3: Students undergoing this program learn to logically question assertions, to recognize patterns and to distinguish between essential and irrelevant aspects of problems. They also share ideas and insights while seeking and benefitting from knowledge and insight of others. This helps them to learn how to behave responsibly in a rapidly changing interdependent society.

PSO4: Students completing this programme will be able to present mathematics clearly and precisely, make vague ideas precise by formulating them in the language of mathematics, describe mathematical ideas from multiple perspectives and explain fundamental concepts of mathematics to non-mathematicians.

PSO5 : Students will able to demonstrate the ability to analyze data and draw appropriate statistical conclusions.

PSO6 : Students will have the requisite programming skills to solve problems using programming languages like C/C++.

PSO7 : Investigate and apply mathematical problems and solutions in a variety of contexts related to science, technology, business and industry, and illustrate these solutions using symbolic, numeric, or graphical methods.

PSO8 : Demonstrate the ability to apply analytical and theoretical skills to model and solve mathematical problems. Formulate mathematical models of real-life models and suggest possible solutions for them.

PSO9: This programme will also help students to enhance their employability for government jobs, jobs in banking, insurance and investment sectors, data analyst jobs and jobs in various other public and private enterprises.

PSO10: Demonstrate the ability to effectively utilize a variety of ICT enabled teaching techniques and classroom strategies to positively influence student learning.

➤ B.Sc. Program in Mathematics :

Upon Completion of B.Sc. (Program) in Mathematics, Students will able to

PSO1: Demonstrate basic mathematical skills in various branches of mathematics like algebra, analysis, geometry, calculus.

PSO2: Appreciate the role of mathematical proof in formal deductive reasoning.

PSO3: Inculcate the ability to think independently and reason.

PSO5: Demonstrate the ability to analyse data and draw appropriate statistical conclusions.

PSO6: Demonstrate the ability to apply analytical and theoretical skills to model and solve mathematical problems.

PSO7: Recognize and appreciate the connections of mathematics with other branches of science.

PSO8: Develop Programming skills to solve problems using C language. Present mathematical ideas with clarity and coherence, both verbally and written.

Course Outcomes .

➤ B.Sc. Honours in Mathematics :

Semester-I

❖ Classical Algebra and Abstract Algebra – I (CC-1) :

This course helps the students to -

CO1. Perform basic algebraic manipulation with complex numbers and understand the geometric interpretation of complex numbers .

CO2. Know methods of finding the nth roots of complex numbers and the solutions of simple polynomial equations.

CO3. Find quotients and remainders from integer division .

CO4. Apply Euclid's algorithm and backwards substitution and determine multiplicative inverses, modulo n and use to solve linear congruences .

CO5. Use graphic, numeric, algebraic, and mental strategies to solve cubic equations with at least one integer root.

CO6. Students will acquire knowledge of the concepts of functions, one-one, onto and bijective functions which will be helpful to them in studying other courses of mathematics like Real Analysis and Topology.

CO7. Students will gain working knowledge of important mathematical concepts in abstract algebra such as definition of a group, order of a finite group and order of an element.

CO8. Students will have knowledge of many mathematical concepts studied in abstract algebra such as Permutation groups, Abelian groups, Cyclic groups and they will be able to understand the structure and characterization of these groups.

CO9. Students will be introduced to the mathematical concepts of rings, zero divisors, Integral domains, fields and their properties.

❖ Real Analysis-I and Integral Calculus –I (CC-2) :

This course helps the students to -

CO1. Understand the real number system Archimedean properties and point set theory.

CO2. Get the knowledge of Sequence real numbers , limit of a function at a point and uniform continuity .

CO3. Have the knowledge of Continuity and differentiability of functions and get exposed to Mean Value Theorems .

CO4. Find the Envelope, asymptote, curvature , maximum and minimum values of a function.

CO5. Have the knowledge of the Fundamental Theorem of Integral Calculus , double and triple integral , Fubini's theorem .

CO6. Find the Areas of Surfaces and Volumes of Solids of Revolution. Evaluation of Centre of Gravity of some Standard Symmetric Uniform Bodies .

CO7. Have the knowledge of Quadrature and Rectification , Intrinsic Equations of Plane Curves and Evaluation of Lengths of Space Curves.

Semester-II

❖ Linear Algebra and Abstract Algebra – II (CC-3):

Upon successful completion of the course –

CO1. Students will be acquainted with the process of expansion of determinants by using the properties of determinants and by Laplace's method.

CO2. Students will be introduced to the process of evaluating rank of a matrix, normal form of a matrix.

CO3. Students will be introduced to the mathematical concepts of vector spaces, sub-spaces of a vector space, linear dependence and independence of vectors, linear span of a set of vectors.

CO4. Students will be able to demonstrate knowledge and understanding of basis and dimension of vector spaces and apply these concepts on various vector spaces and subspaces and also about row space and column space .

CO5. Students will be able to solve systems of linear equations-homogeneous & non-homogenous using the concepts of rank of a matrix.

CO6. Students will be able to understand the concepts of Normal subgroups , homomorphism , isomorphism and ideal of a ring .

CO7. Students will be introduced to the concepts of Partial order relation , maximal and minimal elements , definition of lattice .

CO8. Students will be introduced to the concepts of Boolean algebra , CNF ,DNF , switching circuits .

❖ Geometry of Two and Three Dimension (CC-4) :

Upon successful completion of the course –

CO1. Students will demonstrate knowledge of geometry and its applications in the real world.

CO2. Students will be introduced to the concepts of Transformation of rectangular coordinate axes, Classification of conics , Chord of contacts , pole and polar .

CO3. Students will be able to understand the concepts of Pair of straight lines , Bisectors of angles between pair of lines and Polar equation of a conic, tangent, normal in two dimension .

CO4. Students will be familiar with the concepts of direction ratios, direction cosines and projection of a straight line.

CO5. Students will gain knowledge of coordinate axes and coordinate planes in three dimensions.

CO6. Students will have a working knowledge of the geometry of plane, straight line, sphere, cone, right circular cone and study their properties .

CO7. Students will have an idea of the geometrical shapes of central conicoids- Ellipsoid, Hyperboloid of one and two sheets, Paraboloid and study their properties .

Semester-III

- ❖ **Vector Analysis and Tensor Calculus (CC-5):**

After taking this course, the student should be able to –

CO1. Understand the concept of Vectors, some examples of vectors from physics: velocity, acceleration, force. Properties of vector operations.

CO2. Understand the gradient vector. The directional derivative. The relation of the gradient vector and directional derivatives at a point. Geometric properties of the gradient vector. Gradient vector in cartesian coordinates. Gradient vector of a function of three variables and its properties. Tangent planes to level surfaces.

CO3. Understand the Vector integration and will be able to apply Green's Theorem, Gauss' Divergence Theorem and Stokes' Theorem .

CO4. Find the moving trihedron of a curve and write its intrinsic and canonical equations and Calculate the curvature and torsion of a curve .

CO5. Find the osculating surface and the osculating curve at any point of a given curve and Calculate the first and the second fundamental forms of a surface.

CO6. Calculate the Gaussian curvature, the mean curvature, the curvature lines, the asymptotic lines, the geodesics of a surface .

CO7. Use efficiently the mathematical tool of tensor calculus in the study of surfaces.

- ❖ **Real Analysis II and Number Theory (CC-6) :**

Upon successful completion of the course –

CO1. Students will be acquainted to concept of Riemann integrability of a bounded function on a closed & bounded interval and learn important results concerning Riemann integration.

CO2. Students will get acquainted with different types of improper integrals and study their convergence.

CO3. Students will be able to understand Fundamental theorem of integral calculus and the concepts of anti derivative for continuous functions .

CO4. Students will get the knowledge of Congruence , Fermat's theorem, Wilson's theorem, Euler's theorem , Chinese remainder theorem .

CO5. Students will have an idea about Number of divisors of a number and their sum, Eulers φ function , Mobius μ – function and Diophantine equations .

❖ **Differential Equation (CC-7) :**

Upon successful completion of the course, students will –

CO1. Get familiar with concepts of order, degree of a differential equation and able to distinguish between linear, nonlinear, ordinary and partial differential equations.

CO2. Get idea of integrating factor and learn rules for finding integrating factors and Acquainted with various methods for solving differential equations of first order and first degree .

CO3. Acquainted with concepts of complementary function and particular integrals and hence can solve linear differential equations with constant coefficients .

CO4. Solve linear homogeneous differential equations by Cauchy-Euler method .

CO5. Solve linear second order linear differential equations with constant coefficients , recognize and solve total differential equations and simultaneous equation.

CO6. Formulate partial differential equations and solve them using Lagrange's and Charpit's method.

❖ **Mathematical Study on Local Weather Conditions (SEC-1):**

Upon successful completion of the course, students will –

CO1: Understand weather phenomena winds, humidity and precipitation .

CO2: Be aware about changes about the local weather conditions with the help of mathematical graph , pie chart etc .

CO3 : Gain knowledge about behaviour and the changes of the local environment and create an awareness of the impact of Mathematics on the environment, society, and development outside the scientific community.

Semester-IV

❖ Real Analysis-III (CC-8) :

Upon successful completion of the course –

CO1. Students will be able to demonstrate knowledge and understanding Bolzano-Weierstrass theorem, Heine-Borel theorem.

CO2. Students will get acquainted with series of non-negative terms , their convergence , Series of arbitrary numerical terms .

CO3. Students will able to recognize the difference between pointwise and uniform convergence of sequence and series of functions.

CO4. Students will be able to illustrate the effect of uniform convergence on the limit function and sum function with respect to continuity, integrability and differentiability.

CO5. Students will be familiar with concepts of Fourier series, Half-range series .

CO6. Students will have the knowledge of Theory of maxima and minima , Jacobian, Implicit function theorem for functions of several variables .

❖ Introduction to Operations Research (CC-9):

Upon successful completion of the course –

CO1. Students will have the knowledge of Hyperplanes, Convex sets and their properties .

CO2. Students will be able to State and describe the basic terminology and results concerning linear optimization and linear programming .

CO3. Students will be able to illustrate duality and its implications for the solutions of linear programs.

CO4. Students will be to solve the Transportation Problem , Assignment Problem and Traveling salesman problem .

CO5. Students will get acquainted with the theory of game and use it to solve simple cooperative games , Pure and Mixed Strategies games .

❖ Mechanics I (CC-10):

After successful completion of the course –

CO1. Students will have a basic understanding about the type of forces, work, power and energy and also Rectilinear motion .

CO2. Students will get acquainted with Simple Harmonic Motion , Hook's law , Damped harmonic oscillations .

CO3. Students will be able to formulate simple mathematical models for a particle moving in a straight line and they will also exposed to find analytical solution .

CO4. Students will study in details about Central Orbit, Planetary Motion and constrained motion , Newton's law , Kepler's laws of planetary motion .

CO5. Students will also be exposed to the mathematical problems of motion in a resisting medium and Constrained motion , Change of mass, Motion of a rocket .

❖ **Mathematical Study on Environmental Pollutions (SEC-2):**

Upon successful completion of the course, students will –

CO1: Understand the importance of Atmosphere and the structure, composition of Atmosphere .

CO2: Be aware about pollution in the local area with the help of mathematical graph , pie chart and other statistical tools .

CO3: Gain knowledge about rate and the changes of various type of pollution in the local environment and create an awareness of the impact on the environment, society with help of the mathematical data and development outside the scientific community .

Semester-V

❖ **Metric Spaces and Elementary Complex Analysis (CC-11) :**

After studying this course, students should be able to –

CO1. Explain the geometric meaning of each of the metric space properties , the various example of metric space and also be able to verify whether a given distance function is a metric .

CO2. Distinguish between open and closed balls in a metric space and be able to determine them for given metric spaces .

CO3. Define convergence for sequences in a metric space and determine whether a given sequence in a metric space converges .

CO4.Understand the concepts of Continuous functions , uniform continuity of the distance function , completeness and compactness .

CO5.Explain the fundamental concepts of complex analysis and their role in modern mathematics and applied contexts .

CO6. Apply problem-solving using complex analysis techniques applied to diverse situations in physics, engineering and other mathematical contexts .

CO7. Understand the concepts of Bilinear transformations, the group of Mobius transformation and its generators-the inversion .

❖ Mechanics-II (CC-12) :

After successful completion of the course –

CO1. Students will be able to understand the concepts of Newton's laws of motion , Galilean transformation , applications of Newton's laws in solving problems of mechanics .

CO2. Students will have a basic understanding about the type of forces, work, power , energy , linear momentum , D'Alembert Principle , Conservation principles .

CO3. Students will study in details about Moments and product of inertia , parallel and perpendicular axis theorems .

CO4. Students will get acquainted with Motion about a point and about fixed axes , kinetic energy , general motion of rigid body.

CO5. Students will understand the laws of motion such as motion of a uniform heavy solid sphere , motion of a uniform heavy circular cylinder which will help them to tackle real life problems with confidence .

❖ Linear Algebra (DSE-1) :

After successful completion of the course –

CO1. Students will get acquainted with concepts of linear transformations, null space, range space .

CO2. Students will be able to determine matrix representation of a linear transformation relative to ordered bases of finite dimensional vector spaces .

CO3. Students will gain knowledge of the mathematical concepts of inner product space , Orthogonal projections , best approximation .

CO4. Students will be acquainted with the mathematical concepts of characteristic polynomial, Eigen values and Eigen vectors.

CO5. Students will be introduced to the concepts of diagonalisation of matrices , Jordan Canonical form.

CO6. Students will be acquainted with bilinear form, Quadratic form, Rank, Signature and index of a quadratic form and its application to Geometry and Mechanics .

❖ **Integral Transforms (DSE-2) :**

After successful completion of the course –

CO1. Students will be acquainted with the mathematical concepts of Fourier Transforms , Fourier sine and cosine transforms .

CO2. Students will gain knowledge of Convolution Theorem , Convolution Theorem , application of Fourier transforms to Heat, Wave and Laplace equations.

CO3. Students will be acquainted with the existence theorem of Laplace Transforms and learn the Laplace Transforms of some elementary functions.

CO4. Students will learn the use of Laplace Transforms to solve ordinary differential equations with constant coefficients.

CO5. Students will be able to determine Inverse Laplace Transform of derivative, integration, multiplication and division by p.

Semester-VI

❖ **Numerical Analysis (CC-13) :**

After taking this course, the student should be able to -

CO1. Understand the concepts of approximation of numbers , round off errors , inherent errors in numerical methods .

CO2. Construct a function which closely fits given n- points in the plane by using interpolation method .

CO3. Investigate the solution of a nonlinear equation , find the solution of an equation by the fixed-point iteration and by the Newton-Raphson method .

CO4. Learn the explaining and understanding of the several available methods to Solve the simultaneous equations .

CO5. Understand the concept of numerical solution of Ordinary Differential Equations, their stability , multistep methods , Finite difference schemes for solving partial differential equations.

❖ Computer Aided Numerical Practical using Fortran / C (CC-14) :

Upon completion of this course, students will be able to solve the following numerical problems by programming using C or Fortran –

CO1. Numerical Integration by Simpson's 1/3rd Rule and Trapezoidal rule .

CO2. Numerical solution of ordinary differential equation by Runge-Kutta (4th order) method and Modified Euler's method .

CO3. Numerical solution of non-linear equation by Newton-Raphson method and Fixed point iteration method .

CO4. Numerical solution of system of linear equations by Gauss Seidel iterative method .

CO5. Numerical interpolation Lagrange's interpolation formula , Newton's Forward Difference formula .

❖ Discrete Mathematics (DSE- 3) :

After successful completion of the course –

CO1. Students will be acquainted with the mathematical concept of logic , truth table , completeness theorems , Independence of axioms .

CO2. Students will gain knowledge graph theory , Travelling salesman problem , Matrix representation of graph.

CO3. Students will be able to understand the mathematical concepts of Trees , Kruskal's algorithm , Shortest path problem .

CO4. Students will also be exposed to concepts of Combinatorics , The pigeon-hole principle , generating functions and recurrence relations , Lattice , The necklace problem .

CO5. Students will develop an appreciation of mathematical abstraction and generalization and enhance their reasoning capability and logical thinking .

❖ Programming in C / Fortran with Applications (DSE-4) :

After successful completion of the course , student will –

CO1. Gain knowledge of different number systems like Binary, Decimal, Octal, Hexadecimal and will be able to evaluate their conversions.

CO2. Get idea of Character set, variables and Identifiers, keywords ,Operators and Expressions .

CO3. Be familiar with Conditional Statements and Loops : IF- ELSE Statement , While Loop, Do While, For Loop .

CO4. Gain knowledge of Arrays , representation of Matrix by array , representation of Sparse matrices .

CO5. Introduced to knowledge of functions , Global, Static Variables , Structures and Unions , Pointers .

CO6. Get idea of Algorithms and flowchart and able to solve simple problems by programming in C and Fortran.

➢ **B.Sc Program in Mathematics :** .

Semester-I

❖ **Calculus-I (CC-1) :**

After successful completion of the course, Students will be able to –

CO1. Learn the basics of real number system, real functions , continuous functions , monotone functions .

CO2. Understand the concepts of derivative of functions , Mean value theorems , Leibnitz's theorem , Series expansion of sinx , cosx .

CO3. Determine maxima and minima of a function , Indeterminate forms .

CO4. Have working knowledge on evaluation of definite integrals by using properties of definite integrals .

CO5. Learn the basics of Ordinary differential equation , trajectories, orthogonal trajectories .

Semester-II

❖ **Calculus-II (CC-4) :**

After successful completion of the course, Students will be able to –

CO1. Able to solve problems based on sequence and series of real numbers by studying various convergence test.

CO2. Learn the basic concepts of function of several variables, partial derivatives, total differentials, directional derivatives , Envelopes, Curvature, Radius of curvature, tangent and normal, pedal equation of a curve .

CO3. Understand the idea of improper integrals , Beta function , Gamma function and their properties .

CO4. Determine Volume and surface of solids of revolutions, Centre of gravity of simple bodies.

CO5. Learn about higher order of Ordinary differential equation and their solutions .

Semester-III

❖ Algebra (CC-6) :

After successful completion of the course , students will –

CO1. Understand the Fundamental Theorem of Classical algebra , Descarte's rule of signs .

CO2. know methods of finding the nth roots of complex numbers and the solutions of simple polynomial equations.

CO3. be familiarize with the basic concepts of Group theory and subgroups, law of cancellation .

CO4. gain basic knowledge of the concepts of rings, integral domains, zero divisors, sub-rings and sub-fields.

CO5. demonstrate knowledge and understanding of the basic concepts of vector spaces and rank of matrix .

❖ Mathematical Study on Local Weather Conditions (SEC-1):

Upon successful completion of the course, students will –

CO1: Understand weather phenomena winds, humidity and precipitation .

CO2: Be aware about changes about the local weather conditions with the help of mathematical graph , pie chart etc .

CO3 : Gain knowledge about behaviour and the changes of the local environment and create an awareness of the impact of Mathematics on the environment, society, and development outside the scientific community.

Semester-IV

❖ Geometry and Vector Analysis (CC-10) :

After successful completion of the course , students will –

CO1. demonstrate knowledge of the properties of two-and three-dimensional geometric shapes and develop mathematical arguments about geometric relationships.

CO2. be familiar with the basic concepts of direction ratios, direction cosines and projection of a straight line.

CO3. have working knowledge of the geometry of plane, straight line, sphere, right circular cone and study their properties.

CO4. Understand the concept of Vectors, some examples of vectors from physics: velocity, acceleration, force , properties of vector operations.

CO5. Understand the dot product of vectors: algebraic and geometric definition, the gradient vector, properties of the gradient vector.

❖ Object oriented programming in C++ (SEC-2):

After successful completion of the course , students will –

CO1: Gain the knowledge about the basics and brief history of C++ language .

CO2: Be familiar with the concepts of array , pointer , field function , data abstraction etc .

CO3: Able to use C++ to solve basic problems of mathematics and statistics .

Semester-V

❖ Probability and Statistics (DSE-1A):

After successful completion of the course , students will –

CO1. Understand the concepts of probability continuity theory , Boole's inequality , Poisson law of probability .

CO2. Learn about discrete and continuous distribution such as Poisson , Binomial , Beta , Gamma etc.

CO3. Be familiar with the basic concepts of discrete and continuous distribution in two dimension , marginal distribution , moment generating functions .

CO4. Learn about the knowledge of method of least square , curve fitting , sampling theory .

CO5. Be acquainted with maximum likelihood method , testing hypothesis , theory of errors .

❖ **Mathematical Study on Environmental Pollutions (SEC-3):**

Upon successful completion of the course, students will –

CO1: Understand the importance of Atmosphere and the structure, composition of Atmosphere .

CO2: Be aware about pollution in the local area with the help of mathematical graph , pie chart and other statistical tools .

CO3: Gain knowledge about rate and the changes of various type of pollution in the local environment and create an awareness of the impact on the environment, society with help of the mathematical data and development outside the scientific community .

Semester-VI

❖ **Linear Programming Problem (DSE-1B) :**

After successful completion of the course , students will –

CO1. Be able to State and describe the basic terminology and results concerning linear optimization and linear programming .

CO2. Use the basic simplex method to solve linear programs and prove its convergence to a solution.

CO3. Able to describe duality and its implications for the solutions of linear programs.

CO4. Be able to solve the basic Transportation Problem , Assignment Problem and Traveling salesman problem .

CO5. Get acquainted with the theory of game and use it to solve simple cooperative games , Pure and Mixed Strategies games .

❖ **Use of Latex (SEC-3):**

After successful completion of the course , students will –

CO1: Gain the knowledge about the basics and brief history of Latex .

CO2: Be familiar with the concepts of Text symbols, commands, packages, mathematical formula , document management etc.

CO3: Able to use Latex to write mathematical note , thesis , book etc.