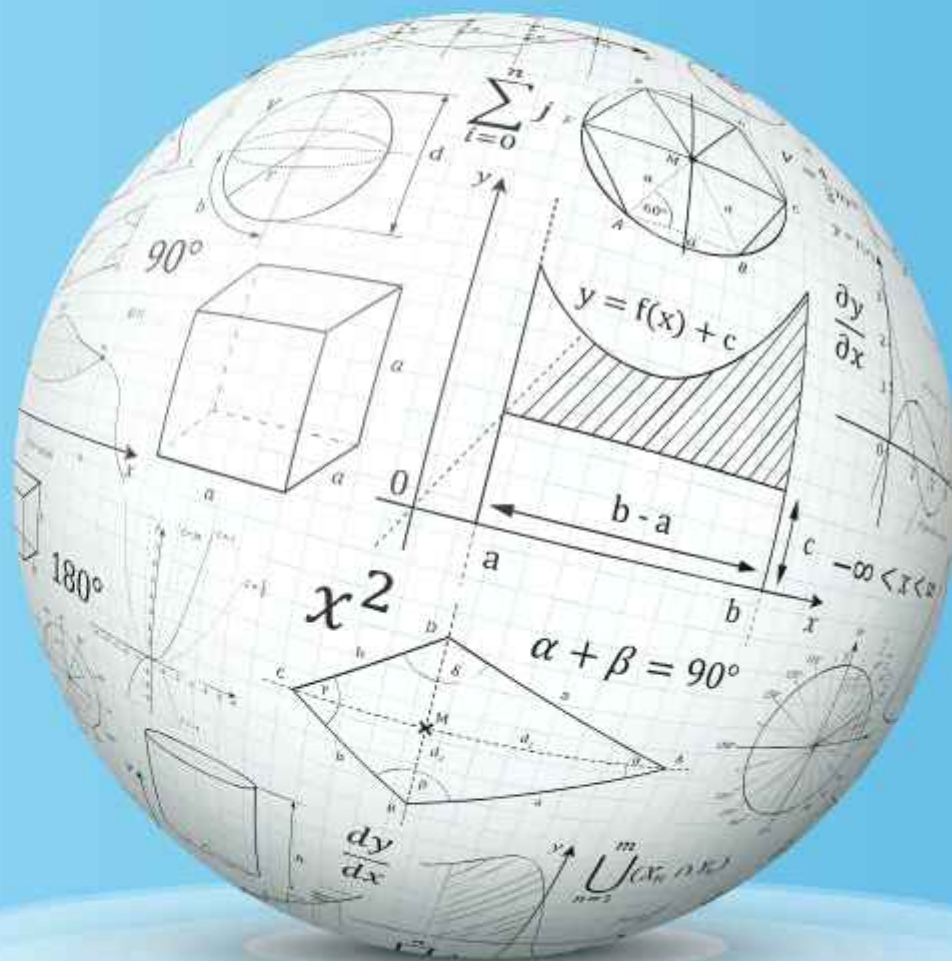


National Curriculum of Pakistan 2026

# MATHEMATICS

Grades 9-12



NATIONAL CURRICULUM COUNCIL WING  
MINISTRY OF FEDERAL EDUCATION AND  
PROFESSIONAL TRAINING, ISLAMABAD  
GOVERNMENT OF PAKISTAN



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## Acknowledgement

The National Curriculum Council Wing (NCCW), Ministry of Federal Education and Professional Training, Government of Pakistan, presents the rationalized Curriculum of Mathematics for Grades IX–XII. This curriculum reflects our collective commitment to provide a coherent, relevant, and forward-looking framework for Mathematics education in Pakistan.

In response to emerging national priorities, global educational trends and the evolving needs of our learners, the curriculum has been carefully rationalized to ensure conceptual clarity, reduced content overload, and enhanced alignment with 21st-century competencies.

The rationalization process involved extensive consultation with subject experts, curriculum specialists, university professors, teachers, assessment bodies, and other stakeholders. To carry out the important task, redundant content has been streamlined, learning outcomes have been made measurable and competency-based, and the content load has been balanced to support deeper learning within the available instructional time.

The National Curriculum Council acknowledges the invaluable contributions of all experts, reviewers, educators, and institutions who participated in the rationalization process for their remarkable efforts on finalizing this document. Their dedication and professional insight have been instrumental in shaping a curriculum that aspires to excellence, equity, and relevance.

We are confident that this rationalized National Curriculum of Mathematics will serve as a strong foundation for improving the quality of science education in Pakistan and nurturing a generation of scientifically literate, innovative, and responsible citizens.

Dr. Tabassum Naz  
Director  
National Curriculum Council Wing  
Ministry of Federal Education and Professional Training  
Islamabad.

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## Introduction

Mathematics is a fundamental discipline that develops logical reasoning, problem-solving skills, analytical thinking, and the ability to represent ideas with clarity and precision. At the secondary and higher secondary levels, mathematics provides learners with essential concepts and methods required for further studies, daily life situations, and future academic and professional pathways.

The National Curriculum of Mathematics for Grades 9–12 is designed to provide a coherent and progressive learning experience. It aims to strengthen students' conceptual understanding, procedural fluency, reasoning ability, and application of mathematical knowledge. The curriculum is organized to support a smooth progression from basic to advanced ideas, enabling learners to connect different areas of mathematics and use appropriate strategies to solve problems.

This curriculum emphasizes meaningful learning rather than memorization. It encourages students to explore patterns, justify solutions, communicate mathematical ideas, and apply mathematical reasoning in familiar and unfamiliar contexts. The content has been selected and sequenced to meet the learning needs of students across Grades 9–12 and to prepare them for higher education, competitive examinations, and practical life.

The curriculum also provides guidance for teachers, textbook developers, assessment bodies, and other stakeholders by clearly identifying the expected learning outcomes, content areas, and progression of mathematical concepts. It serves as a framework for developing quality teaching, learning, and assessment practices in mathematics across Pakistan.

## PROGRESSION GRID

### Domain A: Numbers and Algebra

#### Standard:

Students will understand number systems and their properties, from whole numbers to introductory complex numbers, and apply number-theoretic reasoning to justify relationships and solve problems. Students will use algebraic expressions, equations, inequalities, relations, and functions to model and solve mathematical and contextual problems, applying symbolic methods, rates of change, calculus, simple differential equations, and basic numerical techniques where appropriate.

| Grade 9                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Grade 10 | Grade 11                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Grade 12 |
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| <b>Benchmarks for Grades 9–10</b><br><br><b>Benchmark I: Number Systems, Sets, and Functions</b><br>Students will develop an understanding of number systems, sets, and functions as foundational mathematical structures. They will classify and use real and complex numbers, apply their properties in mathematical operations, represent and interpret sets through appropriate notation and Venn diagrams, and describe relations and functions, including inverse and composite functions, in mathematical and contextual situations.<br><br><b>Benchmark II: Algebraic Expressions, Surds, and Polynomials</b><br>Students will develop fluency in simplifying, factorizing, and manipulating algebraic forms. They will work with algebraic expressions, algebraic fractions, surds, and polynomials; apply laws and properties to simplify expressions; rationalize surds where required; and use factorization, the remainder theorem, and the factor theorem to analyze and factorize polynomial expressions, including cubic polynomials.<br><br><b>Benchmark III: Equations, Inequalities, and Quadratic Models</b><br>Students will develop the ability to formulate, represent, and solve equations and inequalities in one or more variables. They will solve linear equations, systems of two linear equations, linear inequalities, and quadratic equations using appropriate algebraic methods. They will also interpret solutions and apply equations and quadratic models to solve mathematical and real-life problems.<br><br><b>Benchmark IV: Matrices and Algebraic Problem Solving</b><br>Students will develop an understanding of matrices as algebraic tools for representing and solving problems. They will perform basic operations on matrices, evaluate determinants, find inverses of matrices where applicable, and use matrices to solve systems of simultaneous linear equations. They |          | <b>Benchmarks for Grades 11–12</b><br><br><b>Benchmark I: Advanced Algebraic Structures and Number Systems</b><br>Students will extend their understanding of algebraic and numerical structures by working with real and complex numbers, sequences, series, and algebraic expressions in advanced mathematical contexts. They will use the properties of numbers and algebraic operations to simplify, transform, and analyze mathematical expressions, and apply these ideas to solve problems involving patterns, relationships, and generalizations.<br><br><b>Benchmark II: Functions, Rates of Change, and Mathematical Modeling</b><br>Students will develop a deeper understanding of functions and their applications in mathematical and real-life situations. They will analyze different types of functions, including linear, polynomial, rational, exponential, logarithmic, and trigonometric functions, and interpret their behavior through algebraic, graphical, and numerical representations. Students will determine and interpret the rate of change of functions where appropriate, and use this understanding to describe variation, growth, decay, periodic behavior, and other mathematical relationships. They will also use functions and mathematical models to represent, analyze, and solve contextual problems.<br><br><b>Benchmark III: Matrices, Vectors, and Systems of Equations</b><br>Students will use matrices and vectors as mathematical tools for representing quantities, transformations, and systems. They will perform operations on matrices and vectors, apply determinants and inverses where applicable, solve systems of linear equations, and interpret results in mathematical and applied contexts. This benchmark supports students in connecting algebraic methods with geometric and real-world representations. |          |



will also connect matrix methods with other algebraic approaches to problem solving.

#### **Benchmark IV: Calculus and Analytical Reasoning**

Students will develop an understanding of limits, differentiation, and integration as fundamental tools for analyzing change, accumulation, and functional behavior. They will apply differentiation to determine rates of change, tangents, normal, increasing and decreasing behavior, maxima and minima, and other related applications. They will use integration to find anti-derivatives, areas, and solve problems involving accumulation and simple differential equations.

#### **Benchmark V: Numerical and Analytical Problem Solving**

Students will apply analytical and numerical methods to solve mathematical problems that cannot always be solved by elementary algebraic techniques. They will use simple iterative methods to approximate solutions of nonlinear equations, interpret the accuracy of results, and select appropriate mathematical strategies for solving problems. This benchmark develops students' ability to combine algebraic reasoning, calculus-based methods, and numerical approaches in advanced studies.

## Student Learning Outcomes

### Real Numbers

[SLO: M-09-A-01]:

Recall the set of real numbers.

Cognitive Level: Remembering

[SLO: M-09-A-02]:

Understand the properties of equality and inequality of real numbers.

Cognitive Level: Understanding

[SLO: M-09-A-03]:

Apply laws of indices to simplify radical expressions and surds.

Cognitive Level: Applying

[SLO: M-09-A-04]:

Express a number in scientific notation and vice versa.

Cognitive Level: Understanding

[SLO: M-09-A-05]:

Recognize logarithm of a number.

Cognitive Level: Remembering

[SLO: M-09-A-06]:

Define common logarithm, characteristics and mantissa of log of a number.

Cognitive Level: Remembering

[SLO: M-09-A-07]:

Differentiate between common and natural logarithm.

Cognitive Level: Understanding

### Complex Numbers

[SLO: M-10-A-01]:

Recognize complex number, its conjugate and modulus.

Cognitive Level: Remembering

[SLO: M-10-A-02]:

Perform basic algebraic operations on complex numbers.

Cognitive Level: Understanding

[SLO: M-10-A-03]:

Recognize the condition for equality of two complex numbers.

Cognitive Level: Remembering

[SLO: M-10-A-04]:

Apply and verify the fundamental properties of complex numbers under addition and multiplication, including closure, commutative, associative, identity, inverse, and distributive properties.

Cognitive Level: Applying

[SLO: M-10-A-05]:

Verify the following properties of a complex number  $z$  (e.g.  $z = 2 + 3i$ )

$$\bar{\bar{z}} = z, |z| = |-z| = |\bar{z}| = |-\bar{z}|$$

$$z\bar{z} = |z|^2, \overline{z_1 + z_2} = \bar{z}_1 + \bar{z}_2$$

$$\overline{z_1 z_2} = \bar{z}_1 \bar{z}_2, \overline{\left(\frac{z_1}{z_2}\right)} = \frac{\bar{z}_1}{\bar{z}_2}, z_2 \neq 0$$

Cognitive Level: Evaluating

### Complex Numbers

[SLO: M-11-A-01]:

Define simultaneous linear equations with complex coefficients.

Cognitive Level: Remembering

[SLO: M-11-A-02]:

Solve simultaneous linear Equations with complex coefficients.

For example:

$$5z - (3 + i)w = 7 - i$$

$$(2 - i)z + 2iw = -1 + i$$

Cognitive Level: Applying

[SLO: M-11-A-03]:

Write a polynomial  $P(z)$  as product of linear factors.

For example:

$$(i) \quad z^2 + a^2 = (z + ia)(z - ia)$$

$$(ii) \quad z^3 - 3z^2 + z + 5 = (z + 1)(z - 2 - i)(z - 2 + i)$$

Cognitive Level: Understanding

[SLO: M-11-A-04]:

Solve quadratic equations of the form

$$pz^2 + qz + r = 0, (p \neq 0)$$

by completing the square, where  $p, q, r$  are real numbers and  $z$  a complex number. For example:

$$z^2 - 2z + 5 = 0$$

$$(z - 1 - 2i)(z - 1 + 2i) = 0$$

Cognitive Level: Applying

|                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |  |
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| <p><b>SLO: M-09-A-08]:</b><br/>Define antilog of a number.<br/>Cognitive Level: Remembering</p> <p><b>SLO: M-09-A-09]:</b><br/>Find common logarithm and antilogarithm of a number.<br/>Cognitive Level: Applying</p> <p><b>[SLO: M-09-A-10]:</b><br/>Apply laws of logarithms to real life situations.<br/>Cognitive Level: Applying</p> | <p><b>[SLO: M-10-A-06]:</b><br/>Separate real and imaginary parts from complex numbers of the type:</p> <p>(i) <math>(x + iy)^n, n = 1, 2</math><br/>(ii) <math>\frac{x_1 + iy_1}{x_2 + iy_2}, x_2 + iy_2 \neq 0</math></p> <p>Cognitive Level: Analyzing</p> <p><b>[SLO: M-10-A-07]:</b><br/>Interpret complex numbers geometrically on the Argand plane and determine their modulus as the distance from the origin.<br/>Cognitive Level: Understanding</p>                   | <p><b>[SLO: M-11-A-05]:</b><br/>Explain the polar coordinate system and represent a complex number in polar form.<br/>Cognitive Level: Understanding</p> <p><b>[SLO: M-11-A-06]:</b><br/>Apply operations with complex numbers in polar form.<br/>Cognitive Level: Applying</p> <p><b>[SLO: M-11-A-07]:</b><br/>Solve simple equations involving complex numbers in polar form.<br/>Cognitive Level: Applying</p> <p><b>[SLO: M-11-A-08]:</b><br/>Apply complex numbers to solve real life situations.<br/>Cognitive Level: Applying</p> |  |
|                                                                                                                                                                                                                                                                                                                                           | <p><b>Matrices and Determinants</b></p> <p><b>[SLO: M-10-A-08]:</b><br/>Display information in the form of matrix and identify its order.<br/>Cognitive Level: Understanding</p> <p><b>[SLO: M-10-A-09]:</b><br/>Identify various types of matrices.<br/>Cognitive Level: Remembering</p> <p><b>[SLO: M-10-A-10]:</b><br/>Solve situations involving sum, difference (up to order: 3 by 3) and product of two matrices (up to order: 2 by 2).<br/>Cognitive Level: Applying</p> | <p><b>Matrices and Determinants</b></p> <p><b>[SLO: M-11-A-09]:</b><br/>Apply operations on matrices (addition, subtraction and multiplication) with real and complex entries.<br/>Cognitive Level: Applying</p> <p><b>[SLO: M-11-A-10]:</b><br/>Evaluate the determinant of a 3 by 3 matrix using cofactors and properties of determinants.<br/>Cognitive Level: Evaluating</p> <p><b>[SLO: M-11-A-11]:</b><br/>Use row operations to find the inverse and rank of a matrix.<br/>Cognitive Level: Applying</p>                          |  |



|  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |  |
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|  | <p><b>[SLO: M-10-A-11]:</b><br/>Calculate the product of the scalar quantity and a matrix.<br/>Cognitive Level: Applying</p> <p><b>[SLO: M-10-A-12]:</b><br/>Evaluate the determinant and inverse of a matrix of order 2 by 2.<br/>Cognitive Level: Evaluating</p> <p><b>[SLO: M-10-A-13]:</b><br/>Analyze the matrix inversion method and Cramer's rule for solving simultaneous linear equations in two variables.<br/>Cognitive Level: Analyzing</p> <p><b>[SLO: M-10-A-14]:</b><br/>Apply matrices to solve real life situations.<br/>Cognitive Level: Applying</p> | <p><b>[SLO: M-11-A-12]:</b><br/>Explain consistent and inconsistent systems of linear equations and demonstrate through examples.<br/>Cognitive Level: Understanding</p> <p><b>[SLO: M-11-A-13]:</b><br/>Solve a system of 3 by 3 linear equations using</p> <ul style="list-style-type: none"> <li>(i) matrix inversion method.</li> <li>(ii) Cramer's Rule.</li> <li>(iii) Gauss elimination method.</li> <li>(iv) Gauss Jordan method.</li> </ul> <p>Cognitive Level: Applying</p> <p><b>[SLO: M-11-A-14]:</b><br/>Analyze how matrices can be used to solve real-life situations.<br/>Cognitive Level: Applying</p> |  |
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| <p><b>Sets and Relations</b><br/>[SLO: M-09-A-11]:<br/>Apply set operations on three sets (subsets, overlapping sets and disjoint sets), using Venn diagrams.<br/>Cognitive Level: Applying<br/>[SLO: M-09-A-12]:<br/>Apply properties/laws of union and intersection of three sets through Venn diagrams.<br/>Cognitive Level: Applying<br/>[SLO: M-09-A-13]:<br/>Apply set theory to real life situations.<br/>Cognitive Level: Applying<br/>[SLO: M-09-A-14]:<br/>Explain Cartesian product and Binary Relations.<br/>Cognitive Level: Understanding<br/>[SLO: M-09-A-15]:<br/>Find domain and range of given binary relation.<br/>Cognitive Level: Understanding<br/>[SLO: M-09-A-16]:<br/>Interpret the representation of a relation using tables, ordered pairs, and graphs.<br/>Cognitive Level: Understanding</p> | <p><b>Functions and Graphs</b><br/>[SLO: M-10-A-15]:<br/>Recognize function, its notation and determine its value.<br/>Cognitive Level: Understanding<br/>[SLO: M-10-A-16]:<br/>Identify types of functions (one-to-one/injective, onto/surjective, and bijective) using mapping diagrams.<br/>Cognitive Level: Remembering<br/>[SLO: M-10-A-17]:<br/>Explain algebraic operations on functions.<br/>Cognitive Level: Understanding<br/>[SLO: M-10-A-18]:<br/>Evaluate composite functions using the definition<br/><math>(f \circ g)(x) = f(g(x))</math>.<br/>Cognitive Level: Evaluating<br/>[SLO: M-10-A-19]:<br/>Plot graphs of constant function, identity function, linear function and absolute valued functions.<br/>Cognitive Level: Applying<br/>[SLO: M-10-A-20]:<br/>Apply functions and graphs to solve real life situations.<br/>Cognitive Level: Applying</p> | <p><b>Sequences and Series</b><br/>[SLO: M-11-A-15]:<br/>Solve problems by analyzing arithmetic sequences, mean and series up to n-terms.<br/>Cognitive Level: Analyzing<br/>[SLO: M-11-A-16]:<br/>Solve problems by analyzing geometric sequences, mean and series up to n-terms.<br/>Cognitive Level: Analyzing<br/>[SLO: M-11-A-17]:<br/>Solve problems by analyzing harmonic sequences and mean up to n-terms.<br/>Cognitive Level: Analyzing<br/>[SLO: M-11-A-18]:<br/>Recognize the given sequence as arithmetic or geometric sequence.<br/>Cognitive Level: Remembering<br/>[SLO: M-11-A-19]:<br/>Explain the method for determining the sum of:<br/> <ul style="list-style-type: none"> <li>the first <math>n</math> natural numbers (<math>\sum n</math>),</li> <li>the squares of first <math>n</math> natural numbers (<math>\sum n^2</math>),</li> <li>the cubes of first <math>n</math> natural numbers (<math>\sum n^3</math>).</li> </ul> Cognitive Level: Understanding<br/>[SLO: M-11-A-20]:<br/>Find sum to n-terms and sum to infinite number of terms of given sequence, using sigma notation.<br/>Cognitive Level: Applying</p> | <p><b>Functions and Graphs</b><br/>[SLO: M-12-A-01]:<br/>Recognize linear, quadratic and square root functions.<br/>Cognitive Level: Remembering<br/>[SLO: M-12-A-02]:<br/>Define inverse functions and illustrate their domain and range with examples.<br/>Cognitive Level: Understanding<br/>[SLO: M-12-A-03]:<br/>Plot graph of the function <math>y = ax^n</math> where <math>n</math> is<br/> <ul style="list-style-type: none"> <li><math>a + ve</math> integer,</li> <li><math>a - ve</math> integer and <math>x \neq 0</math>,</li> <li>a rational number for <math>x &gt; 0</math>.</li> </ul> Cognitive Level: Applying<br/>[SLO: M-12-A-04]:<br/>Plot the graph of a quadratic function of the form <math>y = ax^2 + bx + c</math>, (<math>a \neq 0, b, c</math> are integers)<br/> <ol style="list-style-type: none"> <li>Using direct method,</li> <li>Factor method.</li> </ol> Cognitive Level: Applying<br/>[SLO: M-12-A-05]:<br/>Identify, sketch and interpret graphs of:<br/> <ul style="list-style-type: none"> <li>linear functions</li> <li>quadratic functions</li> <li><math>y = ax^n</math> where <math>n</math> is an integer or a rational number for <math>x &gt; 0</math>.</li> <li>reciprocal and exponential</li> </ul> </p> |
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|  |  | <p><b>[SLO: M-11-A-21]:</b><br/>         Apply sequence and series to solve real life situations.<br/>         Cognitive Level: Applying</p> | <p>functions.<br/>         Cognitive Level: Understanding<br/> <b>[SLO: M-12-A-06]:</b><br/>         Predict functions (linear and quadratic) from their graphs. (Use factor form to predict equation of function of the type: <math>(x) = ax^2 + bx + c</math>, (<math>a \neq 0</math>) if two points where the graph crosses x-axis and third point on the curve are given).<br/>         Cognitive Level: Understanding<br/> <b>[SLO: M-12-A-07]:</b><br/>         Analyze the intersection point graphically when intersection occurs between:</p> <ul style="list-style-type: none"> <li>• a linear function and coordinate axes,</li> <li>• two linear functions,</li> <li>• a linear and a quadratic function.</li> </ul> <p>Cognitive Level: Analyzing<br/> <b>[SLO: M-12-A-08]:</b><br/>         Solve graphically real life problems using linear and quadratic functions.<br/>         Cognitive Level: Applying<br/> <b>SLO: M-12-A-09]:</b><br/>         Analyze the graphs of exponential and logarithmic functions, describing their domain and range.<br/>         Cognitive Level: Analyzing</p> |
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## Factorization

[SLO: M-09-A-17]:

Recall factorization of expressions of the following types:

- (i)  $ka + kb + kc$
- (ii)  $ac + ad + bc + bd$
- (iii)  $a^2 \pm 2ab + b^2$
- (iv)  $a^2 - b^2$
- (v)  $a^2 \pm 2ab + b^2 - c^2$

(Guidelines for authors: Include an exercise covering all above types to factorize.)

Cognitive Level: Remembering

[SLO: M-09-A-18]:

Factorize biquadratic and cubic algebraic expressions:

Type I:

$$a^4 + a^2b^2 + a^4 \text{ or } a^4 + 4b^4$$

Type II:

$$x^2 + px + q, ax^2 + bx + c$$

Type III:

- $(ax^2 + bx + c)$   
 $(ax^2 + bx + d) + k$
- $(x + a)(x + b)(x + c)$   
 $(x + d) + k$
- $(x + a)(x + b)$   
 $(x + c)(x + d) + kx^2$

Type IV:

$$a^3 \pm 3a^2b + 3ab^2 \pm b^3$$

Type V:  $a^3 \pm b^3$

Cognitive Level: Applying

## Algebraic Fractions

[SLO: M-10-A-21]:

Describe rational expressions.

Cognitive Level: Understanding

[SLO: M-10-A-22]:

Factorize and simplify rational expressions.

Cognitive Level: Applying

[SLO: M-10-A-23]:

Demonstrate manipulation of algebraic fractions.

Cognitive Level: Applying

[SLO: M-10-A-24]:

Perform operations on rational expressions (limited to numerators and denominators that are monomials, binomials, or trinomials).

Cognitive Level: Applying

[SLO: M-10-A-25]:

Apply rational equations (limited to numerators and denominators that are monomials, binomials, or trinomials) to real life situations.

Cognitive Level: Applying

## Mathematical Induction and Binomial Theorem

[SLO: M-11-A-22]:

Recognize mathematical induction.

Cognitive Level: Remembering

[SLO: M-11-A-23]:

Apply the principle of mathematical induction to prove statements, identities, divisibility of numbers and summation formulae.

Cognitive Level: Applying

[SLO: M-11-A-24]:

State and apply the Binomial Theorem to expand expressions of the form  $(a + b)^n$ , where  $n$  is a positive integer.

Cognitive Level: Applying

[SLO: M-11-A-25]:

Explain how Pascal's triangle is used to determine binomial coefficients.

Cognitive Level: Understanding

[SLO: M-11-A-26]:

Expand expression of the form  $(1 + x)^n$  by using Binomial series, where  $n$  is negative integer or fraction.

Cognitive Level: Applying

[SLO: M-11-A-27]:

Expand expressions using Binomial Theorem and series to solve appropriate problems.

Cognitive Level: Applying

[SLO: M-12-A-10]:

Solve real life problems that involve exponential and logarithmic equations.

Cognitive Level: Applying

[SLO: M-12-A-11]:

Demonstrate transformations of a graph, including horizontal shifts, vertical shifts, and scaling.

Cognitive Level: Applying

## Limit and Continuity of a Function

[SLO: M-12-A-12]:

Recognize and find the limit of a function.

Cognitive Level: Understanding

[SLO: M-12-A-13]:

State and apply theorems on the limits of the sum, difference, product, and quotient of functions to algebraic, exponential, and trigonometric functions.

Cognitive Level: Applying

[SLO: M-12-A-14]:

Test continuity and discontinuity of a function at a point and in an interval.

Cognitive Level: Evaluating

### Division of Polynomial

[SLO: M-09-A-19]:

Apply remainder theorem and factor theorem to factorize cubic polynomials.

Cognitive Level: Applying

[SLO: M-09-A-20]:

Apply synthetic division to factorize cubic and quartic polynomials.

Cognitive Level: Applying

[SLO: M-09-A-21]:

Describe how the highest common factor (HCF) and least common multiple (LCM) of algebraic expressions are determined.

Cognitive Level: Understanding

[SLO: M-09-A-22]:

Describe the relationship between HCF and LCM.

Cognitive Level: Understanding

[SLO: M-09-A-23]:

Explain how square root of algebraic expressions can be found by factorization and division.

Cognitive Level: Understanding

[SLO: M-09-A-24]:

Apply factorization of quadratic and cubic algebraic expressions to real life situations.

Cognitive Level: Applying

[SLO: M-11-A-28]:

Find an approximate value of an expression using the Binomial Theorem.

Cognitive Level: Applying

[SLO: M-11-A-29]:

Use Binomial Theorem to find the remainder when a number to some large exponent is divided by a number.

Cognitive Level: Applying

[SLO: M-11-A-30]:

Use Binomial Theorem to find the last digit of a number, test the divisibility by a number and compare two large numbers. (Guidelines for author and paper setter: Questions should be level appropriate.)

Cognitive Level: Applying

[SLO: M-11-A-31]:

Formulate and solve real-life problems using mathematical induction, Binomial Theorem, and Binomial series.

Cognitive Level: Creating

### Differentiation

[SLO: M-12-A-15]:

Recognize the tangent to the curve at a point.

Cognitive Level: Remembering

[SLO: M-12-A-16]:

Calculate the gradient of a curve at a point and recognize the derivative as a rate of change of a function (as a limit of difference quotient).

Cognitive Level: Applying

[SLO: M-12-A-17]:

Calculate the derivative of a given function at a point.

Cognitive Level: Applying

[SLO: M-12-A-18]:

Estimate the derivative as a rate of change of velocity, temperature and profit.

Cognitive Level: Evaluating

[SLO: M-12-A-19]:

Apply rates of change to displacement, velocity and acceleration of an object moving along a straight line.

Cognitive Level: Applying

[SLO: M-12-A-20]:

Recognize the derivative of a function and find the derivative of algebraic functions by using first principle.

Cognitive Level: Applying



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|  |  |  | <p><b>[SLO: M-12-A-21]:</b><br/>State, prove, and apply the constant, coefficient, power, sum and difference, product, and quotient rules of differentiation.<br/>Cognitive Level: Applying</p> <p><b>[SLO: M-12-A-22]:</b><br/>Find the derivative of a polynomial or rational function by combining differentiation rules.<br/>Cognitive Level: Applying</p> <p><b>[SLO: M-12-A-23]:</b><br/>Find the derivatives of trigonometric, inverse trigonometric, exponential and logarithmic functions.<br/>Cognitive Level: Applying</p> <p><b>[SLO: M-12-A-24]:</b><br/>Apply differentiation to state increasing and decreasing functions.<br/>Cognitive Level: Applying</p> <p><b>[SLO: M-12-A-25]:</b><br/>Apply differentiation to find equations of tangent and normal to a curve at a point.<br/>Cognitive Level: Applying</p> <p><b>[SLO: M-12-A-26]:</b><br/>Apply differentiation to real world situations.<br/>Cognitive Level: Applying</p> |
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|  |  |  | <p><b>[SLO: M-12-A-27]:</b><br/>Explain differentials and illustrate their use in approximating the change in a quantity.<br/>Cognitive Level: Applying</p> <p><b>[SLO: M-12-A-28]:</b><br/>Calculate the relative error and percentage error in using a differential approximation (e.g., volume of a cube and a sphere).<br/>Cognitive Level: Applying</p> <p><b>Higher Order Derivatives</b></p> <p><b>[SLO: M-12-A-29]:</b><br/>Explain the procedure of finding higher order derivatives of algebraic, implicit, parametric, trigonometric, inverse trigonometric, exponential and logarithmic functions.<br/>Cognitive Level: Understanding</p> <p><b>[SLO: M-12-A-30]:</b><br/>Illustrate global extrema (absolute extrema) and local extrema (relative extrema).<br/>Cognitive Level: Understanding</p> <p><b>[SLO: M-12-A-31]:</b><br/>Explain how the second derivative test is used to determine the extreme values of a function.<br/>Cognitive Level: Understanding</p> <p><b>[SLO: M-12-A-32]:</b><br/>Find the critical points of a function over a closed interval.<br/>Cognitive Level: Applying</p> |
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|  |  |  | <p><b>[SLO: M-12-A-33]:</b><br/>Use critical points to locate absolute extrema over a closed interval.<br/>Cognitive Level: Applying</p> <p><b>[SLO: M-12-A-34]:</b><br/>Apply derivatives to find maximum and minimum value of a function under certain conditions.<br/>Cognitive Level: Applying</p> <p><b>[SLO: M-12-A-35]:</b><br/>Apply higher order derivatives to solve real life situations.<br/>Cognitive Level: Applying</p> <p><b>Indefinite Integrals</b></p> <p><b>[SLO: M-12-A-36]:</b><br/>Determine the general antiderivative of a given function.<br/>Cognitive Level: Understanding</p> <p><b>[SLO: M-12-A-37]:</b><br/>Recognize standard terms and notations for antiderivatives.<br/>Cognitive Level: Remembering</p> <p><b>[SLO: M-12-A-38]:</b><br/>State the power rule for integration.<br/>Cognitive Level: Remembering</p> <p><b>[SLO: M-12-A-39]:</b><br/>State the properties of indefinite integrals.<br/>Cognitive Level: Remembering</p> |
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|  |  |  | <p><b>[SLO: M-12-A-40]:</b><br/>Integrate functions involving trigonometric, exponential and logarithmic functions.<br/>Cognitive Level: Applying</p> <p><b>[SLO: M-12-A-41]:</b><br/>Solve integration problems using trigonometric substitution.<br/>Cognitive Level: Applying</p> <p><b>[SLO: M-12-A-42]:</b><br/>Identify situations where integration by parts is applicable and apply it to solve appropriate problems.<br/>Cognitive Level: Applying</p> <p><b>[SLO: M-12-A-43]:</b><br/>Integrate a rational function using the method of partial fractions.<br/>(Guideline for authors: Add one exercise on the concept of partial fractions before the topic.)<br/>Cognitive Level: Applying</p> <p><b>[SLO: M-12-A-44]:</b><br/>Apply differentiation and integration with respect to time to solve simple problems concerning displacement, velocity and acceleration.<br/>Cognitive Level: Applying</p> |
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|  |  |  | <p><b>Definite Integrals</b></p> <p><b>[SLO: M-12-A-45]:</b><br/> Define a definite integral and the terms integrand, limits of integration and variable of integration.<br/> Cognitive Level: Remembering</p> <p><b>[SLO: M-12-A-46]:</b><br/> State the properties of definite integrals.<br/> Cognitive Level: Remembering</p> <p><b>[SLO: M-12-A-47]:</b><br/> State the Fundamental Theorem of Calculus to evaluate definite integrals.<br/> Cognitive Level: Remembering</p> <p><b>[SLO: M-12-A-48]:</b><br/> Find the area of a region bounded by a curve and lines parallel to the axes, between a curve and a line, or between two curves.<br/> Cognitive Level: Applying</p> <p><b>[SLO: M-12-A-49]:</b><br/> Apply integrals to solve real life situations.<br/> Cognitive Level: Applying</p> |
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## Linear Equations and Inequalities

[SLO: M-09-A-25]:

Recall linear equation in one variable and its solution.

Cognitive Domain: Remembering

[SLO: M-09-A-26]:

Apply the properties of radicals to solve radical equations and verify the validity of their solutions.

Cognitive Level: Applying

[SLO: M-09-A-27]:

Explain the concept of absolute value in real and algebraic forms

Cognitive Level: Understanding

[SLO: M-09-A-28]:

Solve absolute valued linear equations in one variable.

Cognitive Level: Applying

[SLO: M-09-A-29]:

Solve linear inequalities in one variable with rational coefficients and represent solution set on a number line.

Cognitive Level: Applying

## Linear Inequalities

[SLO: M-10-A-26]:

Solve absolute valued inequalities in one variable and express the solution as a range of values on a number line.

Cognitive Level: Applying

[SLO: M-10-A-27]:

Interpret graphically the linear inequalities in two variables.

Cognitive Level: Applying

[SLO: M-10-A-28]:

Determine graphically the region bounded by up to three simultaneous linear inequalities of non-negative variables and shade the region bounded by them.

Cognitive Level: Applying

[SLO: M-10-A-29]:

Show the feasible region graphically in a system of linear inequalities.

Cognitive Level: Applying

## Differential Equations

[SLO: M-12-A-50]:

Identify and construct first order differential equations from practical situations.

Cognitive Level: Creating

[SLO: M-12-A-51]:

Solve first-order, first-degree differential equations of the following types:

- (i) Separable variable equations
- (ii) Homogeneous equations

Cognitive Level: Applying

[SLO: M-12-A-52]:

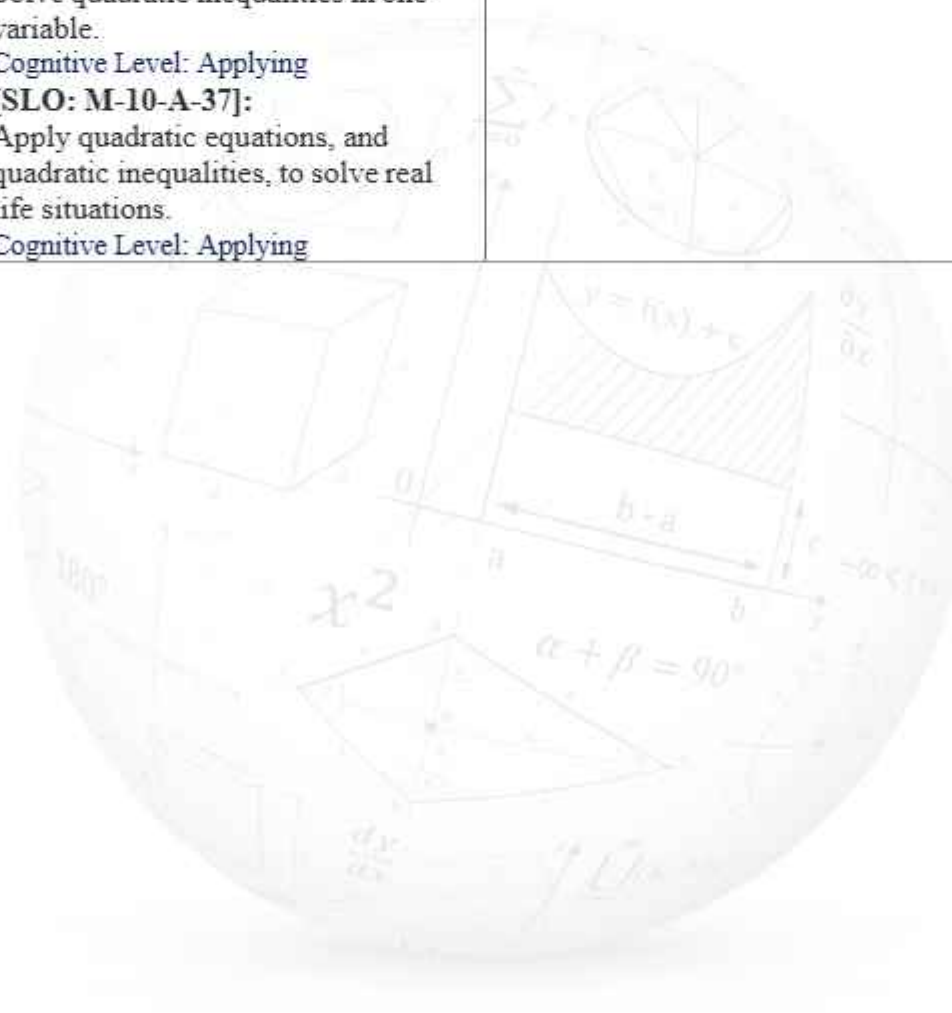
Apply first order differential equations to solve real life situations.

Cognitive Level: Applying



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| <p><b>[SLO: M-09-A-30]:</b><br/>Solve linear inequalities involving compound inequalities in one variable.<br/>Cognitive Level: Applying</p> | <p><b>Quadratic Equations and Inequalities</b></p> <p><b>[SLO: M-10-A-30]:</b><br/>Solve quadratic equations of the form <math>ax^2 + bx + c = 0</math>, <math>a \neq 0</math> using factorization, the quadratic formula, completing the square, and graphs (within given interval).<br/>Cognitive Level: Applying</p> <p><b>[SLO: M-10-A-31]:</b><br/>Examine equations that can be reduced to quadratic equations and solve them.<br/>Cognitive Level: Analyzing</p> <p><b>[SLO: M-10-A-32]:</b><br/>Interpret the relationship between roots and coefficients of quadratic equations.<br/>Cognitive Level: Understanding</p> <p><b>[SLO: M-10-A-33]:</b><br/>Form a quadratic equation when roots are given.<br/>Cognitive Level: Creating</p> <p><b>[SLO: M-10-A-34]:</b><br/>Identify nature of roots of quadratic equations using the discriminant.<br/>Cognitive Level: Understanding</p> <p><b>[SLO: M-10-A-35]:</b><br/>Solve a pair of:<br/>(i) Linear and quadratic equations simultaneously.<br/>(ii) Both quadratic equations simultaneously.</p> |  | <p><b>Numerical Solution of Nonlinear Equations</b></p> <p><b>[SLO: M-12-A-53]:</b><br/>Analyze the searching of roots of an equation by graphical means and/or searching for the sign change.<br/>Cognitive Level: Analyzing</p> <p><b>[SLO: M-12-A-54]:</b><br/>Explain the basic principles of solving a nonlinear equation in one variable.<br/>Cognitive Level: Understanding</p> <p><b>[SLO: M-12-A-55]:</b><br/>Calculate real roots of a nonlinear equation in one variable by Bisection method, Regular-Falsi method, Newton Raphson method.<br/>Cognitive Level: Applying</p> <p><b>[SLO: M-12-A-56]:</b><br/>Approximate definite integral by using:<br/>(i) Trapezoidal's rule.<br/>(ii) Simpson's 1/3 rule.<br/>Cognitive Level: Evaluating</p> <p><b>[SLO: M-12-A-57]:</b><br/>Apply nonlinear equations to solve real life situations.<br/>Cognitive Level: Applying</p> |
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|  | <p>(Guidelines for authors: Avoid solving one homogeneous and one non-homogeneous quadratic equation.)</p> <p>Cognitive Level: Applying</p> <p><b>[SLO: M-10-A-36]:</b></p> <p>Solve quadratic inequalities in one variable.</p> <p>Cognitive Level: Applying</p> <p><b>[SLO: M-10-A-37]:</b></p> <p>Apply quadratic equations, and quadratic inequalities, to solve real life situations.</p> <p>Cognitive Level: Applying</p> |  |  |
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## Grade Wise Suggested Classroom Activities (Domain A)

### Grade IX

**Real Number Line Activity:** Use a number line on the floor for students to place rational and irrational numbers.

**Scientific Notation Scavenger Hunt:** Students find very large/small numbers in science articles and convert them.

**Logarithm in Real Life:** Model population growth/decay using log graphs.

**Factorization Puzzle:** Select algebraic expressions to be matched with their factors.

**HCF/LCM of Expressions:** Use Venn diagrams to find HCF and LCM of algebraic terms.

**Algebraic Fractions Card Game:** Simplify fractions through a matching game.

### Grade X

**Complex Numbers Gallery Walk:** Stations with problems on conjugates, modulus, operations.

**Function Role-Play:** Students act as different functions (linear, quadratic, absolute value).

**Synthetic Division Relay:** Team race to divide polynomials using synthetic division.

**Quadratic Modelling:** Model projectile motion with quadratic equations using data from a ball toss.

### Grade XI

**Complex Numbers in Engineering:** Research and present on applications (e.g., AC circuits).

**Sequence Story Problems:** Create real-world stories using arithmetic/geometric sequences.

**Mathematical Induction Debate:** “Prove or disprove” session using induction

**Binomial Expansion Contest:** Expand expressions using Pascal’s triangle in teams.

### Grade XII

**Graph Intersection Lab:** Use graphing software to find intersection points of linear/quadratic functions.

**Derivative Car Race:** Use motion sensors to collect displacement data, then differentiate to find velocity.

**Optimization Challenge:** Design a box with maximum volume from a given sheet of paper.

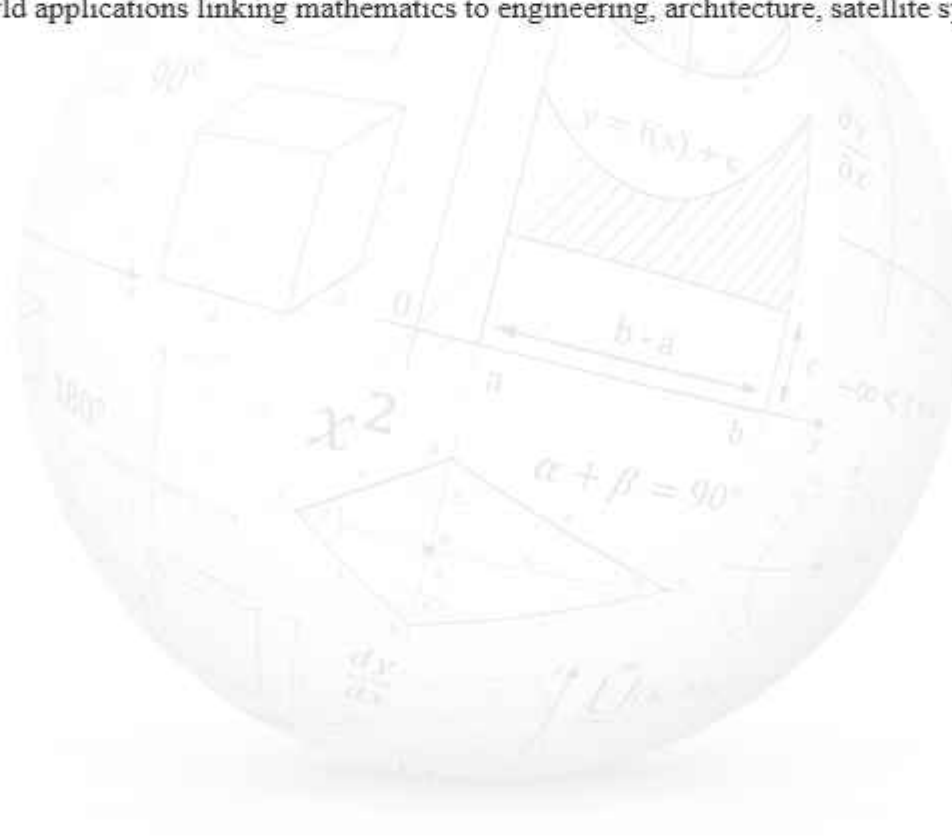
**Area Under Curve Art:** Use integration to calculate area of irregular shapes drawn by students.

**Numerical Methods Lab:** Use spreadsheet to solve equations via Bisection/Newton-Raphson method.



## Suggested Outdoor Activities (Domain A)

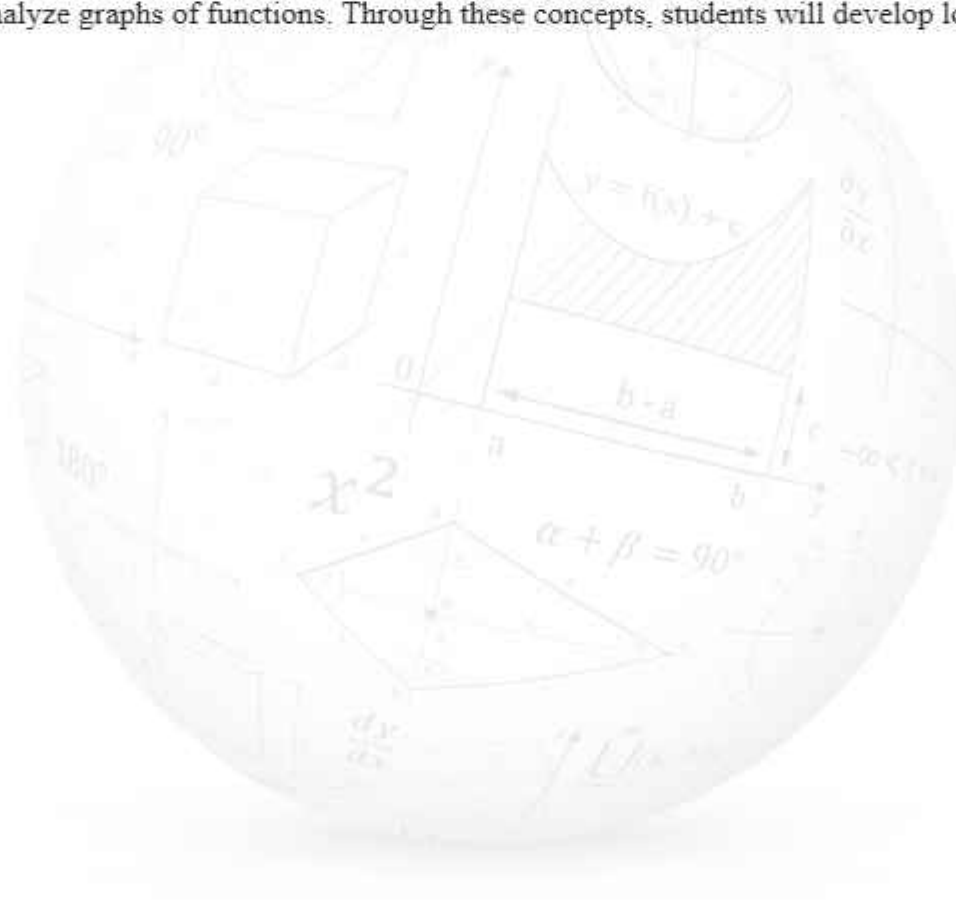
- Engage students in number line, sequence, and pattern placement activities on large-scale outdoor setups.
- Conduct scavenger hunts to identify real-life examples of numbers, sequences, or mathematical patterns.
- Use ground-based graphing to plot functions, linear/quadratic graphs, and Pascal's triangle.
- Organize team relay challenges to solve algebraic, polynomial, matrix, and function problems.
- Facilitate function role-play and motion-based modelling for linear, quadratic, trigonometric, and vector concepts.
- Implement projectile, optimization, and geometric construction challenges to connect theory with physical measurement.
- Apply integration and area estimation exercises through drawing and measurement of irregular shapes.
- Create stations for real-world applications linking mathematics to engineering, architecture, satellite systems, and physical phenomena.



## Domain B: Geometry

### Standard:

Students will be able to apply the characteristics and properties of points, lines, angles, triangles, quadrilaterals, parallelograms, and circles to establish and justify geometric relationships. They will use measurements of length, perimeter, area, circumference, surface area, and volume to solve real-world problems. They will also solve problems involving coordinate geometry, plane analytical geometry, and vectors; recognize and apply trigonometric identities; analyze conic sections; and draw, interpret, and analyze graphs of functions. Through these concepts, students will develop logical reasoning, geometric argumentation, and problem-solving skills.



| Grade 9                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Grade 10 | Grade 11                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Grade 12 |
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| <p><b>Benchmark I:</b> Students will be able to use and interpret Cartesian coordinates and vectors in two dimensions to determine distances, midpoints, gradients, equations of straight lines, angles between lines, and vector sums and differences, and apply these concepts to real-world problems involving navigation, map reading, and positioning.</p> <p><b>Benchmark II:</b> Students will be able to apply the properties of angles, triangle, regular polygons, and circles to calculate unknown measures, establish geometric relationships, construct logical arguments, and solve geometrical problems.</p> <p><b>Benchmark III:</b> Students will be able to calculate the surface area and volume of composite solids and use the relationships between the areas of similar figures and the volumes of similar solids to solve practical problems.</p> <p><b>Benchmark IV:</b> Students will be able to recognize and apply trigonometric identities, ratios, laws, and formulae to verify trigonometric relationships, solve triangles, and address relevant real-world problems.</p> |          | <p><b>Benchmark I:</b> Students will be able to analyze and solve problems involving straight lines and triangles in the coordinate plane. They will derive and transform equations of straight lines in different forms; determine gradients, intercepts, and angles between lines; investigate the concurrency of medians, altitudes, and angle bisectors; calculate the areas of triangular regions; analyze homogeneous linear and quadratic equations; and apply concepts of analytical geometry to real-world situations.</p> <p><b>Benchmark II:</b> Students will be able to identify and represent vectors in three-dimensional space and perform operations involving vector addition, subtraction, scalar multiplication, dot products, cross products, and scalar triple products. They will apply these concepts to determine angles, projections, areas, volumes, coplanarity, and other geometrical and physical relationships. Students will also differentiate and integrate vector-valued functions and use vector methods to solve relevant mathematical and real-world problems.</p> <p><b>Benchmark III:</b> Students will be able to recognize, derive, verify, and apply trigonometric identities and formulae; formulate and solve trigonometric equations within specified domains; and use appropriate trigonometric laws and relationships to solve mathematical and real-world problems. They will also draw, interpret, and analyze the graphs of trigonometric and inverse trigonometric functions, including their domains, ranges, periods, amplitudes, transformations, and key properties.</p> <p><b>Benchmark IV:</b> Students will be able to identify, represent, and analyze conic sections, including circles, parabolas, ellipses, and hyperbolas. They will determine their equations and key geometric properties and apply these concepts to solve mathematical and real-world problems.</p> |          |



## Student Learning Outcomes

### Coordinate Geometry

**[SLO: M-09-B-01]:**

Explain coordinate geometry.

Cognitive Level: Understanding

**[SLO: M-09-B-02]:**

Derive distance formula to calculate distance between two points.

Cognitive Level: Analyzing

**[SLO: M-09-B-03]:**

Apply distance formula by locating the position of two points in coordinate plane.

Cognitive Level: Applying

**[SLO: M-09-B-04]:**

Recognize the formula to find the mid-point of the line segment joining two points.

Cognitive Level: Remembering

**[SLO: M-09-B-05]:**

Calculate the midpoint of a line segment.

Cognitive Level: Applying

**[SLO: M-09-B-06]:**

Find the gradient of a straight line given the coordinates of two points.

Cognitive Level: Applying

**[SLO: M-09-B-07]:**

State the conditions for two straight lines to be parallel or perpendicular.

Cognitive Level: Remembering

### Coordinate Geometry

**[SLO: M-12-B-01]:**

Derive equation of a straight line in the slope intercept form, point slope form, two-point form, two intercepts form, symmetric form and normal form.

Cognitive Level: Analyzing

**[SLO: M-12-B-02]:**

Reduce the general form of the equation of a straight line to other standard forms.

Cognitive Level: Applying

**[SLO: M-12-B-03]:**

Find the equation of the family of lines passing through the point of intersection of two given lines.

Cognitive Level: Applying

**[SLO: M-12-B-04]:**

Find the angle between two coplanar intersecting straight lines.

Cognitive Level: Applying

**[SLO: M-12-B-05]:**

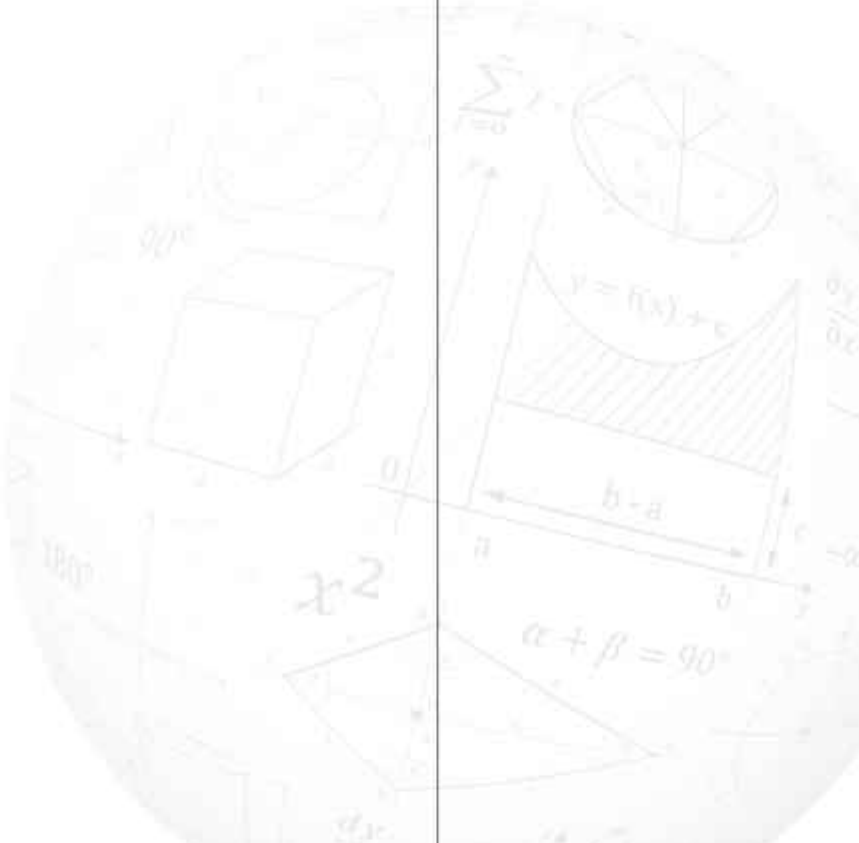
Calculate interior angles of the triangle when the slopes of the sides are given.

Cognitive Level: Applying

**[SLO: M-12-B-06]:**

Explain the condition of concurrency of three straight lines.

Cognitive Level: Understanding

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| <p><b>[SLO: M-09-B-08]:</b><br/>Check whether the given straight lines are parallel or perpendicular.<br/>Cognitive Level: Analyzing</p> <p><b>[SLO: M-09-B-09]:</b><br/>Apply coordinate geometry to solve real life situations.<br/>Cognitive Level: Applying</p> |  | <p><b>[SLO: M-12-B-07]:</b><br/>Construct the equation of median, altitude and right bisector of a triangle.<br/>Cognitive Level: Creating</p> <p><b>[SLO: M-12-B-08]:</b><br/>Investigate that the three perpendicular bisectors, the three medians, and the three altitudes of a triangle are concurrent.<br/>Cognitive Level: Analyzing</p> <p><b>[SLO: M-12-B-09]:</b><br/>Find the area of a triangular region whose vertices are given.<br/>Cognitive Level: Applying</p> <p><b>[SLO: M-12-B-10]:</b><br/>Recognize homogeneous linear and quadratic equations in two variables.<br/>Cognitive Level: Remembering</p> <p><b>[SLO: M-12-B-11]:</b><br/>Investigate that a second-degree equation in two variables represents a pair of straight lines through origin and find an acute angle between them.<br/>Cognitive Level: Analyzing</p> <p><b>[SLO: M-12-B-12]:</b><br/>Apply analytical geometry to solve real life situations.<br/>Cognitive Level: Applying</p> |
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|  | <p><b>Vectors in Plane</b></p> <p>[SLO: M-10-B-01]:<br/>Introduce the rectangular coordinate system in a plane.<br/>Cognitive Level: Remembering</p> <p>[SLO: M-10-B-02]:<br/>Represent vectors as directed line segments and express a vector in terms of its position vector.<br/>Cognitive Level: Understanding</p> <p>[SLO: M-10-B-03]:<br/>Express a vector in terms of two non-zero and non-parallel coplanar vectors.<br/>Cognitive Level: Understanding</p> <p>[SLO: M-10-B-04]:<br/>Express a translation using a vector.<br/>Cognitive Level: Understanding</p> <p>[SLO: M-10-B-05]:<br/>Explain the concept and method for determining the magnitude of a vector.<br/>Cognitive Level: Understanding</p> <p>[SLO: M-10-B-06]:<br/>Add and subtract vectors, and multiply a vector by a scalar.<br/>Cognitive Level: Understanding</p> <p>[SLO: M-10-B-07]:<br/>Solve geometric problems involving vectors.<br/>Cognitive Level: Applying</p> <p>[SLO: M-10-B-08]:<br/>Apply vectors in plane to solve real life situations.<br/>Cognitive Level: Applying</p> | <p><b>Vectors in Space</b></p> <p>[SLO: M-11-B-01]:<br/>Recognize the rectangular coordinate system in space.<br/>Cognitive Level: Remembering</p> <p>[SLO: M-11-B-02]:<br/>Recognize unit vectors <math>\hat{i}</math>, <math>\hat{j}</math> and <math>\hat{k}</math> as components of a vector.<br/>Cognitive Level: Remembering</p> <p>[SLO: M-11-B-03]:<br/>Explain the concept and method for determining the magnitude of a vector.<br/>Cognitive Level: Understanding</p> <p>[SLO: M-11-B-04]:<br/>Repeat all fundamental mathematical operations for vectors in space which, in the plane, have already been discussed.<br/>Cognitive Level: Understanding</p> <p>[SLO: M-11-B-05]:<br/>Understand:</p> <ol style="list-style-type: none"> <li>Commutative law for vector addition.</li> <li>Associative law for vector addition.</li> <li>0 as the identity for vector addition.</li> <li><math>-\underline{a}</math> as the additive inverse for <math>\underline{a}</math>.</li> </ol> <p>Cognitive Level: Understanding</p> | <p><b>Vector Valued Functions</b></p> <p>[SLO: M-12-B-13]:<br/>Explain the need for a vector-valued function.<br/>Cognitive Level: Understanding</p> <p>[SLO: M-12-B-14]:<br/>Construct a vector-valued function to represent a given vector or physical quantity.<br/>Cognitive Level: Creating</p> <p>[SLO: M-12-B-15]:<br/>Identify domain and range of vector valued functions.<br/>Cognitive Level: Understanding</p> <p>[SLO: M-12-B-16]:<br/>Identify difference between scalar and vector valued functions.<br/>Cognitive Level: Understanding</p> <p>[SLO: M-12-B-17]:<br/>Explain the derivative of a vector-valued function of a single variable and elaborate the result:<br/>If<br/> <math display="block">\underline{f}(t) = f_1(t)\underline{i} + f_2(t)\underline{j} + f_3(t)\underline{k}</math> where <math>f_1(t)</math>, <math>f_2(t)</math>, <math>f_3(t)</math> are differentiable functions of a scalar variable <math>t</math>, then<br/> <math display="block">\frac{d\underline{f}}{dt} = \frac{df_1}{dt}\underline{i} + \frac{df_2}{dt}\underline{j} + \frac{df_3}{dt}\underline{k}</math> Cognitive Level: Understanding</p> |
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|  | <p><b>[SLO: M-11-B-06]:</b><br/>Explain the dot (scalar) product of two vectors and provide its geometric interpretation.<br/>Cognitive Level: Understanding</p> <p><b>[SLO: M-11-B-07]:</b><br/>Express the dot product of two vectors in terms of their components.<br/>Cognitive Level: Understanding</p> <p><b>[SLO: M-11-B-08]:</b><br/>Understand the condition for orthogonality of two vectors.<br/>Cognitive Level: Understanding</p> <p><b>[SLO: M-11-B-09]:</b><br/>Use the dot product to find angle between two vectors.<br/>Cognitive Level: Applying</p> <p><b>[SLO: M-11-B-10]:</b><br/>Find the projection of a vector along another vector.<br/>Cognitive Level: Applying</p> <p><b>[SLO: M-11-B-11]:</b><br/>Find the work done by a constant force in moving an object along a given vector.<br/>Cognitive Level: Applying</p> <p><b>[SLO: M-11-B-12]:</b><br/>Explain the cross (vector) product of two vectors and provide its geometric interpretation.<br/>Cognitive Level: Understanding</p> <p><b>[SLO: M-11-B-13]:</b><br/>Apply a cross product to find the angle between two vectors and area parallelogram so formed.<br/>Cognitive Level: Applying</p> | <p><b>[SLO: M-12-B-18]:</b><br/>Apply vector differentiation to calculate velocity and acceleration of a position vector<br/><math>f(t) = x(t)\hat{i} + y(t)\hat{j} + z(t)\hat{k}</math><br/>Cognitive Level: Applying</p> <p><b>[SLO: M-12-B-19]:</b><br/>Apply vector-valued functions to solve real life situations.<br/>Cognitive Level: Applying</p> |
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|  |  | <p><b>[SLO: M-11-B-14]:</b><br/>Describe scalar triple product of vectors.<br/>Cognitive Level: Understanding</p> <p><b>[SLO: M-11-B-15]:</b><br/>Express scalar triple product of vectors in terms of components (determinant form).<br/>Cognitive Level: Understanding</p> <p><b>[SLO: M-11-B-16]:</b><br/>Understand that dot and cross are inter- changeable in scalar triple product. i.e.<br/> <math display="block">\hat{i} \cdot \hat{j} \times \hat{k} = \hat{j} \cdot \hat{k} \times \hat{i} = \hat{k} \cdot \hat{i} \times \hat{j} = 1</math> <math display="block">\hat{i} \cdot \hat{k} \times \hat{j} = \hat{j} \cdot \hat{i} \times \hat{k} = \hat{k} \cdot \hat{j} \times \hat{i} = -1</math> Cognitive Level: Understanding</p> <p><b>[SLO: M-11-B-17]:</b><br/>Find the volume of a parallelepiped, tetrahedron, determined by three given vectors.<br/>Cognitive Level: Applying</p> <p><b>[SLO: M-11-B-18]:</b><br/>Define coplanar vectors and determine the condition for three vectors to be coplanar.<br/>Cognitive Level: Understanding</p> <p><b>[SLO: M-11-B-19]:</b><br/>Apply vectors in space (including dot and cross product) to solve real life situations.<br/>Cognitive Level: Applying</p> |  |
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| <p><b>Trigonometry and Bearings</b><br/> <b>[SLO: M-09-B-10]:</b><br/> Identify angles in standard position, expressed in degrees and radians.<br/> Cognitive Level: Remembering<br/> <b>[SLO: M-09-B-11]:</b><br/> Apply the Pythagoras theorem and the sine, cosine, and tangent ratios for acute angles to find a side or an angle of a right-angled triangle.<br/> Cognitive Level: Applying<br/> <b>[SLO: M-09-B-12]:</b><br/> Prove the basic trigonometric identities.<br/> Cognitive Level: Creating<br/> <b>[SLO: M-09-B-13]:</b><br/> Apply basic trigonometric identities to find different relations.<br/> Cognitive Level: Applying<br/> <b>[SLO: M-09-B-14]:</b><br/> Apply trigonometric ratios (involving angle of elevation and depression) to solve real life situations.<br/> Cognitive Level: Applying<br/> <b>[SLO: M-09-B-15]:</b><br/> Interpret three figure bearings.<br/> Cognitive Level: Understanding<br/> <b>[SLO: M-09-B-16]:</b><br/> Apply bearing to solve real-life situations.<br/> Cognitive Level: Applying</p> | <p><b>Applications of Trigonometry</b><br/> <b>[SLO: M-10-B-09]:</b><br/> Extend the sine and cosine functions to angles between <math>90^\circ</math> and <math>180^\circ</math>.<br/> Cognitive Level: Applying<br/> <b>[SLO: M-10-B-10]:</b><br/> Solve problems using the laws of sine, cosine, and tangent, as well as the half-angle and area formulae for any triangle.<br/> Cognitive Level: Applying<br/> <b>[SLO: M-10-B-11]:</b><br/> Apply trigonometry to solve real life situations.<br/> Cognitive Level: Applying</p> | <p><b>Fundamental Law of Trigonometry</b><br/> <b>[SLO: M-11-B-20]:</b><br/> Establish The Fundamental Law of Trigonometry.<br/> Cognitive Level: Creating<br/> <b>[SLO: M-11-B-21]:</b><br/> Apply the fundamental law and its deductions to derive trigonometric ratios of allied angles, double angle, half angle and triple angle identities.<br/> Cognitive Level: Applying<br/> <b>[SLO: M-11-B-22]:</b><br/> Express products of sines and cosines as sums or differences of sines and cosines.<br/> Cognitive Level: Understanding<br/> <b>[SLO: M-11-B-23]:</b><br/> Solve simple trigonometric problems in three dimensions.<br/> Cognitive Level: Applying</p> <p><b>Trigonometric Functions</b><br/> <b>[SLO: M-11-B-24]:</b><br/> Explain the domain and range of trigonometric functions.<br/> Cognitive Level: Understanding<br/> <b>[SLO: M-11-B-25]:</b><br/> Define even, odd functions and the periodicity of trigonometric functions.<br/> Cognitive Level: Remembering</p> |  |
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|  |  | <p><b>[SLO: M-11-B-26]:</b><br/>Interpret the maximum and minimum value of a given function of the type:</p> <ul style="list-style-type: none"> <li>(i) <math>a + b \sin \theta</math>,</li> <li>(ii) <math>a + b \cos \theta</math>,</li> <li>(iii) <math>a + b \sin(c\theta + d)</math>,</li> <li>(iv) <math>a + b \cos(c\theta + d)</math>,</li> <li>(v) the reciprocals of above,</li> </ul> <p>where <math>a</math>, <math>b</math>, <math>c</math> and <math>d</math> are real numbers.<br/>Cognitive Level: Understanding</p> <p><b>Graphs of Trigonometric Functions</b></p> <p><b>[SLO: M-11-B-27]:</b><br/>Analyze the graphs of trigonometric functions sine, cosine, and tangent, and use them to solve problems.<br/>Cognitive Level: Analyzing</p> <p><b>[SLO: M-11-B-28]:</b><br/>Explain the properties of the graphs of sine, cosine, and tangent functions.<br/>Cognitive Level: Understanding</p> <p><b>[SLO: M-11-B-29]:</b><br/>Apply trigonometric functions, identities, graphs, periodicity, even odd functions, extreme values to solve real life situations.<br/>Cognitive Level: Applying</p> |  |
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## Inverse Trigonometric Functions

[SLO: M-11-B-30]:

Interpret domain and range of principal trigonometric functions and inverse trigonometric functions.

Cognitive Level: Understanding

[SLO: M-11-B-31]:

Draw the graphs of the inverse trigonometric functions of cosine, sine, tangent, secant, cosecant and cotangent within the domain from  $-2\pi$  to  $2\pi$ .

Cognitive Level: Applying

[SLO: M-11-B-32]:

State, prove and apply the addition and subtraction formulae of inverse trigonometric functions.

Cognitive Level: Applying

## Solution of Trigonometric Equations

[SLO: M-11-B-33]:

Solve trigonometric equations of the type:  $\sin\theta = k$ ,  $\cos\theta = k$  and  $\tan\theta = k$ , using periodic, even/odd and translation properties.

Cognitive Level: Applying

**[SLO: M-11-B-34]:**

Solve graphically the trigonometric equations of the type:  $\sin\theta = \alpha$ ,  
 $\cos\theta = \alpha$ ,  $\tan\theta = \alpha$

Where  $\alpha = \frac{\theta}{2}, \theta, 2\theta$

and  $-\pi/2 < \theta \leq \pi/2$

Cognitive Level: Applying

**[SLO: M-11-B-35]:**

Use the periods of trigonometric functions to find the general solution of the trigonometric equations.

Cognitive Level: Applying

**[SLO: M-11-B-36]:**

Apply inverse trigonometric functions and solution of trigonometric equations to solve real life situations.

Cognitive Level: Applying



## Loci and Polygons

[SLO: M-09-B-17]:

State the criteria for similarity of polygons.

Cognitive Level: Remembering

[SLO: M-09-B-18]:

Solve problems using the relationship between areas of similar figures.

Cognitive Level: Applying

[SLO: M-09-B-19]:

Solve problems using the relationship between volume of similar solids.

Cognitive Level: Applying

[SLO: M-09-B-20]:

Solve problems that involve the properties of regular polygons, triangles and parallelograms.

Cognitive Level: Applying

[SLO: M-09-B-21]:

Solve problems using the following loci and the method of intersecting loci for sets of points in two dimensions which are:

- at a given distance from a given point.
- at a given distance from a given straight line.
- equidistant from two given points.
- equidistant from two given intersecting straight lines.

Cognitive Level: Applying

## Chords and Arcs of a Circle

[SLO: M-10-B-12]:

Solve problems by using the property of a circle:

One and only one circle can pass through three non-collinear points.

Cognitive Level: Applying

[SLO: M-10-B-13]:

Solve problems by using the property of circle:

- A straight line, drawn from the centre of a circle to bisect a chord (which is not a diameter) is perpendicular to the chord.
- Perpendicular from the centre of a circle on a chord bisects it.

Cognitive Level: Applying

[SLO: M-10-B-14]:

Solve problems by using the property of circle:

- If two chords of a circle are congruent then they will be equidistant from the centre.
- Two chords of a circle which are equidistant from the centre are congruent.

Cognitive Level: Applying

## Analytical Geometry of Conic Sections

[SLO: M-12-B-20]:

Recognize the concept of conics and members of its family i.e. circle, parabola, ellipse and hyperbola.

Cognitive Level: Remembering

[SLO: M-12-B-21]:

Derive equation of a circle in standard form. i.e.

$$(x - h)^2 + (y - k)^2 = r^2$$

Cognitive Level: Analyzing

[SLO: M-12-B-22]:

Find the equation of a circle passing through:

- three non collinear points,
- two points and having its centre on a given line,
- two points and equation of tangent at one of these points is known,
- two points and touching a given line.

Cognitive Level: Applying

[SLO: M-12-B-23]:

Establish the condition when:

- a line intersects the circle.
- a line touches the circle.

Cognitive Level: Evaluating

[SLO: M-12-B-24]:

Find the equation of a tangent in slope form and normal to a circle at a point.

Cognitive Level: Applying

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|  | <p><b>[SLO: M-10-B-15]:</b><br/>Solve problems by using the property of circle:</p> <ul style="list-style-type: none"> <li>• If two arcs of a circle (or of congruent circles) are congruent then the corresponding chords are equal.</li> <li>• If two chords of a circle (or of congruent circles) are equal, then their corresponding arcs (minor, major or semi-circular) are congruent.</li> </ul> <p>Cognitive Level: Applying</p> <p><b>[SLO: M-10-B-16]:</b><br/>Solve problems by using the property of circle:</p> <ul style="list-style-type: none"> <li>• Equal chords of a circle (or of congruent circles) subtend equal angles at the centre (at the corresponding centres).</li> <li>• If the angles subtended by two chords of a circle (or congruent circles) at the centre (corresponding centres) are equal, the chords are equal.</li> </ul> <p>Cognitive Level: Applying</p> <p><b>[SLO: M-10-B-17]:</b><br/>Design real-life problems by using the concept of chords and arcs of a circle.<br/>Cognitive Level: Creating</p> |  | <p><b>[SLO: M-12-B-25]:</b><br/>Find the length of tangent to a circle from a given external point.<br/>Cognitive Level: Applying</p> <p><b>[SLO: M-12-B-26]:</b><br/>Derive the standard equations of parabola, ellipse and hyperbola, and find their key elements.<br/>Cognitive Level: Analyzing</p> <p><b>[SLO: M-12-B-27]:</b><br/>Sketch the graphs of parabola, ellipse and hyperbola, and label their key elements.<br/>Cognitive Level: Applying</p> <p><b>[SLO: M-12-B-28]:</b><br/>Convert a given equation to the standard form of an ellipse, determine its key elements, and sketch its graph.<br/>Cognitive Level: Applying</p> <p><b>[SLO: M-12-B-29]:</b><br/>Find the equation of a parabola with the following given key elements:</p> <ul style="list-style-type: none"> <li>• focus and vertex,</li> <li>• focus and directrix,</li> <li>• vertex and directrix.</li> </ul> <p>Cognitive Level: Applying</p> <p><b>[SLO: M-12-B-30]:</b><br/>Find the equation of an ellipse with the following given elements:</p> <ul style="list-style-type: none"> <li>• major and minor axes,</li> <li>• two points,</li> </ul> |
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## Tangent and Angles of a Circle

[SLO: M-10-B-18]:

Solve problems by using the property of circle:

- If a line is drawn perpendicular to a radial segment of a circle at its outer end point, it is tangent to the circle at that point.
- The tangent to a circle and the radial segment joining the point of contact and the centre are perpendicular to each other.

Cognitive Level: Applying

[SLO: M-10-B-19]:

Solve problems by using the property of circle:

The two tangents drawn to a circle from a point outside it, are equal in length.

Cognitive Level: Applying

[SLO: M-10-B-20]:

Solve problems by using the property of a circle:

If two circles touch externally or internally, the distance between their centres is respectively equal to the sum or difference of their radii.

Cognitive Level: Applying



- foci, vertices or lengths of a latera recta,
- foci, minor axes or length of a latus rectum.

Cognitive Level: Applying

[SLO: M-12-B-31]:

Find the equation of a hyperbola with the following given elements:

- transverse and conjugate axes with centre at origin.
- two points.
- eccentricity, latera recta and transverse axes.
- focus, eccentricity and centre.
- focus, centre and directrix.

Cognitive Level: Applying

[SLO: M-12-B-32]:

Establish the condition when a line is tangent to parabola, ellipse and hyperbola at a point.

Cognitive Level: Evaluating

[SLO: M-12-B-33]:

Find the equation of a tangent to parabola, ellipse and hyperbola in slope form.

Cognitive Level: Applying

[SLO: M-12-B-34]:

Find the equation of a tangent and normal to parabola, ellipse and hyperbola at a point.

Cognitive Level: Applying

[SLO: M-12-B-35]:

Apply conic sections to solve real-life situations.

Cognitive Level: Applying



**[SLO: M-10-B-21]:**

Solve problems by using the property of circle:

The measure of a central angle of a minor arc of a circle is double that of the angle subtended by the corresponding major arc.

Cognitive Level: Applying

**[SLO: M-10-B-22]:**

Solve problems by using the property of a circle:

Any two angles in the same segment of a circle are equal.

Cognitive Level: Applying

**[SLO: M-10-B-23]:**

Solve problems by using the property of circle:

The angle in a semi-circle is a right angle, in a segment greater than a semi-circle is less than a right angle, in a segment less than a semi-circle is greater than a right angle.

Cognitive Level: Applying

**[SLO: M-10-B-24]:**

Solve problems by using the property of circle:

The opposite angles of any quadrilateral inscribed in a circle are supplementary.

Cognitive Level: Applying

**[SLO: M-10-B-25]:**

Design real-life problems by using the concept of tangents and arcs of a circle.

Cognitive Level: Creating



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| <p><b>Practical Geometry of Triangles</b></p> <p><b>[SLO: M-09-B-22]:</b><br/>Construct a triangle given two of its sides and the angle opposite one of them, considering all three possible cases.<br/>Cognitive Level: Creating</p> <p><b>[SLO: M-09-B-23]:</b><br/>Draw angle bisectors, perpendicular bisectors, medians and altitudes of a given triangle and verify their concurrency. (Guidelines for authors and paper setters: Use SAS, SSS, HS, AAS for the construction of triangles.)<br/>Cognitive Level: Applying</p> | <p><b>Practical Geometry of Circles</b></p> <p><b>[SLO: M-10-B-26]:</b><br/>Locate the centre of a given circle.<br/>Cognitive Level: Understanding</p> <p><b>[SLO: M-10-B-27]:</b><br/>Draw a circle passing through three given non collinear points.<br/>Cognitive Level: Applying</p> <p><b>[SLO: M-10-B-28]:</b><br/>Complete the circle:</p> <ul style="list-style-type: none"> <li>• by finding the centre,</li> <li>• without finding the centre when a part of its circumference is given.</li> </ul> <p>Cognitive Level: Applying</p> <p><b>[SLO: M-10-B-29]:</b><br/>Draw a tangent to a given arc, without using the centre, through a given point P when P is</p> <ul style="list-style-type: none"> <li>• the middle point of the arc,</li> <li>• at the end of the arc,</li> <li>• outside the arc.</li> </ul> <p>Cognitive Level: Applying</p> <p><b>[SLO: M-10-B-30]:</b><br/>Draw a tangent to a given circle from a point P when P lies</p> <ul style="list-style-type: none"> <li>• on the circumference,</li> <li>• outside the circle.</li> </ul> <p>Cognitive Level: Applying</p> |  |  |
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|  | <p><b>[SLO: M-10-B-31]:</b><br/>         Draw two tangents to a circle that meet at a given angle, and construct the direct and transverse common tangents to two circles.</p> <p>Cognitive Level: Applying</p> <p><b>[SLO: M-10-B-32]:</b><br/>         Design real-life problems by using practical geometry of circles.</p> <p>Cognitive Level: Creating</p> |  |  |
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## Grade Wise Suggested Classroom Activities (Domain B)

### Grade IX

**Gradient Treasure Hunt:** Find slopes between points marked on the school field.

**Trigonometry Clinometer Project:** Measure heights of school buildings using clinometers.

**Triangle Construction Fair:** Use compass/ruler to construct triangles given SAS, SSS, etc.

### Grade X

**Vector Addition with String:** Use ropes to demonstrate vector addition in the classroom.

**Circle Property Posters:** Create posters illustrating circle theorems with proofs.

**Tangents Construction Contest:** Construct tangents to circles using geometric tools.

### Grade XI

**Work Done by Force:** Calculate work done using dot product with real weights/pulleys.

**Trigonometric Graphs Dance:** Use body movement to simulate sine/cosine waves.

**Trigonometric Equation Solving Tournament:** Compete to solve trigonometric equations.

### Grade XII

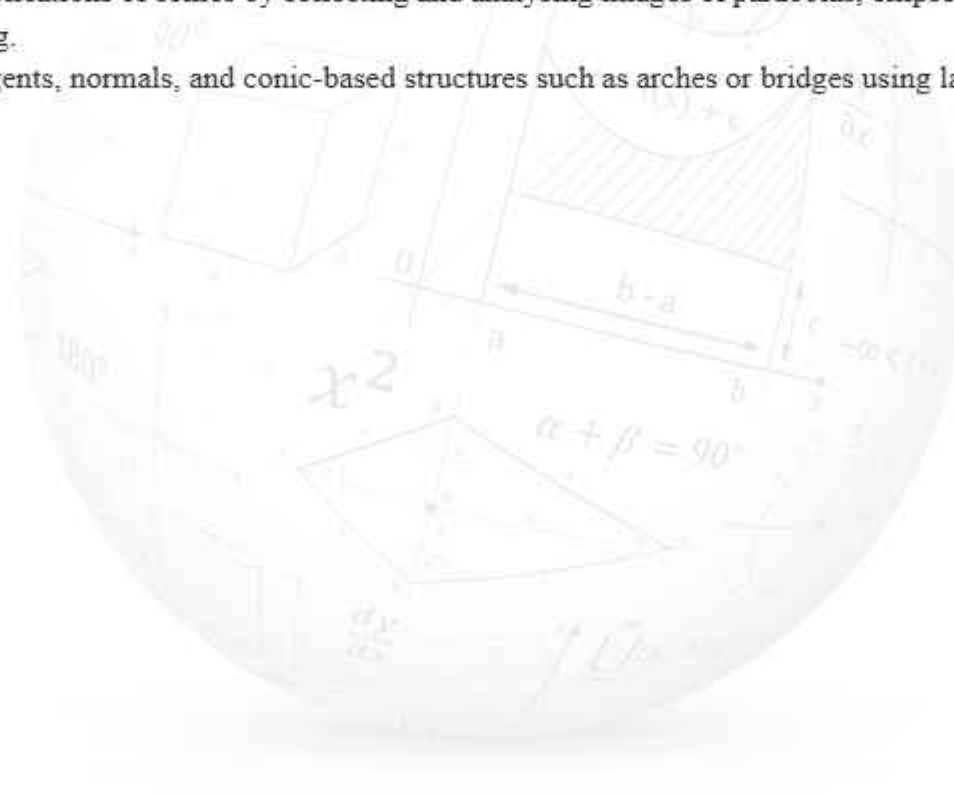
**Conics in Real Life:** Collect images of parabolas, ellipses, hyperbolas from architecture/nature.

**Tangent/Normal to Conics Lab:** Use GeoGebra to explore tangents to circles/parabolas.

**Conic Section Design Project:** Design a bridge/arch using parabolic equations.

## Suggested Outdoor Activities (Domain B)

- Conduct gradient and slope treasure hunts by measuring slopes between points in outdoor spaces.
- Use clinometers or other measurement tools to determine heights of buildings, trees, or poles.
- Organize triangle construction challenges on the ground using ropes, chalk, and geometric tools to explore SAS, SSS, and other cases.
- Demonstrate vector addition and subtraction using ropes, poles, or marked paths to visualize magnitude and direction.
- Plan circle and tangent construction exercises on large surfaces to illustrate circle properties and tangents.
- Implement dot product and work-related activities using real objects (weights, pulleys, ropes) to connect vectors with physical quantities.
- Simulate trigonometric functions with body movement or large-scale markings to understand sine, cosine, and tangent graphs.
- Conduct trigonometric problem-solving tournaments in outdoor stations for competitive and collaborative learning.
- Explore real-world applications of conics by collecting and analysing images of parabolas, ellipses, and hyperbolas from architecture, nature, and engineering.
- Design and model tangents, normals, and conic-based structures such as arches or bridges using large-scale outdoor setups or software-assisted projections.



## Domain C: Mathematical Statistics

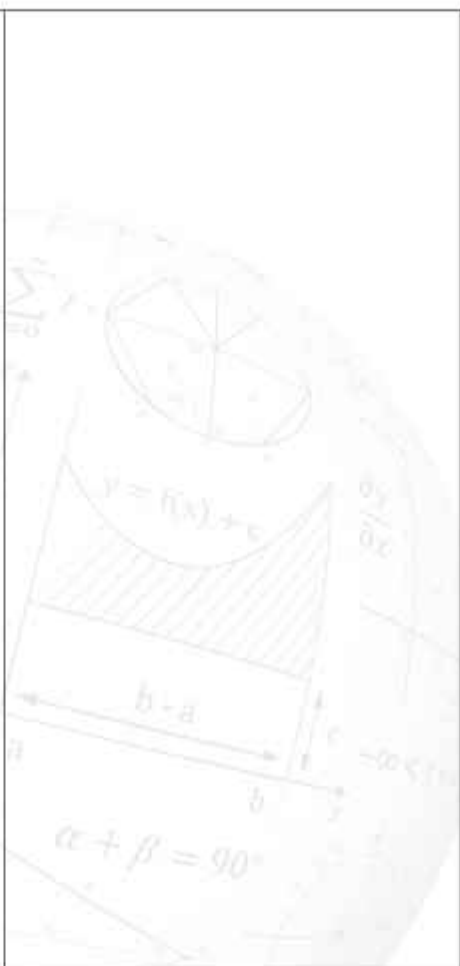
**Standard:** The students will be able to collect, organize, analyze, display and interpret data/ information.

| Grade 9                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Grade 10 | Grade 11                                                                                                                                                                                                                                                | Grade 12 |
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| <p><b>Benchmark I:</b> Students will be able to calculate and interpret measures of central tendency and dispersion, construct and analyze cumulative frequency curves, investigate correlation using scatter diagrams, and draw meaningful conclusions from statistical data.</p> <p><b>Benchmark II:</b> Students will be able to represent and predict the outcomes of single and combined events using appropriate diagrams, calculate the probabilities of simple and compound events, and apply probability concepts to mathematical and real-life situations.</p> |          | <p><b>Benchmark:</b> Students will be able to apply the fundamental counting principle, permutations, and combinations to solve mathematical problems and address a variety of real-life situations involving selection, arrangement, and counting.</p> |          |



## Student Learning Outcomes

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| <p><b>Statistics and Probability</b></p> <p><b>Information Handling</b></p> <p>[SLO: M-09-C-01]:<br/>Construct a grouped frequency table, histogram (with unequal class intervals) and frequency polygon.<br/>Cognitive Level: Creating</p> <p>[SLO: M-09-C-02]:<br/>Calculate mean, weighted mean, median and mode of a grouped frequency distribution.<br/>Cognitive Level: Applying</p> <p>[SLO: M-09-C-03]:<br/>Apply mean, weighted mean, median, and mode to solve real life situations.<br/>Cognitive Level: Applying</p> <p><b>Probability and Expected Outcomes</b></p> <p>[SLO: M-09-C-04]:<br/>Calculate the probability of a single event and the probability of event not occurring.<br/>Cognitive Level: Applying</p> <p>[SLO: M-09-C-05]:<br/>Calculate relative frequency as an estimate of probability.<br/>Cognitive Level: Applying</p> | <p><b>Statistics and Probability</b></p> <p><b>Information Handling</b></p> <p>[SLO: M-10-C-01]:<br/>Construct cumulative frequency table, cumulative frequency polygon or Ogive.<br/>Cognitive Level: Creating</p> <p>[SLO: M-10-C-02]:<br/>Interpret the median, quartiles, deciles, percentiles, and inter quartile range from cumulative frequency curve.<br/>Cognitive Level: Understanding</p> <p>[SLO: M-10-C-03]:<br/>Construct and interpret data from scatter diagrams and draw lines of best fit.<br/>Cognitive Level: Creating</p> <p>[SLO: M-10-C-04]:<br/>Measure correlation using scatter diagram.<br/>Cognitive Level: Applying</p> <p>[SLO: M-10-C-05]:<br/>Calculate the range, standard deviation and variance for grouped data.<br/>Cognitive Level: Applying</p> <p>[SLO: M-10-C-06]:<br/>Use the mean and standard deviation to compare two sets of data.<br/>Cognitive Level: Applying</p> | <p><b>Permutation and Combination</b></p> <p>[SLO: M-11-C-01]:<br/>Explain the use of fundamental counting principle.<br/>Cognitive Level: Understanding</p> <p>[SLO: M-11-C-02]:<br/>Describe the use of factorial notation.<br/>Cognitive Level: Understanding</p> <p>[SLO: M-11-C-03]:<br/>Explain and solve problems that involve permutations.<br/>Cognitive Level: Applying</p> <p>[SLO: M-11-C-04]:<br/>Explain and solve problems that involve combinations.<br/>Cognitive Level: Applying</p> <p>[SLO: M-11-C-05]:<br/>Apply permutation and combination to solve real life situations.<br/>Cognitive Level: Applying</p> |  |
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| <p><b>[SLO: M-09-C-06]:</b><br/>Calculate expected frequencies.<br/>Cognitive Level: Applying</p> <p><b>[SLO: M-09-C-07]:</b><br/>Assess the suitability of probability, relative frequency, and expected frequency for solving real-life situations.<br/>Cognitive Level: Evaluating</p> | <p><b>[SLO: M-10-C-07]:</b><br/>Apply measures of dispersion to solve real life situations.<br/>Cognitive Level: Applying</p> <p><b>Probability of Combined Events</b></p> <p><b>[SLO: M-10-C-08]:</b><br/>Calculate the probability of combined events using sample space diagrams such as Possibility diagram, Tree diagram and Venn diagram, where appropriate.<br/>Cognitive Level: Applying</p> <p><b>[SLO: M-10-C-09]:</b><br/>Apply addition law of probability to solve problems involving mutually exclusive events such as left and right hand turns, tossing a coin, even and odd numbers on a die, winning and losing a game.<br/>Cognitive Level: Applying</p> <p><b>[SLO: M-10-C-10]:</b><br/>Apply the Multiplication law of probability to solve real life situations.<br/>Cognitive Level: Applying</p> |  |  |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|--|

## Grade Wise Suggested Classroom Activities (Domain C)

### Grade IX

**Histogram of Heights:** Measure heights of class and plot histogram with unequal intervals.

**Relative Frequency Experiment:** Toss coins/dice and compare experimental vs. theoretical probability.

### Grade X

**Scatter Plot Correlation Hunt:** Collect data (study time vs. marks) and plot scatter diagrams.

**Probability Card Games:** Explore dependent/independent events using card draws.

### Grade XI

**Permutation Locker Puzzle:** How many ways to arrange books in a locker?

**Real-World Combinations:** Plan a committee selection or menu combination activity.

## Suggested Outdoor Activities (Domain C)

- Conduct histogram and frequency measurement activities by measuring heights, weights, or other class/group attributes and plotting outdoor histograms with unequal intervals.
- Organize probability experiments such as coin tosses, dice rolls, or random draws in an open space to compare experimental and theoretical probabilities.
- Plan scatter plot and correlation exercises by collecting real-life data (e.g., study time vs. marks, steps walked vs. calories burned) and plotting outdoors on large grids.
- Conduct pack of cards and dice games in outdoor settings to explore dependent and independent events.
- Implement permutation and combination challenges using physical objects, lockers, or stations to model arrangements, selections, or committee/menu planning.

## Cross-Domain / Integrated Activities

**Grade IX-X (Domains A & B): Math in Art:** Use symmetry, tessellation, and geometric patterns to create Islamic art.

**Grade XI-XII (Domains A & B): Projectile Motion Project:** Use quadratic equations, vectors, and calculus to model motion.

**Grade X-XI (Domains A & C): Cryptography Workshop:** Use matrices and permutations to encode/decode messages.



## Guidelines for Text book Authors

### Author's Approach:

Content should match the cognitive level of students, using clear, straightforward language and well-chosen examples to strengthen conceptual understanding.

### Scope and Coverage:

Textbooks must offer comprehensive yet manageable content that is accurate, current, and aligned with national standards.

### Organization and Presentation:

Material should progress logically simple to complex, familiar to unfamiliar, concrete to abstract. Use labelled sections, visual aids (diagrams, graphs, tables), and feature boxes for formulas, theorems and key rules.

### Exercises and Assessment:

Include varied exercises: multiple-choice (conceptual), short-response (analytical/application), and extended-response (problem-solving). Ensure alignment with Student Learning Objectives (SLOs).

### Real-Life Connections:

Incorporate relevant examples linking mathematics to everyday life, science, engineering, and national data.

### Language and Design:

Use concise, engaging, and grade-appropriate language. Highlight key points with visuals, colours, and boxes.

### Unit Structure:

- Introduce real-life relevance and SLOs at the start.
- Include summaries and glossaries at the end.
- Suggest digital resources (QR codes, interactive content).

**Accuracy and Review:**

Ensure content is error-free, peer-reviewed, and cross-checked. Provide unit-wise answer keys.

**Technology Integration:**

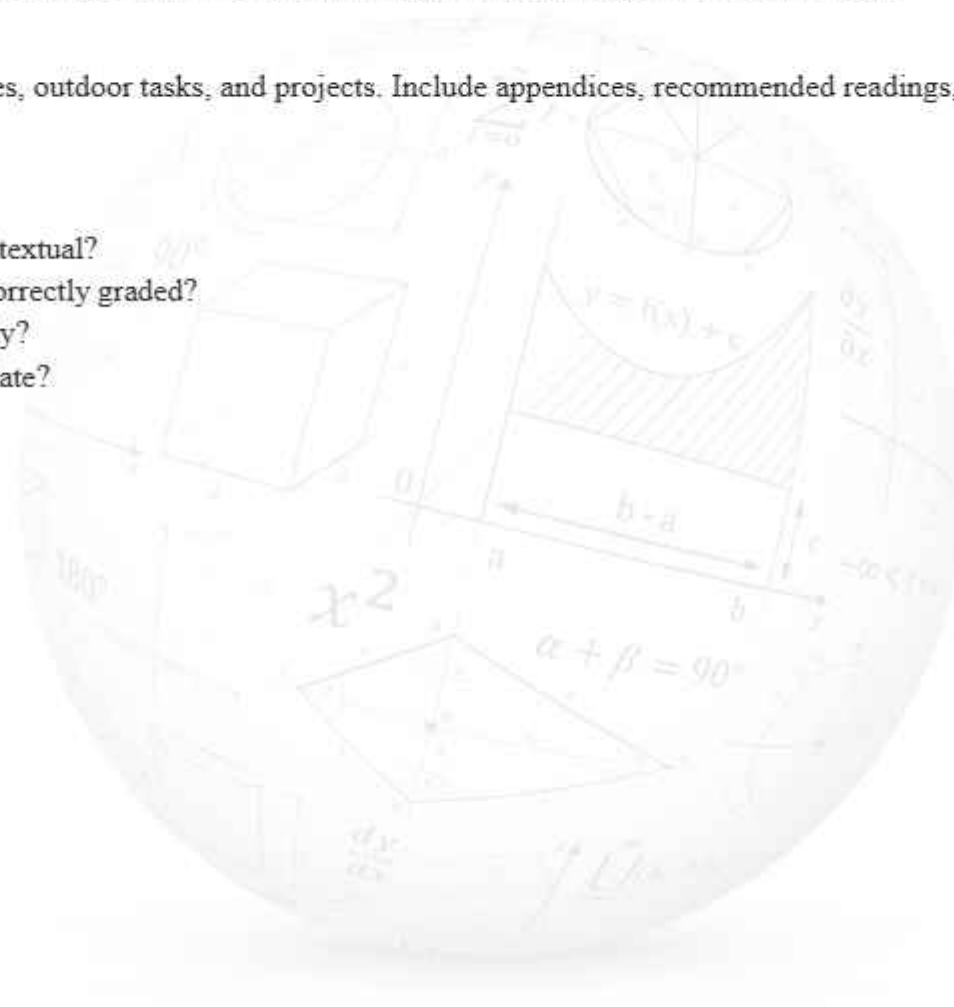
Reference digital tools (e-books, apps, software like GeoGebra/Desmos) and provide guidance for their use.

**Teacher and Student Support:**

Offer guidance for classroom activities, outdoor tasks, and projects. Include appendices, recommended readings, and an index of key terms.

**Quality Checklist:**

- Are SLOs fully addressed?
- Are examples diverse and contextual?
- Are exercises sufficient and correctly graded?
- Are diagrams labelled correctly?
- Is language clear and appropriate?
- Is the answer key complete



## Assessment Strategies in Mathematics

**Introduction:** Assessment is an integral part of the teaching learning process. Its purpose extends beyond evaluating performance to supporting learning, guiding instruction, and improving educational outcomes.

### Principles of Effective Assessment:

- Align with Student Learning Outcomes (SLOs)
- Balance formative and summative approaches
- Ensure fairness, transparency, and inclusivity
- Emphasize conceptual understanding and reasoning
- Provide continuous, actionable feedback

**Formative Assessment:** Ongoing strategies to monitor learning include classroom questioning, short quizzes, homework, practice exercises, and observation records.

**Summative Assessment:** Evaluates cumulative learning through unit tests, term, or annual examinations.

**Diagnostic Assessment:** Identifies prior knowledge, misconceptions, and learning gaps to inform instruction.

**Performance Based Assessment:** Measures application and problem-solving through tasks, projects, investigations, and mathematical modeling.

**Alternative Assessment Methods:** Include oral assessments, peer assessment, and self-assessment to encourage reflection and collaborative learning.

**Rubrics:** Provide clear evaluation criteria to ensure transparency and consistency.

**Continuous Assessment Records:** Maintain records of quizzes, assignments, participation, and projects to track progress over time.

**Feedback and Remedial Support:** Follow assessments with constructive feedback and targeted remedial or enriched support.

**Role of Teachers:** Implement diverse, curriculum aligned assessment strategies to promote comprehensive learning and student development.

**Conclusion:** A balanced assessment system enhances teaching effectiveness, fosters meaningful learning, and supports students in achieving their full potential.



## International Best Practices in Paper Setting

To ensure fairness, clarity, and alignment with global standards, the following guidelines should be followed when designing mathematics papers (based on internationally recognized assessment frameworks such as Cambridge, IB, UK, and Australian boards):

- **Mandatory Self-Solving:**

The paper setter must independently solve the entire question paper prior to submission, including preparing complete solutions and marking schemes/rubrics.

- **Teacher Student Time Ratio:**

The total time taken by the paper setter to solve the paper should not exceed one-third of the total examination duration. Generally, the expected student solving time should be approximately 2.5 to 3 times the paper setter's solving time.

- **Time Validation:**

If the paper setter requires excessive time to the paper, it should be reviewed and revised to reduce length or difficulty.

- **Moderation and Trial Solving:**

Where feasible, the paper should be reviewed or trial-solved by a second subject expert to ensure balance, fairness, and appropriateness of timing.

- **Avoidance of Speed-Based Assessment:**

Questions designed solely as time traps or requiring unnecessarily lengthy computations should be avoided. Assessment should prioritize conceptual understanding, reasoning, and accuracy rather than speed alone.

### Concluding Remarks:

A well-designed mathematics paper builds student's confidence, promotes meaningful learning, and differentiates achievement levels. Assessment should inspire a student to engage with mathematics positively, rather than fostering fear or anxiety.

### Suggested Unit wise Time Distribution and Weightage (%)

**Grade-IX:** [Number of periods = days per week  $\times$  weeks per month  $\times$  number of months =  $5 \times 4 \times 7 = 140$ ]

| Unit #                               | Unit Title                        | Number of Periods | Weightage (%) |
|--------------------------------------|-----------------------------------|-------------------|---------------|
| 1                                    | Real Numbers                      | 15                | 10.71%        |
| 2                                    | Sets and Relations                | 15                | 10.71%        |
| 3                                    | Factorization                     | 14                | 10%           |
| 4                                    | Division of Polynomials           | 15                | 10.71%        |
| 5                                    | Linear Equations and Inequalities | 08                | 5.71%         |
| 6                                    | Coordinate Geometry               | 08                | 5.71%         |
| 7                                    | Loci and Polygons                 | 15                | 10.71%        |
| 8                                    | Trigonometry and Bearings         | 21                | 15%           |
| 9                                    | Practical Geometry of Triangles   | 07                | 5%            |
| 10                                   | Statistics and Probability        | 22                | 15.71%        |
| Total Number of Lessons/Weighted (%) |                                   | 140               | 100%          |

**Grade-X:** [Number of periods = days per week  $\times$  weeks per month  $\times$  number of months =  $5 \times 4 \times 7 = 140$ ]

| Unit #                               | Unit Title                       | Number of Periods | Weightage (%) |
|--------------------------------------|----------------------------------|-------------------|---------------|
| 1                                    | Complex Numbers                  | 14                | 10%           |
| 2                                    | Matrices and Determinants        | 07                | 5%            |
| 3                                    | Functions and Graphs             | 13                | 9%            |
| 4                                    | Algebraic Fractions              | 07                | 5%            |
| 5                                    | Linear Inequalities              | 07                | 5%            |
| 6                                    | Quadratic Equations & Inequality | 20                | 14%           |
| 7                                    | Vectors in Plane                 | 07                | 5%            |
| 8                                    | Applications of Trigonometry     | 07                | 5%            |
| 9                                    | Chords and Arcs of a Circle      | 11                | 8%            |
| 10                                   | Tangent and Angles of a Circle   | 09                | 6%            |
| 11                                   | Practical Geometry of Circles    | 19                | 14%           |
| 12                                   | Statistics and Probability       | 19                | 14%           |
| Total Number of Lessons/Weighted (%) |                                  | 140               | 100%          |

**Grade XI:** (7 periods per week i.e. days per week  $\times$  weeks per month  $\times$  number of months =  $7 \times 4 \times 7 = 196$  approx.)

| Unit #                                      | Unit Title                                  | Number of Periods | Weightage (%) |
|---------------------------------------------|---------------------------------------------|-------------------|---------------|
| 1                                           | Complex Numbers                             | 14                | 7.14%         |
| 2                                           | Matrices and Determinants                   | 21                | 10.71%        |
| 3                                           | Sequences and Series                        | 21                | 10.71%        |
| 4                                           | Mathematical Induction and Binomial Theorem | 21                | 10.71%        |
| 5                                           | Vectors in Space                            | 21                | 10.71%        |
| 6                                           | Fundamental Law of Trigonometry             | 21                | 10.71%        |
| 7                                           | Trigonometric Functions and Graphs          | 21                | 10.71%        |
| 8                                           | Inverse Trigonometric Functions             | 21                | 10.71%        |
| 9                                           | Solution of Trigonometric Equations         | 21                | 10.71%        |
| 10                                          | Permutation and Combination                 | 14                | 7.14%         |
| <b>Total Number of Lessons/Weighted (%)</b> |                                             | <b>196</b>        | <b>100%</b>   |

**Grade XII:** (7 periods per week i.e. days per week  $\times$  weeks per month  $\times$  number of months =  $7 \times 4 \times 7 = 196$  approx.)

| Unit #                                      | Unit Title                                | Number of Periods | Weightage (%) |
|---------------------------------------------|-------------------------------------------|-------------------|---------------|
| 1                                           | Functions and Graph                       | 22                | 11.2          |
| 2                                           | Limit and Continuity of a Function        | 10                | 5.1           |
| 3                                           | Differentiation                           | 24                | 12.2          |
| 4                                           | Higher Order Derivatives                  | 24                | 12.2          |
| 5                                           | Indefinite Integrals                      | 16                | 8.2           |
| 6                                           | Definite Integrals                        | 16                | 8.2           |
| 7                                           | Differential Equations                    | 10                | 5.1           |
| 8                                           | Numerical Solution of Nonlinear Equations | 16                | 8.2           |
| 9                                           | Coordinate Geometry                       | 16                | 8.2           |
| 10                                          | Vector Valued Functions                   | 10                | 5.1           |
| 11                                          | Analytical Geometry of Conic Sections     | 32                | 16.3          |
| <b>Total Number of Lessons/Weighted (%)</b> |                                           | <b>196</b>        | <b>100%</b>   |



## The Web Based Digital Resources

The resources are mapped to secondary and higher secondary mathematics, with emphasis on conceptual understanding, visualization, problem solving, applications, and exam readiness.

| Sr# | Resource                       | Type                            | Primary Category            | Practical Focus                                             | Grades | Access Model | URL                                                                                                       | Best for Domains |
|-----|--------------------------------|---------------------------------|-----------------------------|-------------------------------------------------------------|--------|--------------|-----------------------------------------------------------------------------------------------------------|------------------|
| 1   | Khan Academy Mathematics       | Interactive Platform            | Core Instruction & Practice | Self-Paced Concept Mastery, Structured Practice, Assessment | IX–XII | Free         | [khanacademy.org/math]<br><a href="https://www.khanacademy.org/math">https://www.khanacademy.org/math</a> | A, B, C          |
| 2   | GeoGebra                       | Dynamic Software                | Visualization & Discovery   | Interactive Geometry, Algebra, Calculus Exploration         | IX–XII | Free         | [geogebra.org]<br><a href="https://www.geogebra.org">https://www.geogebra.org</a>                         | A, B, C          |
| 3   | Desmos Graphing Calculator     | Online Tool                     | Visualization & Discovery   | Graphing Functions, Transformations and Data                | IX–XII |              | [desmos.com]<br><a href="https://www.desmos.com">https://www.desmos.com</a>                               | A, B, C          |
| 4   | Wolfram Alpha                  | Computational Engine            | Tools & Calculators         | Algebraic Solving, Calculus verification                    | X–XII  | Freemium     | [wolframalpha.com]<br><a href="https://www.wolframalpha.com">https://www.wolframalpha.com</a>             | A, B             |
| 5   | MIT OpenCourseWare Mathematics | OER Repository                  | Enrichment & Reasoning      | Advanced Problem Solving, Theoretical Reasoning             | XI–XII | Free         | [ocw.mit.edu]<br><a href="https://ocw.mit.edu">https://ocw.mit.edu</a>                                    | A, B             |
| 6   | CK-12 Foundation Mathematics   | Digital Textbooks & Simulations | Core Instruction & Practice | Conceptual Clarity, Adaptive Practice                       | IX–XII | Free         | [ck12.org]<br><a href="https://www.ck12.org">https://www.ck12.org</a>                                     | A, B, C          |
| 7   | Math Is Fun                    | Interactive Website             | Problem-Solving & Tutorials | Concept Reinforcement, Intuition Building                   | IX–X   | Free         | [mathsisfun.com]<br><a href="https://www.mathsisfun.com">https://www.mathsisfun.com</a>                   | A, B, C          |
| 8   | Purplemath                     | Tutorial Website                | Problem-Solving & Tutorials | Algebraic Manipulation & Step by Step Reasoning             | IX–XI  | Free         | [purplemath.com]<br><a href="https://www.purplemath.com">https://www.purplemath.com</a>                   | A, B             |

|    |                                            |                                            |                             |                                                              |        |                 |                                                                                                                    |         |
|----|--------------------------------------------|--------------------------------------------|-----------------------------|--------------------------------------------------------------|--------|-----------------|--------------------------------------------------------------------------------------------------------------------|---------|
| 9  | NROC Math Resources                        | Digital Modules                            | Supplemental                | Problem Solving, Conceptual Models                           | IX–XII | Institutional   | [nroc.org]<br><a href="https://www.nroc.org">https://www.nroc.org</a>                                              | A, B, C |
| 10 | PatrickJMT                                 | Video Tutorials                            | Problem-Solving & Tutorials | Step by Step Problem Solving                                 | IX–XII | Free            | [youtube.com/patrickJMT]<br><a href="https://www.youtube.com/patrickJMT">https://www.youtube.com/patrickJMT</a>    | A, B, C |
| 11 | ExamSolutions                              | Video Tutorials                            | Problem-Solving & Tutorials | Exam Oriented Tutorials (Trigonometry, Calculus and Algebra) | X–XII  | Free / Freemium | [brilliant.org]<br><a href="https://www.examsolutions.net">https://www.examsolutions.net</a>                       | A, B, C |
| 12 | Brilliant.org Mathematics                  | Interactive Platform                       | Enrichment & Reasoning      | Logical Reasoning, Proofs, Creative Thinking                 | IX–XII | Freemium        | [brilliant.org]<br><a href="https://brilliant.org">https://brilliant.org</a>                                       | A, B, C |
| 13 | NRICH (University of Cambridge)            | Problem Bank                               | Enrichment & Reasoning      | Mathematical Reasoning & Proof Oriented Problems             | IX–XII | Free            | [nrich.maths.org]<br><a href="https://nrich.maths.org">https://nrich.maths.org</a>                                 | A, B, C |
| 14 | OpenStax Mathematics                       | Open Textbooks                             | Core Instruction & Practice | Conceptual Understanding & Applications                      | IX–XII | Free            | [openstax.org]<br><a href="https://openstax.org">https://openstax.org</a>                                          | A, B, C |
| 15 | Math Stack Exchange                        | ExamSolutions                              | Reference & Community       | Analytical Problem Solving and Q&A                           | X–XII  | Free            | [math.stackexchange.com]<br><a href="https://math.stackexchange.com">https://math.stackexchange.com</a>            | A, B, C |
| 16 | PhET Interactive Simulations (Mathematics) | Brilliant.org Mathematics                  | Visualization & Discovery   | Interactive Simulations for Functions, Modelling             | IX–XI  | Free            | [phet.colorado.edu]<br><a href="https://phet.colorado.edu">https://phet.colorado.edu</a>                           | A, B, C |
| 17 | Integral Calculator                        | Online Calculus Tool                       | Tools & Calculators         | Integration Techniques & Verification                        | XI–XII | Free            | [integral-calculator.com]<br><a href="https://www.integral-calculator.com">https://www.integral-calculator.com</a> | A, B    |
| 18 | Symbolab                                   | Step Wise Math Solver                      | Tools & Calculators         | Algebra, calculus, limits                                    | IX–XII | Freemium        | [symbolab.com]<br><a href="https://www.symbolab.com">https://www.symbolab.com</a>                                  | A, B, C |
| 19 | MathWorld (Wolfram)                        | Online Encyclopedia                        | Reference                   | Mathematical Definitions, Theorems & theory                  | X–XII  | Free            | [mathworld.wolfram.com]<br><a href="https://mathworld.wolfram.com">https://mathworld.wolfram.com</a>               | A, B    |
| 20 | Desmos Classroom Activities                | Teacher Guided Activities (Lesson Library) | Visualization & Discovery   | Teacher Guided, Inquiry Based Learning Activities            | IX–XII | Free            | [teacher.desmos.com]<br><a href="https://teacher.desmos.com">https://teacher.desmos.com</a>                        | A, B, C |



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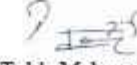
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Ministry of Federal Education and Professional Training  
\*\*\*\*\*

Islamabad: July 31, 2026

**NOTIFICATION**

**F. No.1-1/2025/NCC(Acad).** In exercise of the powers conferred under Section 3(2)(a) of the Federal Supervision of Curricula, Textbooks and Maintenance of Standards of Education Act, 1976, the competent authority, i.e., the Director, NCC Wing, Ministry of Federal Education and Professional Training (M/o FE&PT), has approved National Curriculum of Pakistan (NCP-2026) for the subjects Urdu, English, Mathematics, Physics, Chemistry, Biology, Computer Science for grades IX to XII & General Science for grades IX-X. The NCP-2026 has been developed through the rationalization and refinement of the National Curriculum of Pakistan (NCP2022-23).

This curriculum shall be implemented in all public and private educational institutions within the Islamabad Capital Territory (ICT), and in educational institutions under the Federal Government across the country, w.e.f academic year 2027. The curriculum can be downloaded from official website of the National Curriculum Council Wing M/o FE & PT, at [www.ncc.gov.pk](http://www.ncc.gov.pk)



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4. APS to Joint Educational Advisor, FE&PT, Islamabad
5. The Chairman, Federal Board of Intermediate & Secondary Education, Islamabad.
6. The Executive Director, Inter-Board Coordination Commission, Islamabad (with the request to circulation with IBCC members)
7. APS to Director, NCC Wing, M/o FE&PT, Islamabad.

(Assistant Educational Advisor)





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