

Program Outcomes (POs)

B.Sc. Mathematics program outcomes:

1. **Disciplinary Knowledge:** Understand core areas of mathematics — algebra, calculus, geometry, differential equations, and related branches.
2. **Communication Skills:** Communicate mathematical ideas clearly with examples and visualizations.
3. **Critical Thinking & Analytical Reasoning:** Apply logical reasoning to analyse mathematical and real-life problems.
4. **Problem Solving:** Analyse problems and identify techniques (including computational) to solve them.
5. **Digital Literacy:** Use software tools for solving equations, visualization, and computation.
6. **Research Skills:** Develop questions and exploratory approaches in mathematics for deeper learning or research.
7. **Employability:** Be equipped for careers in government jobs, banking, data analysis, insurance, tech, research, and education.

I Semester MATHEMATICS-I

COURSE OBJECTIVE:

This course helps students learn the basics of matrices and how they are used. It also teaches the fundamentals of differentiation and integration. Students will also understand 3D geometry, including how to write equations of lines, planes, and curves and solve geometry problems using algebra.

COURSE OUTCOMES (COS):

By the end of the program the students will be equipped with the following aspects:

CO1: Understand how to use elementary transformations, find eigenvalues and eigenvectors of matrices, and apply the Cayley–Hamilton theorem.

CO2: Learn the basics of differentiation, find higher-order derivatives, use Leibniz's theorem, and solve problems involving partial derivatives, total derivatives, and Jacobians.

CO3: Understand reduction formulas and Leibniz rule and apply differentiation and integration to study the shapes and properties of curves and surfaces.

CO4: Understand three-dimensional analytical geometry and learn the equations of a sphere, right circular cylinder, and cone.

Unit 1:

MATRICES

Recapitulation of Symmetric and Skew Symmetric matrices, Elementary row and column transformations, Row reduced echelon form, Rank of a matrix, Normal form of a matrix, Inverse of a matrix by elementary operations.

Solution of system of linear equations; Criteria for existence of non-trivial solutions of homogeneous system of linear equations, Solution of nonhomogeneous system of linear equations. Eigen values and Eigen vectors of square matrices of order 2 and 3, Cayley-Hamilton theorem (with proof), Finding A^2, A^3, A^4 and inverse of matrices by Cayley-Hamilton theorem.

Unit 2

DIFFERENTIAL CALCULUS-I

Ordinary Derivatives: Successive Differentiation, nth Derivatives of Standard functions $e^{ax+b}, (ax + b)^n, \log(ax + b), \sin(ax + b), \cos(ax + b), e^{ax} \sin(bx + c), e^{ax} \cos(bx + c)$, Leibnitz theorem (with proof) and examples based on Leibnitz theorem.

Partial Derivatives: Functions of two or more variables-explicit and implicit functions, partial derivatives of higher order, Homogeneous functions- Euler's theorem, total derivatives, differentiation of implicit and composite functions, Jacobians and standard properties and problems.

Unit 3

INTEGRAL CALCULUS

Recapitulation of definite integrals and its related properties.

Reduction formulae – $\int \sin^n x dx$, $\int \cos^n x dx$, $\int \tan^n x dx$, $\int \cot^n x dx$, $\int \sin^m x \cos^n x dx$ and its related problems. Differentiation under integral sign by Leibnitz rule and problems. Computation of length of an arc, area of plane curves, surface area and volume of solids of revolution for standard curves in Cartesian and polar forms.

Unit 4

ANALYTICAL GEOMETRY

Direction cosines and ratios, Equation of spheres in different forms (general, standard, central and diametric forms in both Cartesian and Vector forms), tangent plane to a sphere, derivation of condition for orthogonal of spheres and problems, standard equation of right circular cone and right circular cylinder in both Cartesian and Vector forms and problems, Derivations of paraboloid, ellipsoid, Hyperboloid of one and two sheets.

MATHEMATICS PRACTICAL-I

Mathematics Practical with Free/Libre and Open-Source Software (FLOSS) tool for computer programs (i. e., Theory Based Practical-IV)

Note-1: Before the execution, all problems must be solved manually and the same should also be written in the records along with Aim / Motivation, Algorithm, Computer Program / Python code and output.

The minimum 15 programs must be done from the following list of suggested programs:

1. Introduction to Python
2. Program to basics of software with simple examples.
 - I. compares two numbers using if statements
 - II. sum of natural numbers using while loop
 - III. finding the factors of a number using for loop
 - IV. to check the given number is prime or not
 - V. finds the factorial of a number vi. simple programs to illustrate logical operators (and or not)
3. Program to Computation of a rank of matrix by row reduced and normal forms.
4. Program to Solving the system of homogeneous linear equations.
5. Program to Solving the system of non-homogeneous linear equations
6. Program to Computation of inverse of a matrix by using Cayley-Hamilton theorem.
7. Program to finding the n th derivative of a function without Leibnitz theorem.
8. Program to finding the n th derivative of a function with Leibnitz theorem.
9. Program to Partial differentiation of some standard functions and Jacobian.
10. Program to Verification of Euler's theorems with examples.
11. Program to find the Jacobians.
12. Program to find reduction formula with limits.
13. Program to find reduction formula without limits.
14. Program to compute surface area of solids.
15. Program to compute Volume of solids of revolution
16. Program to find equation and plot sphere, cone, cylinder.
17. Program to find equation and plot paraboloid, ellipsoid and hyperboloid.

SECOND SEMESTER MATHEMATICS-II

Course Objective:

This course helps students understand the basics of mathematical logic and Boolean algebra, which are important for logical thinking and digital systems. Students will also learn polar coordinates and plane curves to represent and study curves in a different way. In addition, the course teaches methods to solve different types of differential equations and how to apply them to real-life problems.

COURSE OUTCOMES (COS):

CO 1: Concepts of Mathematical logic, mean value theorems of differential calculus

CO2: Application of differential equations in various fields by mathematical modelling. Application of Mathematical logic in switching networks /circuits.

CO 3: Illustrate the applications of differential calculus

CO 4: Determine the method of solving problems on differential calculus and equations

Unit-I

Mathematical Logic and Boolean algebra

Mathematical Logic: Propositions, logical connectors, truth tables, logical equivalences, tautology, contradiction, contingent statements, negations, inverse, converse and contra positive statements. Open sentences and quantifiers, truth sets connectives involving quantifiers, Methods of proof: Direct proofs, indirect proofs, Contradiction method, contrapositive method and mathematical induction (explanation with simple examples).

Boolean algebra: Definition, examples, laws of Boolean algebra, normal disjunctive form, prime implicants, Karnaugh map theorem for reducing logical circuits.

Unit-2

Polar Co-ordinates

Polar coordinates, angle between the radius vector and tangent. Angle of intersection of two curves (polar forms), length of perpendicular from pole to the tangent, pedal equations. Derivative of an arc in Cartesian, parametric and polar forms.

Curvature of plane curve- radius of curvature formula (in cartesian, parametric, polar and pedal forms), Centre of curvature, asymptotes, singular points and double points.

Tracing of Standard curves (Cartesian, polar and parametric).

Unit-3

Differential Calculus-II

Limits, Continuity, Differentiability and properties. Properties of continuous functions. Intermediate value theorem, Rolle's Theorem, Lagrange's Mean Value theorem,

Cauchy's Mean value theorem and examples. Taylor's theorem & Maclaurin's series of one variable, indeterminate forms and evaluation of limits using L'Hôpital rule.

Unit-4

Ordinary Differential Equations-I

Recapitulation of differential equations of first order and first degree, Linear Differential equations and equations reducible to linear form (Bernoulli's equation), Exact Differential equations, Necessary and sufficient condition for the equations to be exact, Equations reducible to exact form. Differential equations of the first order and higher degree: Equations solvable for p , x , y . Clairaut's equation; general and singular solution. Orthogonal trajectories of Cartesian and polar curves.

MATHEMATICS PRACTICAL-II

Mathematics Practical with Free / Libre and Open-Source Software (FLOSS)

tool for computer programs (i. e., Theory Based Practical-II)

Note-1: Before the execution, all problems has to be solved manually and the same should also be written in the records along with Aim / Motivation, Algorithm, Computer Program / Python code and output. The minimum 15 programs have to be done from the following list of suggested programs:

1. Construction of truth tables for compound propositions
2. Verifying whether given proposition is tautology or contradiction
3. Problems on Karnaugh map theorem for reducing logical circuits
4. Finding the angle between the radius vector and tangent
5. Finding the angle between two curves
6. Finding the radius of curvature of the given curve
7. Plotting of standard Cartesian, polar and parametric curves
8. Program to find limit and continuity of functions
9. Program to verify Rolle's, Lagrange's and Cauchy's mean value theorem
10. Program to find Maclaurin's expansion.
11. Program to find limits by L'Hospital's rule.
12. Solution of Linear differential equation.
13. Solution of Exact differential equation.
14. Solving non- linear differential equations for p , x and y
15. Finding the general and singular solutions of Clairaut's equation.

THIRD SEMESTER- MATHEMATICS-III

Course Objective:

This course helps students understand the basic rules of groups in algebra and learn to find subgroups and use important results like Lagrange's theorem. Students will also study sequences and series and learn how to check whether they converge or diverge. In addition, the course introduces vector algebra and helps students develop logical thinking and problem-solving skills.

COURSE OUTCOMES (COS):

CO1: Understand propositional logic, learn different proof methods, and apply Boolean algebra to logic circuits.

CO2: Learn different ways to represent curves (Cartesian, parametric, and polar forms) and study their properties like curvature, asymptotes, and special points. Also learn how to trace standard curves.

CO3: Understand limits, continuity, and differentiability, and solve problems using Rolle's, Lagrange's, and Cauchy's mean value theorems.

CO4: Learn methods to solve differential equations and understand how they are used in different fields.

Unit-I

Group-I:

Algebraic structures, Definition of Binary Operation, Groups and its properties, Abelian groups, Subgroups and its properties, order of an elements, Coset decomposition, Cyclic groups and its properties, Index of a group, Lagrange's theorem, and its consequences (Fermat theorem and Euler theorem).

Unit-II

Sequences of Real Numbers:

Definition and examples of sequences, Bounded sequences, and its properties (some theorems), Limit of a sequence, Nature of sequences, Algebra of limits of sequence, Monotonic sequences (theorems and problems), Behaviour of standard sequences. Cauchy's general principle for convergence of a sequence

Unit-III

Series of Real Numbers:

Series of real numbers (Infinite series), Definition and examples of Convergence, Divergence, Oscillatory series, Geometric, p-series, Comparison test, D'Alembert's Ratio test, Raabe's test, Cauchy root test, Alternate series-Leibnitz test. Absolute convergence and conditional convergence of a series. Summation of series: Binomial, exponential and logarithmic.

Unit-IV

Vector Algebra:

Multiple product – scalar triple product, vector triple product, geometrical interpretation, related problems, vector function of a scalar variable – interpretation as a space curve.

Scalar field: Gradient of a scalar field, geometrical meaning, directional derivative, unit normal to the surfaces - tangent plane and normal to the surface.

Vector field: Divergence and curl of a vector field, solenoidal and irrotational fields, Laplacian of a scalar field, Vector identities.

MATHEMATICS PRACTICAL-III

Mathematics Practical with Free / Libre and Open-Source Software (FLOSS) tool for computer programs (i. e., Theory Based Practical-III)

Note-1: Before the execution, all problems have to be solved manually and the same should also be written in the records along with Aim / Motivation, Algorithm, Computer Program / Python code and output. The minimum 15 programs must be done from the following list of suggested programs:

1. Program to verifying whether given operator is binary or not.
2. Program to find identity and inverse element of a group
3. Program to find the order of an element.
4. Program to find left and right cosets
5. Program to verify Lagrange's theorem for a finite group.
6. Program to find the limit of a sequence.
7. Program to verify the convergence of a sequence.
8. Program to check whether the sequence is monotonically increasing or decreasing.
9. Program to check whether the sequence is bounded or not
10. Program to test the convergence of series using partial sums.
11. Program to test the convergence of series by using comparison test
12. Program to test the convergence of series by using D'Alembert's ratio Test
13. Program to test the convergence of series by using Raabe's Test
14. Program to test the convergence of alternating series using Leibnitz's theorem.
15. Program to find Gradient of a scalar field.
16. Program to find Divergence of a vector field.
17. Program to find Curl of a vector field.
18. Program to find Laplacian of a scalar field.
19. Program to verify whether the given vector field is solenoidal or not.
20. Program to verify whether the given vector field is irrotational or not.

FOURTH SEMESTER MATHEMATICS-IV

Course Objective:

This course helps students learn important ideas in group theory like normal subgroups, quotient groups, homomorphisms, and isomorphisms, and how they are used. Students will also learn Laplace transforms and inverse Laplace transforms, as well as Fourier series and Fourier transforms, and how to apply them to solve problems. In addition, the course teaches methods to solve higher-order differential equations.

Course Outcomes:

CO1: Understand normal subgroups, quotient groups, homomorphisms, and isomorphisms, and learn about the kernel and image of homomorphisms.

CO2: Learn what the Laplace transform is, understand its properties, and find Laplace transforms of common functions.

CO3: Learn how to represent periodic functions using Fourier series, understand convergence and Fourier coefficients, study half-range sine and cosine series, and know the basic properties of the Fourier transform.

CO4: Learn how to solve second and higher-order ordinary differential equations and use them to model and analyse real-world problems.

Unit 1

Group-II:

Normal subgroups-Examples and problems, Quotient group, Homomorphism of groups, Kernel and Image of a homomorphism, Normality of the kernel, Fundamental theorem of homomorphism and its related problems.

Unit 2

Laplace transform:

Definition and basic properties Laplace transform of some common functions and Standard results, Inverse Laplace transforms. Laplace transform of periodic functions- Laplace transforms of derivatives and the integral of functions, Laplace transforms of Heaviside function convolution theorem (without proof) and related problems, solution of second order differential equations

Unit 3

Fourier Series and Fourier Transform:

Periodic functions. Fourier Coefficients. Fourier series of functions with period $2L$. Fourier series of even and odd functions. Half range sine and cosine series. Fourier transform; Finite Fourier sine and cosine transform.

Unit 4

Ordinary Differential Equations-II:

Ordinary Differential Equations (Second and higher order), Linear Differential Equations of n^{th} order with constant coefficient (Complementary Function and

Particular Integral) of standard functions, Cauchy-Euler equations, Legendre's solving second order linear differential equations by applying - 5 different methods

- (i) When a part of complementary function is given
- (ii) Changing the independent variable
- (iii) Changing the dependent variable
- (iv) Variation of parameters
- (v) Conditions for exactness and the solution when the equation is exact

MATHEMATICS PRACTICAL-IV

Mathematics Practical with Free / Libre and Open-Source Software (FLOSS)

tool for computer programs (i. e., Theory Based Practical-IV)

Note-1: Before the execution, all problems has to be solved manually and the same should also be written in the records along with Aim / Motivation, Algorithm, Computer Program / Python code and output. The minimum 15 programs must be done from the following list of suggested programs:

1. Program to verify the Normality of a given subgroup.
2. Program to verify the given function is homomorphism or not.
3. Program to verify the given function is isomorphism or not.
4. Program to find the Laplace transform of some Standard functions.
5. Program to find an inverse Laplace transform of some Standard functions.
6. Program to solve first order ordinary linear differential equation with constant coefficients using Laplace transform.
7. Program to solve second order ordinary linear differential equation with constant coefficients using Laplace transform.
8. Program to find the Fourier series of some functions with period $2L$.
9. Program to find half range Fourier sine series of some functions.
10. Program to find half range Fourier cosine series of some functions.
11. Program to find the Fourier sine Transform
12. Program to find the Fourier cosine Transform
13. Program to find the complimentary function of linear homogeneous differential equations with constant coefficients.
14. Program to find the particular integral of linear homogeneous differential equations with constant coefficients.
15. Program to find the solution of second order ordinary linear differential equations with variable coefficients by the method of changing independent variable.
16. Program to find solution of second order ordinary linear differential equations with variable coefficients by the method of changing dependent variable.

17. Program to find solution of second order ordinary linear differential equations with variable coefficients by the method of variation of parameters.
18. Program to verify the exactness of second order ordinary linear differential equations.