Government General Degree College Chapra
Department of Mathematics
PO and CO (NEP)
Second Semester

Programme Outcome:
On successful completion of the B.Sc. Mathematics Major/Minor/MDC 2nd Semester, students will be able to:

1. Demonstrate comprehensive knowledge of foundational and advanced topics in mathematics, including set theory, algebra, calculus, linear algebra, statistics, abstract algebra, and fuzzy logic.

2. Develop strong analytical and logical reasoning skills to solve complex mathematical problems, including those involving the use of De Moivre's theorem, group theory, matrix operations.

3. Understand and apply abstract mathematical structures, including groups, permutations, equivalence relations, and functions, fostering a deeper theoretical understanding of modern mathematics.

4. Perform statistical analysis and data interpretation using measures of central tendency, dispersion, skewness, and kurtosis, and create graphical representations of data for effective communication.

5. Understand the nature of fuzzy logic and fuzzy sets, enabling the modeling of uncertainty and approximation in real-life problems involving imprecise data.

6. Communicate mathematical ideas effectively through written, verbal, and visual means, demonstrating clarity and coherence in logical argumentation and proof-writing.

7. Pursue advanced studies or research in mathematics or related disciplines and apply their knowledge to academic, industrial, or governmental roles requiring mathematical expertise.

Course Outcome:

Course code & title	Syllabus	Course Outcome
MATH-T-02: **Algebra-I**	Polar representation of complex numbers, nth roots of unity, De Moivre's theorem for rational indices and its applications. Direct and inverse circular form of trigonometric and hyperbolic functions. Exponential & Logarithm of a complex number. Definition of a_z. Relation between roots and coefficients, transformation of equation, Descartes rule of signs, solution of cubic equation (Cardan's method), solution of biquadratic equation (Ferrari's method). Well-ordering property of positive integers, division algorithm, divisibility and Euclidean algorithm. Congruence relation between integers. Principles of mathematical induction, statement of fundamental theorem of arithmetic. **Unit 2. [25L]** Equivalence relations and partitions. Functions, composition of functions, Invertible functions, one to one correspondence and cardinality of a set. Permutations, cycle notation for permutations, even and odd permutations. Definition and elementary properties of groups. Symmetries of a square, dihedral groups. quaternion groups (through matrices). Permutation group, alternating group, finite groups: S_3, V_4. The group Z_n of integers under addition modulo n and the group U_n of units under multiplication modulo n. Order of an element, order of a group, simple properties. Subgroups and examples of subgroups. Product of two subgroups. Cyclic group. Properties of cyclic groups. Classification of subgroups of cyclic groups.	By the end of the course, students will be able to: **CO1**: Represent complex numbers in polar form and use De Moivre's Theorem to find powers, roots, and exponential/logarithmic forms. **CO2**: Solve polynomial equations using methods like Cardan's for cubics and Ferrari's for biquadratics; apply root-coefficient relationships and Descartes's Rule. **CO3**: Understand divisibility in integers, perform Euclidean algorithms, and use mathematical induction and congruences in proofs. **CO4**: Analyze functions, identify equivalence relations and partitions, and comprehend the notion of cardinality and bijections. **CO5**: Use permutations in cycle form, determine parity, and apply the concepts in group structures such as , and dihedral groups. **CO6**: Identify and work with subgroups and cyclic groups, including classification and subgroup products. **CO7**: Compute rank, inverse, and reduced forms of matrices; solve systems of linear equations using matrix operations.

	Unit 3. [20L] Rank of a matrix, inverse of a matrix, characterizations of invertible matrices. Row reduced and echelon forms, Normal form and congruence operations. Solutions of systems of linear equations of the form $Ax=b$ and their applications.	
MATH-SEC-T-02 **Fuzzy Set Theory**	**Unit 1. [20L]** Fuzzy Sets: Basic concepts, α-cuts and its properties Representations of fuzzy sets, decomposition theorems. Support, convexity, normality, cardinality of fuzzy sets. Standard set-theoretic operations on fuzzy sets. Zadeh's extension principle. **Unit 2. [15L]** Interval numbers, arithmetic operations on interval numbers, Fuzzy numbers. Arithmetic operations on fuzzy numbers (multiplication and division on $\mathbb{R}_+$ only). Fuzzy equations. **Unit 3. [10L]** Crisp versus fuzzy relations. Fuzzy matrices and fuzzy graphs. Composition of fuzzy relations, relational joins. Binary fuzzy relations.	Upon successful completion of the course, students will be able to: **CO1**: Define fuzzy sets and perform operations such as intersection, union, and complement; understand concepts like α-cuts, support, convexity, normality, and cardinality. **CO2**: Apply decomposition theorems and Zadeh's extension principle to interpret and manipulate fuzzy sets. **CO3**: Perform arithmetic operations on interval numbers and fuzzy numbers (especially in R^+); solve fuzzy equations. **CO4**: Differentiate between crisp and fuzzy relations; use fuzzy matrices and graphs in representing fuzzy relations. **CO5**: Compute and analyze binary fuzzy relations, compositions, and relational joins.
MATH-MI-T-01: Algebra & Analytical Geometry	**Unit 1. [20L]** Complex Numbers: De Moivre's theorem and its applications. Exponential, Sine, Cosine and Logarithm of a complex number. Definition of a_z. Inverse circular and hyperbolic functions. Polynomials: Fundamental theorem of algebra	After successful completion of the course, a student will be able to: **CO1**: Apply De Moivre's theorem and understand exponential, trigonometric, and logarithmic forms of

	(Statement only). Polynomials with real coefficients, nature of roots of an equation (surd or complex roots occur in pairs). Statement of Descartes's rule of signs and its applications. Relation between roots and coefficients, transformations of equations. Cardan's method of solution of a cubic equation. Rank of a matrix: Determination of rank either by considering minors or by the sweep-out process. Consistency and solution of a system of linear equations (not more than 3 variables) by matrix method. Equivalence relations and partitions. Functions, composition of functions, invertible functions, one-to-one correspondence and cardinality of a set Definition and elementary properties of groups. Concepts of permutation Group, alternating group, finite groups: S_3, V_4. The group Z_n of integers under addition modulo n. Order of an element, order of a group, subgroups and examples of subgroups. **Unit 2. [30L]** Transformations of rectangular axes: Translation, rotation and their combinations. Invariants. General equation of second degree in x and y: Reduction to canonical forms. Classification of conics. Pair of straight lines: Condition that the general equation of 2^{nd} degree in x and y may represent two straight lines. Point of intersection of two intersecting straight lines. Angle between two lines given by $ax^2+2hxy+by^2=0$. Equation of bisectors. Equation of two lines joining the origin to the points in which a line meets a conic. Polar equation of straight lines and circles. Polar equation of	complex numbers, including inverse functions. **CO2**: Analyze polynomials, apply Descartes's Rule of Signs, understand the nature of roots, and solve cubic equations using Cardan's method. **CO3**: Determine the rank of matrices and solve systems of linear equations using matrix methods, ensuring consistency and interpretation of solutions. **CO4**: Understand equivalence relations, partitions, and function types, including one-to-one correspondences and cardinality. **CO5**: Define and explore group structures, identify subgroups, and analyze group properties including permutations and finite groups like S_3, V_4, and Z_n. **CO6**: Perform transformations of rectangular axes and use them to reduce general second-degree equations to canonical forms. **CO7**: Classify and analyze conics and pairs of straight lines through algebraic conditions, bisectors, angles, and point intersections. **CO8**: Use polar coordinates for conics and straight lines, derive equations of tangents, normals, and chords, and explore 3D figures like spheres and cones.

	a conic refers to a focus as a pole. Equation of chord joining two points. Equations of tangents and normals. Sphere and its tangent planes. Right circular cone.	
MATH-MD-T-02 **Basic Mathematics**	**Unit 1. Set Theory: [5L]** • Introduction to sets and their representations. The empty set, finite and infinite sets, equal sets, subsets, power set, and Universal set. • Venn Diagrams, operations on sets, complement of a set, problems on union and intersection of sets. **Unit 2. Complex Numbers: [5L]** • Polar representation of complex numbers. • De Moivre's theorem (without proof) for rational indices and their applications. **Unit 3. Theory of Equations: [10L]** • Introduction and definition of equation. Types of equations. • Relation between roots and coefficients. Descartes's rule of signs. • Linear and quadratic equations and their solution. Nature of the roots of quadratic equations. **Unit 4. Matrix & Determinant: [10L]** • Definition of a Matrix. Types of Matrices. Elementary operations on Matrices. • Determinant of a square matrix (up to third order). Properties of determinants. Cofactors and minor of a determinant. • Transpose and Adjoint of a matrix. Symmetric and Skew Symmetric Matrices. • Inverse of a matrix. Solution of system of linear equations (up to third order) using matrix inversion method and Cramer's Rule.	After completing this course, the student will be able to: **CO1**: Understand the concept of sets, perform set operations using Venn diagrams, and solve problems involving union, intersection, and complement. **CO2**: Represent complex numbers in polar form and apply De Moivre's Theorem to compute powers and roots. **CO3**: Identify and solve linear and quadratic equations; apply Descartes's Rule of Signs and use root-coefficient relationships. **CO4**: Understand the structure and types of matrices, compute determinants, and solve systems of equations using inverse and Cramer's Rule. **CO5**: Grasp the basic concepts of statistics, differentiate between types of data, and represent data effectively using tables and graphs. **CO6**: Calculate and interpret measures of central tendency and dispersion, and assess data distribution using skewness and kurtosis.

	Unit 5. [5L] • Definition and scope of statistics, concepts of statistical population and sample. • Data: qualitative and quantitative, discrete and continuous data types, primary and secondary data. • Presentation of data: tabular and graphical. • Frequency distribution, cumulative frequency distribution and their graphical representations: histogram, frequency polygon, frequency curve, and O-gives. **Unit 6. [10L]** • Measures of Central Tendency: mean, weighted mean, median, mode. • Measures of Dispersion: range, mean deviation, standard deviation, coefficient of variation, moments, skewness and kurtosis.	