

**Gujarat University**  
**Choice Based Credit System (CBCS)**  
**B. A. (External)**  
**Syllabus for Semester I (Mathematics)**  
**MAT 101: Calculus and Matrix Algebra**  

Credits: 4

**Remark:** Students, opting for B.A. (External) Mathematics, should be comfortable with the syllabus of F. Y. B. Sc. Regular EC101, which covers 11th–12th Science stream Mathematics, and is necessary to pursue further Mathematics.

**Unit: I**  
Successive Derivatives, standard results for \( n^{th} \) derivative, Leibniz’s Theorem. Definition of limit of a sequence, Convergence and divergence of an infinite series, Alternating Series (Without proof). Comparison test, Ratio test and Root test.

**Unit: II**  
Rolle’s Theorem, Lagrange’s and Cauchy’s Mean Value Theorems (MVT), Increasing and decreasing functions, Taylor’s and Maclaurin’s Theorems (both without proof). Using Taylor’s and Maclaurin’s Theorem find Maclaurin power series expansion of \( \sin x, \cos x, \log (1+ x), e^x, (1+ x)^n \) under proper restrictions (if any). Indeterminate forms: all forms of L'Hôpital's Rules with proof and all forms.

**Unit: III**  

**Unit: IV**  

**Reference Books:**

12. Introduction to Linear Algebra – V. Krishnamurthy, Affiliated East-west Press Pvt Ltd.
Remark: Only problems to be asked.

Unit I:
Problems based on Integral and successive differentiation. (Problem Number 1 - 6).

Unit II:
Problems based on convergence of infinite series, Mean value theorems, Expansions of functions, and L'Hôpital's Rule. (Problem Number 7 - 12).

Unit III:
Problems based on Matrices and its applications. (Problem Number 13 - 17).

Unit IV:
Problems based on tracing of curves. (Problem Number 18 - 20)

List of Problems:

1. Find the limit of sums using the definite integral.
2. Find the definite integrals using substitution.
3. Find the definite integrals using integration by parts.
4. Find the integral by method of partial fractions.
5. Find the nth derivative of the following functions at the given points.
6. Applications of Leibniz theorem.
7. Discuss Convergence of the infinite series-I.
8. Discuss Convergence of the infinite series-II.
9. Geometrical Interpretation of MVT. and verification of MVT.
10. Problems on MVT.
12. Evaluate limit using L'Hôpital's rule.
13. Find RRE form and rank of a matrix.
15. Verify the Cayley-Hamilton(CH) theorem – inverse of matrix using it- problems on CH theorem.
16. Find Eigen values and Eigen vectors.
17. Solution of system of linear equations using row operations and Cramer’s rule.
18. Asymptotes of curves.
19. Concavity and point of inflexion of a curve in \( \mathbb{R}^2 \).
Prerequisites (not to be asked but must be done):
Introduction of Differential equations, its order and degree. Family of curves leading to
differential equation and its solution in family of curves. Different types of solutions (viz.
Differential equations of first order and first degree.

Unit I: (a) Methods of solving Differential Equations of first order and first degree: Variable
separable, Homogeneous and non-homogeneous differential equations, Exact
differential equations( without proof), Integrating factors, Linear differential equation
of first order and first degree, Bernoulli’s differential equation & Differential
Equations reducible to them.
(b) Method of solving differential equations of first order and higher degree: solvable for
y, solvable for x, solvable for p ( where $p = \frac{dy}{dx}$ ), Clairaut’s differential equation
(both general and singular), Lagrange’s differential equation.

Unit II: Linear differential equations of higher order and degree one: Differential operators (D
and $\theta$ ): Linear differential equations of higher order and degree one with constant
coefficients. Complementary and Particular Integrals (Solutions). Inverse operator.
Operational methods for its solutions. Euler form of homogeneous linear differential
equations with variable coefficients.

Unit III: Sphere and Introduction to conicoid:
(a) Definition of a sphere in $\mathbb{R}^3$, Cartesian equaton of a sphere, General equation of a
sphere, Equation of a sphere with diametrically opposite end points, Intersection of a
sphere with Line/plane/sphere( No theory but only problems), Equation of a tangent
plane to a sphere. The tangency of a plane and normality of a line to a sphere,
Orthogonal spheres.
(b) Conicoids: Introduction to conicoid, types of central and non central conicoids in $\mathbb{R}^3$,
figures of conicoids.

Unit IV: Polar coordinate system and Cone and cylinder in $\mathbb{R}^3$:
(a) Polar coordinates in $\mathbb{R}^2$ & $\mathbb{R}^3$ and its Relationships with Cartesian coordinates, polar
equation of line-/circle /conic and properties of conics.
(b) Introduction to different types of cone and cylinder, Equations of enveloping
cone/cylinder. Right circular cone/cylinder (without proof). Problems on cone and
cylinder.

Reference Books:
1. Calculus - JAMES STEWART , THOMSON BROOKS/COLE
2. Calculus - T.M.Apostol
5. A first course in calculus fifth edition By Serge Lang , Springer India
7. Introductory course in Differential equations-Murray
9. Elementary Differential equations –Kella
10. Co-ordinate Geometry By : R.J.T. Bell
Remark: Only problems to be asked.

Unit I: Graphs of standard curves and graphical solution. Introduction to definite integral as a limit of sum, Method of integration by substitution/ partial fractions/ by parts, Reduction formulae (sin^n x, cos^n x and sin^m x cos^n x). (Problem number 1 to 5)

Unit II: Application of reduction formulae. Application of integration (area, volume, length of arc and surface area formulae without proof). (Problem number 6 to 10)

Unit III: Applications of Differential equations. (Problem number 11 to 14)

Unit IV: Polar coordinates, spherical and cylindrical co-ordinates, sphere, cone, cylinder. (Problem number 15 to 20).

List of Problems:
(1) Graphical solution of Cartesian equations
(2) Graphs of parametric equations of some standard curves.
(3) Graphs of polar equations: cardioids, Limacön with a loop, Limacön with a dimple, spirals, rose curves
(4) Problems on definite integral as a limit of sum, method of integration by substitution/by partial fractions/by parts
(5) Derivation of reduction formulae
(6) Evaluate the following using reduction formulae only: sin^n x, cos^n x, tan^n x for different odd/even n \in \mathbb{N}
(7) Evaluate sin^m x cos^n x using reduction formulae only: for different odd/even m, n \in \mathbb{N}
(8) Find the area of a bounded plane region between curves and the volume of a solid body on revolution of a bounded plane region about the co-ordinate axes using definite integral.
(9) Find the length of arcs and curves in Cartesian & parametric forms using definite integral.
(10) Find the area of a surface of revolution of a bounded curve about the co-ordinate axes using definite integral.
(11) Solve the differential equations of order 1 and degree 1 & also higher degree.
(12) Solve the differential equations of higher order and degree 1 with constant coefficients.
(13) Solve the differential equations of higher order and degree 1 with variable coefficients.
(14) Applications of differential equations and orthogonal trajectories
(15) The mutual relation between polar and Cartesian co-ordinate systems in \mathbb{R}^2 and \mathbb{R}^3. Transformation of equations from one system to another.
(16) The mutual relations among Cartesian, cylindrical and spherical co-ordinate system in \mathbb{R}^3
(17) The mutual relations among Cartesian, cylindrical and spherical co-ordinate system in \mathbb{R}^3. Transformation of equations from one system to another
(18) Problems on sphere
(19) Problems on cone
(20) Problems on cylinder
Unit-I: Limit-Continuity of function of several variables and partial derivatives:
Introduction to function of several variables, rectangular and spherical neighbourhood of a point in $\mathbb{R}^n$, Limit of function of several variables, concept of iterated limits, limit and path, continuity of function of several variables.

Unit-II: Differentiability of function of several variables-I
Directional derivatives, Introduction to partial derivatives, different notations and its geometric interpretation, higher order partial derivatives and problems. Differentiability of function of two variables, theorems on differentiability conditions and their converses, Schwartz’s theorem and Young’s theorem.

Unit-III: Differentiability of function of several variables-II
Differential of function of two variables, Chain rules for differentiability, derivatives of implicit functions. Homogeneous functions, Euler’s theorem for homogeneous functions of n-variables, Extreme values of functions of two variables and its theorems, Lagrange’s method of undetermined multipliers (only problems to be asked).

Unit-IV: Applications of partial derivatives
Taylor’s Theorem for function of two variables (proof of two variables only), Maclaurin’s theorem, problems on Taylor and Maclaurin theorems, Concept of multiple points, double points, different types of double points and examples, radius of curvature for Cartesian-parametric-polar equations of a curve in $\mathbb{R}^2$.

Reference Books:
5. Calculus - James Stewart.
9. All the Mathematics you missed but need to know - Thomas A. Garrity, Cambridge Uni.Press.

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Gujarat University  
Choice Based Credit System (CBCS)  
B. A. (External)  
Syllabus for Semester III (Mathematics)  
MAT 202: Linear Algebra-I  

Credits: 4

**Prerequisites:** Relation, Equivalence Relation, Binary Operation.

**Unit I:**
Vector space: Definition, Examples, Properties, Subspaces, Necessary and Sufficient Condition to be a Subspace, Span of a Set, Examples of Subspaces, Intersection, Addition and Direct Sum of Subspaces., Linear Variety.

**Unit II:**
Finite Linear Combination, Linear Dependence/Independence and their properties (with proof), Examples regarding Linear Dependence/ Independence. Dimension and Basis of a vector space, Dimension Theorem.

**Unit III:**

**Unit IV:**
Matrix associated with a Linear Map, Linear Map associated with a Matrix. Linear operations in $\mu_{m,n}$, Only introduction of L(U,V) and Isomorphism between L(U,V) and $\mu_{m,n}$, Dimension Theorems for $\mu_{m,n}$ and L(U,V). Rank – Nullity of Matrices and verification of the Rank-Nullity Theorem for Matrices.

**Text Book:**
An Introduction to Linear Algebra – V. Krishnamurthy & others. (Affiliated East-West press, New Delhi)

**Reference Books:**
1. Linear Algebra a Geometric Approach - S. Kumaresan, PHI.
8. Introduction to Linear Algebra - Serge Lang, Springer, India.
10. Linear Algebra Problem Book - P. R. Halmos.

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Remark: Only problems to be asked.

List of Problems:

Unit I:
1. Problems on different types of errors.
2. To find missing terms from the given table and to express a polynomial in terms of factorial notations.
4. Gauss’s forward interpolation and Gauss’s backward interpolation

Unit II:
5. Stirling’s, Bessel’s and Everette’s interpolation.
6. Lagrange’s interpolation and Newton’s divided interpolation
7. Inverse interpolation for equispaced arguments (Only Newton’s forward interpolation and Newton’s backward interpolation and Gauss’s forward interpolation)
8. Inverse interpolation for unequispaced arguments (Newton’s divided and Lagrange’s inverse interpolation)

Unit III:
12. Curve Tracing- 1 (Cartesian curves in $R^2$), Catenary, $y = x^3$, $y^2(a - x) = x^3$ (Cissoid).
   Curve Tracing-2 (Parametric and Polar curves in $R^2$), Cardioid, Cycloid, Astroid, Spiral.

Unit IV:
13. Examples on Limit, Continuity and Differentiation of functions of several variables using definition.
14. Examples on Euler’s theorem and Examples on Extreme values.
15. Examples on subspace, bases and dimension theory.
16. Matrix Associated with Linear map and linear map associated with matrix.

Reference Books:
2. Elementary Numerical Analysis - Shastry.
Gujarat University
Choice Based Credit System (CBCS)
B. A. (External)
Syllabus for Semester IV (Mathematics)
MAT 204: Advanced Calculus-II

Credits: 4

Unit I: Multiple integrals
Introduction to double integral, repeated or iterated integral, double integral over a closed region, evaluation of double integral, changing the order of double integral, triple integrals, Iterated triple integrals, Geometrical interpretation of double and triple integrals and problems based on it, Introduction to Jacobian(only definition), transformation of double and triple integrals.

Unit II: Beta and Gamma functions and Vector calculus
(a) Definition of beta and gamma functions, properties of beta and gamma functions, relation between beta and gamma functions, duplication formula, evaluation of definite integrals using beta-gamma functions.
(b) Definition of gradient, divergence and curl, properties of theses operators,

Unit III: Line surface and volume integrals
Definition of line integral, Green’s theorem, surface and volume integral, Gauss’s divergence theorem, Stoke’s theorem., verification of the three theorems and problems based on the theorems.

Unit IV: Partial Differential Equations
Formation of Partial differential equations by the elimination of Arbitrary constants and arbitrary functions. Partial differential equations of the first order, the complete and particular integrals, Lagrange's solution of the linear equation. Some special types of equations which can be solved easily by the methods other than Charpit’s method.

Reference Books:
2. Integral calculus – Shanti Narayan.
5. Calculus- James Stewart.

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B. A. (External)
Syllabus for Semester IV (Mathematics)
MAT 205: Abstract Algebra-I

Credits: 4

Unit I:
Relation, Equivalence Relation, Partition of set, Binary operations. Division Algorithm for Integers, Congruence modulo Relation in \( \mathbb{Z} \), Definition and Examples of Groups, Elementary properties of Group, Equivalent Definitions of a Group, Finite Groups and their tables, Commutative and non-commutative groups.

Unit II:
Subgroups: Definition and Examples, normalizer and centralizers, order of an element, order of a group, cyclic subgroup generated by an element, Lattice diagrams of finite groups, cosets and its properties, Lagrange’s theorem and its applications, Euler’s theorem, Fermat’s theorem.

Unit III:
Permutations: Definitions and Examples, cycle, transposition, even and odd permutations, order of a permutation, inverse of a permutation, Symmetric groups and Alternating groups. Examples, Quotient groups.
Normal subgroups: Definitions and Examples, Quotient group.

Unit IV:

Text Book:

Reference Books:
5. Arup Bijganit (Gujarati) - I. H. Sheth, University Granth Nirman Board, Ahmedabad.
6. Algebra - Michael Artin, PHI.
8. A first course in Abstract Algebra (Rings, Groups & fields) - Marlow Anderson & Todd Fel, Chrpman & Halilereivy.

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Gujarat University  
Choice Based Credit System (CBCS)  
B. A. (External)  
Syllabus for Semester IV (Mathematics)  
MAT 206: Problems (Based on MAT204, MAT205 and Numerical Methods-II)  

Credits: 2.5

Remark: Only problems to be asked.

List of Problems:

Unit I:
1. Problems based on relation between roots and coefficients of a polynomial equations and problems of finding equations from given conditions.
2. Cardon’s method to solve a cubic polynomial equation
3. Ferrari’s method to solve a bi-quadratic polynomial equation
4. Graphical method to find a real root of an equation.

Unit II:
5. Bisection method and method of false position
6. Fixed point iteration method and Newton-Raphson’s method
7. Euler’s method to solve an Initial Value Problem(IVP) and Modified Euler’s method to solve an IVP.
8. Taylor’s series method to solve an IVP and Picard’s method to solve an IVP.

Unit III:
9. Runge-Kutta method of order two and order four to solve an IVP.
10. Numerical differentiation for equispaced arguments: Newton’s forward and backward differentiation formula, Gauss’s forward differentiation formula
11. Numerical differentiation for unequispaced arguments: Newton’s divided difference interpolation and Lagrange’s interpolation formula.

Unit IV:
13. Problems on change of the order of integration.
14. Problems on line integrals and volume integrals.
15. Examples of Permutation or symmetric group.
16. Examples of cyclic group and its subgroups and lattice diagrams.

Reference Books:

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