

S. Y. B. Sc Mathematics Semester III

MT-231: Calculus of Several Variables

Unit-1 Limits and Continuity:

- CO 1. Students will be able to define functions of two or more variables and identify their domain and range.
- CO 2. Students will be able to draw and interpret level curves of functions of two or more variables.
- CO 3. Students will be able to compute limits and determine continuity of functions of two or more variables.

Unit-2 Partial Derivatives and Differentiability:

- CO 1. Students will be able to compute partial derivatives of functions of two or more variables and understand their geometric interpretation.
- CO 2. Students will be able to apply the chain rule and differentiate homogeneous functions.
- CO 3. Students will be able to define differentiability and compute differentials of functions of two or more variables.
- CO 4. Students will be able to use Clairaut's theorem and partial differential equations to solve problems.
- CO 5. Students will be able to apply the second derivative test to find extreme values of functions of two variables.

Unit-3 Extreme Values:

- CO 1. Students will be able to find extreme values of functions of two variables using necessary conditions.
- CO 2. Students will be able to apply the Lagrange multiplier method to find extreme values subject to one constraint.

Unit-4 Multiple Integrals:

- CO 1. Students will be able to evaluate double integrals over general regions and use Fubini's theorem to change the order of integration.
- CO 2. Students will be able to evaluate double integrals in polar coordinates.
- CO 3. Students will be able to evaluate triple integrals and use spherical coordinates to simplify integrals.
- CO 4. Students will be able to use change of variables and Jacobians to evaluate multiple integrals over non-rectangular regions.

MT-232(A): Numerical Methods and Its Applications

Unit 1: Solution of Algebraic and Transcendental Equations:

- CO 1. Students will be able to identify and compute different types of errors in numerical methods.
- CO 2. Students will be able to apply the bisection method, false position method, and Newton-Raphson method to solve algebraic and transcendental equations.

Unit 2: Interpolation:

- CO 1. Students will be able to define and compute finite difference operators and their relations, such as forward difference, backward difference, and shift operator.
- CO 2. Students will be able to compute differences of a polynomial and apply Newton's interpolation formulae (forward and backward) and Lagrange's interpolation formula to approximate functions.

Unit 3: Numerical Differentiation and Integration:

- CO 1. Students will be able to compute numerical derivatives using Newton's forward difference formula.
- CO 2. Students will be able to apply general quadrature formulae, trapezoidal rule, Simpson's 1/3 rule, and Simpson's 3/8 rule to approximate integrals.

Unit 4: Numerical solution of first-order ordinary differential equations:

- CO 1. Students will be able to apply Taylor's series method, Picard's method of successive approximations, Euler's method, modified Euler's method, and Runge-Kutta methods to solve first-order ordinary differential equations.

MT 233: Mathematics Practical

Practical 1-4: Problems on Units 1-4 from MT-231:

1. Students will be able to apply concepts and techniques from Unit 1 (Limits and Continuity), Unit 2 (Partial Derivatives and Differentiability), Unit 3 (Extreme Values), and Unit 4 (Multiple Integrals) of MT-231 to solve practical problems.
2. Students will be able to demonstrate their understanding of the theoretical concepts and their ability to apply them to real-world problems.

Practical 5-6: Problems on Units 1-4 from MT-231 using Maxima software:

1. Students will be able to use Maxima software to solve problems related to Units 1-4 of MT-231.
2. Students will be able to demonstrate their ability to use computational tools to solve mathematical problems and interpret the results.

Practical 7-10: Problems on Units 1-4 from MT-232:

1. Students will be able to apply concepts and techniques from Unit 1 (Solution of Algebraic and Transcendental Equations), Unit 2 (Interpolation), Unit 3 (Numerical Differentiation and Integration), and Unit 4 (Numerical solution of first-order ordinary differential equations) of MT-232 to solve practical problems.
2. Students will be able to demonstrate their understanding of the theoretical concepts and their ability to apply them to real-world problems.

Practical 11-12: Problems on Units 1-4 from MT-232 using Maxima software:

1. Students will be able to use Maxima software to solve problems related to Units 1-4 of MT-232.
2. Students will be able to demonstrate their ability to use computational tools to solve mathematical problems and interpret the results.

S. Y. B. Sc Mathematics Semester IV

MT-241: Linear Algebra

After studying this course, students should be able to:

Unit-1: Matrices and System of Linear Equations

- CO 1. Understand the concept of row echelon form and reduced row echelon form of a matrix.
- CO 2. Determine the rank of a matrix using row echelon or row reduced echelon form.
- CO 3. Represent a system of linear equations in matrix form and identify row equivalent matrices.
- CO 4. Determine the consistency of homogeneous and non-homogeneous systems of linear equations using rank and understand the condition for consistency.
- CO 5. Solve systems of equations using Gauss elimination and Gauss-Jordan elimination method.

Unit-2: Vector Spaces-I

- CO 1. Define a vector space and provide examples.
- CO 2. Understand the concept of subspaces.
- CO 3. Identify linear dependence and independence of vectors.
- CO 4. Determine the basis of a vector space.

Unit-3: Vector Spaces-II

- CO 1. Determine the dimension of a vector space.
- CO 2. Identify the row, column, and null space of a matrix.
- CO 3. Determine the rank and nullity of a matrix.

Unit-4: Linear Transformations

- CO 1. Define linear transformations and provide examples.
- CO 2. Understand the properties and equality of linear transformations.
- CO 3. Identify the kernel and range of a linear transformation.
- CO 4. Apply the rank-nullity theorem.
- CO 5. Understand composite and inverse transformations.
- CO 6. Represent linear transformations using matrices.
- CO 7. Perform basic matrix transformations in \mathbb{R}^2 and \mathbb{R}^3 .
- CO 8. Understand the concept of linear isomorphism.

MT 242(A): Vector Calculus

After studying this course, students should be able to:

Unit 1: Vector-Valued Functions

- CO 1. Understand curves in space and the concept of limits and continuity for vector-valued functions.
- CO 2. Calculate derivatives and apply differentiation rules for vector functions.
- CO 3. Determine the vector functions of constant length.
- CO 4. Calculate integrals of vector functions.
- CO 5. Find arc length along a space curve, speed on a smooth curve, and unit tangent vector.
- CO 6. Calculate curvature of a plane curve, circle of curvature for plane curves, and curvature and normal vectors for a space curve.

Unit 2: Integrals

- CO 1. Calculate line integrals of scalar functions, understand additivity, and apply line integral in the plane.
- CO 2. Understand vector fields, gradient fields, and calculate line integral of vector fields, line integrals with respect to dx , dy , dz .
- CO 3. Calculate work done by a force over a curve in space, flow integrals and circulation for velocity fields, flow across the simple closed plane curve.
- CO 4. Understand path independence, conservative and potential functions.
- CO 5. Understand divergence, two forms for Green's theorem, and apply Green's theorem in the plane (proof for special regions).

Unit 3: Surface Integrals

- CO 1. Understand parameterizations of surfaces and implicit surfaces.
- CO 2. Calculate surface integrals, and understand the orientation of surfaces.
- CO 3. Calculate surface integrals of vector fields.

Unit 4: Applications of Integrals

- CO 1. Understand the curl vector field, Stokes' theorem (without proof), and conservative fields and Stokes' theorem.
- CO 2. Understand divergence in three dimensions and the divergence theorem (without proof).
- CO 3. Unify the integral theorems.

MT 243: Mathematics Practical

- CO 1. Develop an understanding of concepts in linear algebra and vector calculus through practical problem-solving.
- CO 2. Apply theoretical concepts of linear algebra and vector calculus to solve real-world problems.
- CO 3. Use software tools such as Maxima to perform computations and solve problems related to linear algebra and vector calculus.
- CO 4. Enhance analytical and critical thinking skills through the process of problem-solving.
- CO 5. Develop communication skills by presenting solutions to problems both in written and oral formats.
- CO 6. Acquire practical skills in the use of mathematical software tools for solving problems related to linear algebra and vector calculus.
- CO 7. Develop an appreciation of the importance of mathematical methods in various scientific and engineering fields.
- CO 8. Demonstrate an ability to work effectively both independently and in a team to solve problems related to linear algebra and vector calculus.

F. Y. B. Sc Mathematics Semester I

MT 111 - Algebra:

Unit 1: Sets Relations and Functions

- CO 1. Understand the concept of sets, subsets, power sets, and the cardinality of a set
- CO 2. Define relations and their types, and learn how to determine whether a relation is an equivalence relation or a partial order
- CO 3. Understand the concept of functions, their domain, range, and different types of functions
- CO 4. Learn how to find the inverse of a function and perform the composition of functions

Unit 2: Divisibility Theory in the Integers

- CO 1. Understand the principle of mathematical induction and the well-ordering principle
- CO 2. Learn the division algorithm and its applications in finding the greatest common divisor and the least common multiple
- CO 3. Understand Euclid's lemma and its applications in proving the fundamental theorem of arithmetic

Unit 3: Primes and the theory of Congruence

- CO 1. Understand prime numbers and their properties, and learn how to determine whether a number is prime or composite
- CO 2. Learn the basic properties of congruence and modular arithmetic
- CO 3. Understand Fermat's theorem and its applications in cryptography

Unit 4: Complex Numbers

- CO 1. Understand the properties of complex numbers, their algebraic operations, and the exponential form of a complex number
- CO 2. Learn how to find the modulus and complex conjugate of a complex number, and perform operations like multiplication and division

CO 3. Understand the n th roots of unity and their geometric representation in the complex plane

MT 112: Calculus I

CO 1. Understand the algebraic and order properties of real numbers, including the arithmetic mean-geometric mean inequality and Bernoulli's inequality.

CO 2. Understand the absolute value function and its properties, including the triangle inequality and its consequences.

CO 3. Understand the completeness property of \mathbb{R} , including the definitions of upper bound, lower bound, supremum, and infimum of subsets of \mathbb{R} .

CO 4. Apply the supremum property of \mathbb{R} to the Archimedean property and density theorem.

CO 5. Understand sequences and their limits, including the definition and examples of sequences of real numbers and the definition of limit of a sequence.

CO 6. Apply limit theorems, including the definition of bounded sequence, algebra of limits, and monotone convergence theorem.

CO 7. Understand sub-sequences and the Bolzano-Weierstrass theorem.

CO 8. Understand functions and their graphs, including the definition of cluster point and limit of a function.

CO 9. Apply limit theorems to algebra of limits and squeeze theorem.

CO 10. Understand the concept of continuity, including the definition of a continuous function at a point and on intervals.

CO 11. Apply the sequential criterion for continuity and the divergence criterion.

CO 12. Understand the properties of continuous functions on intervals, including the boundedness theorem, the minimum-maximum theorem, and the location of root theorem.

CO 13. Apply the Bolzano's intermediate value theorem and the preservation of interval theorem to continuous functions that map closed bounded interval to closed bounded interval.

MT 113: Mathematics Practical

CO 1. Develop problem-solving skills: Students will develop problem-solving skills through solving problems from different units of MT-111 and MT-112 using both written methods and Maxima software.

CO 2. Understand the mathematical concepts: Students will be able to understand the mathematical concepts from different units of MT-111 and MT-112 and apply them to solve problems.

CO 3. Enhance computational skills: Students will enhance their computational skills by performing calculations manually and using Maxima software.

CO 4. Analyze and interpret data: Students will be able to analyze and interpret data obtained from calculations and use it to draw conclusions.

CO 5. Learn to use mathematical software: Students will learn to use Maxima software to perform mathematical calculations and solve problems.

CO 6. Develop communication skills: Students will develop communication skills through presenting their solutions to problems in a clear and concise manner.

F. Y. B. Sc Mathematics Semester II

MT 121-Analytical Geometry

- CO 1. Understand the concept of change of axes in two dimensions, and be able to perform translations and rotations.
- CO 2. Understand the concept of conic sections and be able to derive the general equation of second degree in two variables.
- CO 3. Be able to reduce the equation of a conic section to standard form, find its center, and determine its nature.
- CO 4. Understand the concept of direction cosines and direction ratios, and be able to derive the equation of a plane in normal form and intercept form.
- CO 5. Be able to find the distance of a point from a plane, and the distance between parallel planes.
- CO 6. Be able to determine the angle between two planes and find the bisector plane.
- CO 7. Be able to derive the equation of a line in symmetric and unsymmetric forms, and find the line passing through two points.
- CO 8. Understand the concept of coplanarity and the condition for two lines to be coplanar.
- CO 9. Be able to find the perpendicular distance of a point from a plane, and determine the angle between a line and a plane.
- CO 10. Understand the concept of a sphere and be able to derive its equation in different forms.
- CO 11. Be able to find the plane section of a sphere, the equation of a circle, and the sphere passing through a given circle.
- CO 12. Be able to find the intersection of a sphere and a line, and derive the equation of the tangent plane to a sphere.

MT 122: Calculus-II

- CO 1. Students will understand the concept of derivative of a function at a point, and its applications in real-life situations.
- CO 2. Students will be able to use the rules of differentiation, including the chain rule and the derivative of inverse function.
- CO 3. Students will be familiar with the mean value theorems and their applications in determining extrema and intervals of increasing and decreasing functions.
- CO 4. Students will be able to apply L'Hospital rule to evaluate indeterminate forms and use Taylor's theorem and Maclaurin's theorem with Lagrange's form of remainder in approximating functions.
- CO 5. Students will be able to compute the n th derivative of a function and apply Leibnitz theorem for successive differentiation.
- CO 6. Students will be able to solve linear and separable first-order ordinary differential equations, and understand the existence and uniqueness of solutions for nonlinear equations.
- CO 7. Students will be able to transform nonlinear equations into separable equations and solve exact differential equations using integrating factors.
- CO 8. Students will be able to apply their knowledge of differentiation and differential equations to real-life situations, such as modeling population growth or the spread of disease.

MT-123 : Mathematics Practical

- CO 1. Develop proficiency in solving mathematical problems related to Units 1 to 4 of MT-121 and MT-122.
- CO 2. Acquire hands-on experience in using Maxima software for solving mathematical problems related to Units 1 to 4 of MT-121 and MT-122.
- CO 3. Apply mathematical concepts learned in MT-121 and MT-122 to solve practical problems related to real-life scenarios.
- CO 4. Enhance problem-solving skills and critical thinking abilities by applying mathematical concepts to solve problems.
- CO 5. Develop communication skills by presenting solutions to problems in a clear and concise manner.
- CO 6. Learn how to use mathematical software tools effectively to solve complex problems in a timely and efficient manner.
- CO 7. Gain practical knowledge of various mathematical concepts such as calculus, linear algebra, probability, and statistics.
- CO 8. Improve analytical and numerical skills by using mathematical tools and techniques to analyze and solve problems.
- CO 9. Overall, the course aims to provide students with practical experience in applying mathematical concepts and tools to solve real-world problems. By the end of the course, students should be able to demonstrate proficiency in solving mathematical problems and using mathematical software effectively.