

National Curriculum of Pakistan
2022-23

MATHEMATICS

Grades 1-12



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

بِسْمِ اللّٰهِ الرَّحْمٰنِ الرَّحِیْمِ

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It is with great pride that we, at the National Curriculum Council Secretariat, present the first core curriculum in Pakistan's 75-year history. Consistent with the right to education guaranteed by Article 25-A of our Constitution, the National Curriculum of Pakistan (2022-23) aspires to equip every child with the necessary tools required to thrive in and adapt to an ever-evolving globalized world.

The National Curriculum is in line with international benchmarks, yet sensitive to the economic, religious, and social needs of young scholars across Pakistan. As such, the National Curriculum aims to shift classroom instruction from rote learning to concept-based learning.

Concept-based learning permeates all aspects of the National Curriculum, aligning textbooks, teaching, classroom practice, and assessments to ensure compliance with contemplated student learning outcomes. Drawing on a rich tapestry of critical thinking exercises, students will acquire the confidence to embark on a journey of lifelong learning. They will further be able to acknowledge their weaknesses and develop an eagerness to build upon their strengths.

The National Curriculum was developed through a nationwide consultative process involving a wide range of stakeholders, including curriculum experts from the public, private, and non-governmental sectors. Representatives from provincial education departments, textbook boards, assessment departments, teacher training departments, *deeni madaris*, public and private publishers, private schools, and private school associations all contributed their expertise to ensure that the National Curriculum could meet the needs of all Pakistani students.

The experiences and collective wisdom of these diverse stakeholders enrich the National Curriculum, fostering the core, nation-building values of inclusion, harmony, and peace, making the National Curriculum truly representative of our nation's educational aspirations and diversity.

I take this opportunity to thank all stakeholders, including students, teachers, and parents who contributed to developing the National Curriculum of Pakistan (2022-23)

Dr. Mariam Chughtai

Director

National Curriculum Council Secretariat

Ministry of Federal Education and Professional Training

Math Progression Grid (1-8)

Note: The progression grid identifies the core student learning outcomes.

An asterisk (*) placed at the end of a student learning outcome indicates an advanced/additional skill for that specific learning outcome.

Please refer to the relevant ‘Suggested Guidelines’ document to be informed of more directions for advanced/additional complementary content and ideas.

Domain A: Numbers and Operations

Grade 1	Grade 2	Grade 3	Grade 4	Grade 5	Grade 6	Grade 7	Grade 8
<p>Benchmarks: Students will be able to demonstrate knowledge of place value (up to 4-digit numbers); represent whole numbers with words, diagrams, number lines, or symbols; order and compare numbers.</p> <p>They will add and subtract numbers up to 4-digit numbers; multiply (up to 3-digit numbers with 1-digit) and divide (3-digit by 1-digit number). Solve problems involving odd and even numbers, addition, subtraction, multiplication and division of numbers (involving missing numbers, money, quantities and measures), round numbers to nearest tens, hundreds and thousands and make estimates.</p> <p>Recognise fractions as parts of wholes or collections; represent fractions using words, numbers, equivalent fractions in simplest form; compare and order simple fractions; add and subtract simple like and unlike fractions, including those set in problem situations.</p> <p>Demonstrate knowledge of decimal place value to the tenth.</p>			<p>Benchmarks: Students will be able to demonstrate knowledge of place value (5-digit to 7-digit numbers); represent whole numbers with words, diagrams, number lines, or symbols; order and compare numbers.</p> <p>They will add and subtract numbers up to 6-digit numbers; multiply (up to 5-digit numbers with 3-digit) and divide (up to 5 digit up to 2 digit number) Solve problems involving odd and even numbers, addition, subtraction, multiplication and division of numbers (involving missing numbers, money, quantities and measures), round numbers to nearest tens, hundreds and thousands and make estimates.</p> <p>Recognise fractions as parts of wholes or</p>		<p>Benchmarks: Students will be able use language, notation and Venn diagrams to describe sets and their elements, operate with real numbers, their properties and identify absolute value of real numbers, apply commutative ,associative and distributive laws on real numbers , compare, arrange and round off real numbers to required degree of accuracy, calculate factors, multiples, HCF and LCM, square roots and cube roots, ratio, rate, proportion, percentages, profit, loss, discount, Zakat, Ushr, commission, Taxes, insurance, partnership and Inheritance and apply all of these concepts in real life contexts.</p>		

collections; represent fractions using words, numbers; compare and order simple fractions; add and subtract simple like, unlike fractions, including those set in problem situations.

Demonstrate knowledge of decimal place value (up to three decimal place) compare, order, and round decimals (to the nearest whole number and up to two decimal place); add, subtract, multiply and divide decimals, including those set in real world problems (including money, quantities or measures).

Student Learning Outcomes

[SLO: M-01-A-01] Count objects and numbers to and across 99 (2-digit numbers) forwards and backwards, beginning from zero one, or from any given number.	[SLO: M-02-A-01] Count numbers up to and across 999 (3-digit numbers) forwards and backwards, beginning from zero or one, or from any given number.	[SLO: M-03-A-01] Count up to 9999 (4-digit numbers).	[SLO: M-04-A-01] Count up to 99,999 (5-digit numbers).	[SLO: M-05-A-01] Count up to 9,999,999 (7-digit numbers)	---	---	---
[SLO: M-01-A-02] Read and write numbers up to 99 (2-digit numbers) in	[SLO: M-02-A-02] Read and write numbers up to 999 in numerals and up to	[SLO: M-03-A-02] Read and write up to 999 in numerals and in words.	[SLO: M-04-A-02] Read and write up to 99,999 (5-digit numbers) in numerals	[SLO: M-05-A-02] Read and write up to 9,999,999 (6 and 7 digit numbers) in	---	---	---

numerals and in words.	99 in words.		and in words.	numerals and in words.			
[SLO: M-01-A-03] Recognise the place value of each digit in 2-digit numbers (tens, ones/units).	[SLO: M-02-A-03] Recognise the place value of each digit in 3-digit numbers (hundreds, tens, ones/units).	[SLO: M-03-A-03] Recognise the place value of each digit in 4-digit numbers.	[SLO: M-04-A-03] Recognise the place value of each digit in 5-digit numbers.	[SLO: M-05-A-03] Recognise the place value of each digit in 6 and 7 digit numbers.	---	[SLO: M-07-A-01] With increasing degree of challenge, use the concept of place value for whole numbers, integers, rational numbers and decimal numbers.	---
[SLO: M-01-A-04] Compare and order numbers up to 99 using appropriate language (for instance: more and less, greater, smaller, equal to, same as, increasing, decreasing, smallest to largest and vice versa etc.) [SLO: M-01-A-05] Identify numbers	[SLO: M-02-A-04] Compare and order numbers up to 999 using appropriate language and <, > and = signs.	[SLO: M-03-A-04] Compare numbers using symbols and arrange numbers up to 9999 using appropriate language	[SLO: M-04-A-04] Compare numbers using symbols and arrange numbers up to 99,999	---	---	---	---

before, after and between two numbers.							
---	[SLO: M-02-A-05] Round numbers to the nearest tens using different concrete objects and pictorial representations.	[SLO: M-03-A-05] Round numbers to the nearest tens, hundreds and thousands using different concrete and pictorial representations.	[SLO: M-04-A-05] Reinforce/recall round off numbers to the nearest tens, hundreds, thousands. [SLO: M-04-A-06] Round numbers to the nearest ten thousands.	---	---	[SLO: M-07-A-02] Round off whole numbers, integers, rational numbers and decimal numbers to a required degree of accuracy, significance or decimal places (up to 3 decimal places).	[SLO: M-08-A-01] Round off numbers up to 5 significant figures.
[SLO: M-01-A-06] Recognise the position of objects and write it using ordinal numbers up	[SLO: M-02-A-06] Recognise the position of objects and write it using ordinal numbers up to	---	---	---	---	---	---

to 10.	20.						
---	[SLO: M-02-A-07] Read and write Roman numbers up to 12.	[SLO: M-03-A-06] Read and write Roman numbers up to 20.	[SLO: M-04-A-07] Read and write Roman numbers up to 100.	---	---	---	---
[SLO: M-01-A-07] Find, recall and use addition and subtraction facts to 20.	[SLO: M-02-A-08] Find, recall and use addition and subtraction facts to 100.	---	---	---	---	---	---
[SLO: M-01-A-08] Compare numbers to find how many more and how many less [SLO: M-01-A-09] Add and subtract numbers mentally and in written form including: <ul style="list-style-type: none"> • up to three 1-digit numbers • 2-digit numbers and tens. [SLO: M-01-A-10] Add and subtract numbers mentally and in written form	[SLO: M-02-A-09] Add and subtract numbers mentally and in formal written form (with and without regrouping) including: <ul style="list-style-type: none"> • 3-digit number and a 1-digit number. • 3-digit number and tens. • 3-digit number and a 2-digit number. • Two 3-digit numbers. 	[SLO: M-03-A-07] Add and subtract numbers mentally and in written form (with and without regrouping) including: <ul style="list-style-type: none"> • 4-digit numbers with 1-, 2-, 3- and 4-digit numbers. 	[SLO: M-04-A-08] Add and subtract up to 5-digit numbers mentally and in written form (with and without regrouping) including: <ul style="list-style-type: none"> • 5-digit numbers with 1-digit, 2-digit, 3-digit, 4-digit and 5-digit numbers. 	[SLO: M-05-A-04] Add and subtract up to 6-digit numbers mentally and in written form (with and without regrouping) including: <ul style="list-style-type: none"> • 6-digit numbers with 1-digit, 2-digit, 3-digit, 4-digit, 5-digit and 6-digit numbers. 	---	---	---

including: <ul style="list-style-type: none"> • 2-digit numbers and 1-digit numbers (without regrouping) • Two 2-digit numbers (without regrouping) 							
<u>[SLO: M-01-A-11]</u> Solve real-world word problems with addition and subtraction using concrete objects and pictorial representations (involving missing numbers, money, quantities and measures)	<u>[SLO: M-02-A-10]</u> Solve real-world word problems with addition and subtraction (involving missing numbers, money, quantities and measures)	<u>[SLO: M-03-A-08]</u> Solve real-world word problems (including missing numbers and money) involving addition and subtraction.	<u>[SLO: M-04-A-09]</u> Solve real-world word problems (including multi step) involving addition and subtraction.	<u>[SLO: M-05-A-05]</u> Solve real-world word problems (including multi step) involving addition and subtraction.	---	---	---

---	[SLO: M-02-A-11] Estimate the answer to an addition and subtraction question. (using various approaches)	[SLO: M-03-A-09] Estimate the answer to an addition and subtraction question. (using various approaches)	[SLO: M-04-A-10] Estimate the answer to an addition and subtraction question. (using various approaches)	[SLO: M-05-A-06] Estimate the answer to an addition and subtraction question. (using various approaches)	---	[SLO: M-07-A-03] Use knowledge of rounding off to give an estimate to a calculation; to check the reasonableness of the solution.	[SLO: M-08-A-02] Analyze approximation error when numbers are rounded off. [SLO: M-08-A-03] Solve real-world word problems involving approximation
---	[SLO: M-02-A-12] Recognise even and odd numbers.	[SLO: M-03-A-10] Recognise and differentiate between even and odd numbers.	---	---	---	---	---
[SLO: M-01-A-12] Identify Pakistani coins (Rs. 1, 2, 5 and 10) and notes (Rs. 10, 20, 50, 100, and 500) [SLO: M-01-A-13] Solve money problems involving addition and subtraction of	[SLO: M-02-A-13] Identify international currency and denominations (for instance dollars.) [SLO: M-02-A-14] Solve money problems involving addition and subtraction of Pakistani money and	---	---	---	---	---	[SLO: M-08-A-04] Convert Pakistani currency to well-known international currencies and vice versa.

Pakistani money.	a few selected international currency notes. (for instance dollar)						
<p>[SLO: M-01-A-14] Count and write in 2's, 5s and 10s using concrete objects (such as counters, pebbles, popsicle sticks etc) and pictorial representations (such as number line, hundred square grid)</p> <p>[SLO: M-01-A-15] Recognise counting in 2s, 5s and 10s as multiplication tables of two, five and ten.</p> <p>[SLO: M-01-A-16] Recognise multiplication as repeated addition using concrete objects and pictorial representations (for instance materials, groups and arrays)</p>	<p>[SLO: M-02-A-15] Count and write in 3s, 4s, 5s, 10s and 100s.</p> <p>[SLO: M-02-A-16] Recognise counting in 3s, 4s as multiplication tables of three and four.</p> <p>[SLO: M-02-A-17] Recognise multiplication as repeated addition and develop multiplication tables (times tables) for 2, 3, 4, 5 and 10.</p>	<p>[SLO: M-03-A-11] Count and write in multiple steps. Develop times tables for 6, 7, 8, and 9 and write multiplication sentences using concrete and pictorial representations.</p>	---	---	---	---	---

	[SLO: M-02-A-18] Write multiplication statements (i.e., sentences) using concrete and pictorial representations.						
[SLO: M-01-A-17] Recognise using concrete objects and pictorial representations that the multiplication of any two numbers can be done in any order.	[SLO: M-02-A-19] Recognise using concrete and pictorial representations that the multiplication of any two numbers can be done in any order.	[SLO: M-03-A-12] Reinforce through concrete and pictorial representations that the multiplication of any two numbers can be done in any order.	---	---	---	---	---
---	[SLO: M-02-A-20] Multiply mentally and in written form using the multiplication tables that they know: <ul style="list-style-type: none"> 1 digit number by another 1 digit number. [SLO: M-02-A-21] Multiply mentally and in written form using the multiplication tables	[SLO: M-03-A-13] Multiply mentally and in written form: <ul style="list-style-type: none"> 2 digit numbers by 1 digit numbers. 3 digit numbers by 1-digit numbers. 	[SLO: M-04-A-11] Multiply up to 4-digit numbers with 1-digit and 2-digit numbers mentally and in written form.	[SLO: M-05-A-07] Multiply upto 5-digit numbers with 1-digit, 2-digit and 3-digit numbers in written form.	---	---	---

	<p>that they know:</p> <ul style="list-style-type: none"> • 2-digit number by a 1-digit number using a multiplication grid. <p>[SLO: M-02-A-22] Multiply a number with 0 and 1.</p>						
---	[SLO: M-02-A-23] Solve real-world word problems involving multiplication.	[SLO: M-03-A-14] Solve real-world word problems involving multiplication.	[SLO: M-04-A-12] Solve real-world word problems involving multiplication.	[SLO: M-05-A-08] Solve real-world word problems involving multiplication.	---	---	---
[SLO: M-01-A-18] Recognise division as repeated subtraction using concrete objects and pictorial representation. (groups, arrays and sharing)	[SLO: M-02-A-24] Recognise division as repeated subtraction through concrete and pictorial representation. [SLO: M-02-A-25] Write division statements (i.e., sentences) using concrete and pictorial representations.	---	---	---	---	---	---

[SLO: M-01-A-19] Recognise using concrete objects and pictorial representation that the division of one number by another number cannot be done in any order.	[SLO: M-02-A-26] Recognise using concrete and pictorial representation that the division of one number by another cannot be done in any order.	[SLO: M-03-A-15] Reinforce through concrete and pictorial representation that the division of any two numbers cannot be done in any order (Commutative).	---	---	---	---	---
---	[SLO: M-02-A-27] Divide mentally and in written form: <ul style="list-style-type: none"> • 1-digit number by another 1-digit number (without remainder) • 2-digit number by a 1-digit number (without remainder) 	[SLO: M-03-A-16] Divide mentally and in written form: <ul style="list-style-type: none"> • 2-digit numbers by 1 digit number (with and without remainder) • 3-digit numbers with 1-digit numbers (with and without remainder) [SLO: M-03-A-17] Divide a number by 1 and itself.	[SLO: M-04-A-13] Divide up to 4-digit numbers by 1-digit and 2-digit numbers in written form.	[SLO: M-05-A-09] Divide up to 5-digit numbers by 1-digit and 2-digit numbers in written form.	---	---	---
[SLO: M-01-A-20] Solve simple real world problems involving multiplication and	[SLO: M-02-A-28] Solve real-world word problems involving multiplication and	[SLO: M-03-A-18] Solve real-world word problems involving division.	[SLO: M-04-A-14] Solve real-world word problems involving division.	[SLO: M-05-A-10] Solve real-world word problems involving division.	---	---	---

division using any method (for instance materials, repeated addition, groups and arrays, mental methods, and known multiplication tables).	division using any method (for instance materials, repeated addition/subtraction, groups, arrays, mental and or written methods).						
---	[SLO: M-02-A-29] Solve real-world word problems (including Pakistani currency) involving addition, subtraction, multiplication and division.	[SLO: M-03-A-19] Solve real-world word problems involving addition, subtraction, multiplication and division.	[SLO: M-04-A-15] Use appropriate operations to solve real-world word problems involving addition, subtraction, multiplication and division.	[SLO: M-05-A-11] Use appropriate operations to solve real-world word problems involving addition, subtraction, multiplication and division.	---	----	---
---	---	---	[SLO: M-04-A-16] Identify divisibility rules for 2, 3, 5 and 10 and use them on up to 4-digit numbers.	[SLO: M-05-A-12] Identify divisibility rules for 7 and 11 and use them on up to 5-digit numbers.	---	---	---
---	---	---	[SLO: M-04-A-17] Identify and differentiate between multiples and factors and find: <ul style="list-style-type: none"> • all factor pairs of a number • common factors 	---	[SLO: M-06-A-01] Identify: <ul style="list-style-type: none"> • Factors of up to 3-digit numbers • Multiples of up to 2-digit 	---	---

			<p>of two numbers</p> <p>[SLO: M-04-A-18]</p> <p>Identify and differentiate between multiples and factors and find:</p> <ul style="list-style-type: none"> • common multiples of two or more than 2-digit numbers. 		<p>numbers</p> <ul style="list-style-type: none"> • Prime factors of up to 4-digit numbers and express in index notation 		
---	---	---	---	---	<p>[SLO: M-06-A-02]</p> <p>Identify base and exponent and express numbers given in expanded form in index notation and vice versa.</p>	---	---
---	---	---	<p>[SLO: M-04-A-19]</p> <p>Identify and differentiate between 2-digit prime and composite numbers up to 50.</p>	<p>[SLO: M-05-A-13]</p> <p>Identify and differentiate between 2-digit prime and composite numbers up to 100.</p>	---	---	---
---	---	---	---	<p>[SLO: M-05-A-14]</p> <p>Find H.C.F and L.C.M of two</p>	<p>[SLO: M-06-A-03]</p> <p>Find H.C.F and</p>	<p>[SLO: M-07-A-04]</p> <p>Recall H.C.F and</p>	---

				numbers (up to 2-digits) using various methods. (For instance prime factorization, division method etc.)	L.C.M of two or three numbers (up to 3-digits) using various methods (for instance prime factorization and division method).	L.C.M.	
---	---	---	---	[SLO: M-05-A-15] Solve real-world word problems involving H.C.F and L.C.M.	[SLO: M-06-A-04] Solve real-world word problems involving H.C.F and L.C.M.	---	---
---	---	---	---	---	[SLO: M-06-A-05] Recognise, identify and represent integers (positive, negative and neutral integers) and their absolute or numerical value.	[SLO: M-07-A-05] Recall - Recognise, identify and represent integers (positive, negative and neutral integers) and their absolute or numerical value.	---
---	---	---	---	---	[SLO: M-06-A-06]	---	---

					Arrange a given list of integers and their absolute value in ascending and descending order.		
---	---	---	---	---	[SLO: M-06-A-07] Add and subtract upto-2-digit like and unlike integers and verify commutative and associative laws (where applicable).	---	---
---	---	---	---	---	[SLO: M-06-A-08] Multiply up to 2-digit like and unlike integers and verify commutative, associative and distributive laws. [SLO: M-06-A-09] Divide like and	---	---

					unlike integers.		
[SLO: M-01-A-21] Recognise, find, name and write fractions: - half ($\frac{1}{2}$) - quarter ($\frac{1}{4}$) - two-quarters ($\frac{2}{4}$) - three-quarters ($\frac{3}{4}$) of a length, shape, set of objects or quantity using pictorial representations.	[SLO: M-02-A-30] Identify, name and write; -unit fractions -non-unit fractions -like fractions -unlike fractions of a discrete set of objects using pictorial representations.	[SLO: M-03-A-20] Recognise among: - proper fractions -improper fractions. -mixed numbers	[SLO: M-04-A-20] Differentiate among: -proper fractions -improper fractions -mixed numbers.	---	---	[SLO: M-07-A-06] Identify and represent (on a number line) rational numbers. [SLO: M-07-A-07] Represent whole numbers, integers and decimal numbers on a number line.	[SLO: M-08-A-05] Differentiate between rational and irrational numbers. [SLO: M-08-A-06] Represent real numbers on a number line and Recognise the absolute value of a real number.
---	---	[SLO: M-03-A-21] Identify equivalent fractions and show families of equivalent fractions. [SLO: M-03-A-22] Simplify fractions to the lowest term.	[SLO: M-04-A-21] Convert improper fractions to mixed numbers and vice versa.	---	---	[SLO: M-07-A-08] Identify and convert between various types of fractions.	---
---	[SLO: M-02-A-31] Compare and order unit fractions and like	[SLO: M-03-A-23] Compare and order like fractions using symbols	[SLO: M-04-A-22] Compare and order unlike fractions.	[SLO: M-05-A-16] Compare and order whole numbers,	---	[SLO: M-07-A-09] Compare (using	[SLO: M-08-A-07] Demonstrate the

	fractions (with denominators up to 10) using $<$, $>$ and $=$ sign.	$<$, $>$ and $=$.		proper, improper fractions and mixed numbers in ascending and descending order.		symbols $<$, $>$, $=$, \leq and \geq) and arrange (in ascending or descending order) whole numbers, integers, rational numbers and decimal numbers.	ordering properties of real numbers.
---	[SLO: M-02-A-32] Add and subtract like fractions within one whole (e.g., $\frac{1}{4} + \frac{3}{4} = \frac{4}{4}$).	[SLO: M-03-A-24] Add and subtract like and unlike fractions (with denominators that are multiples of the same number).	[SLO: M-04-A-23] Add and subtract like and unlike fractions (with denominators that are multiples of the same number) and write the answer in mixed numbers (if applicable).	[SLO: M-05-A-17] Add and subtract; two or three unlike fractions and mixed numbers.	---	[SLO: M-07-A-10] Verify associative and commutative properties of rational numbers.	---
---	---	---	[SLO: M-04-A-24] Multiply and divide proper, improper fractions and mixed numbers by a whole number. [SLO: M-04-A-25] Multiply two fractions and/or mixed	[SLO: M-05-A-18] Multiply and divide proper, improper fractions and mixed numbers and express the answer in its simplest form (if applicable).	---	[SLO: M-07-A-11] Verify associative, commutative and distributive properties of rational numbers.	[SLO: M-08-A-08] Demonstrate the following properties: -closure property -associative property - existence of identity element

			numbers.				-existence of inverses - commutative property - distributive property
---	---	---	[SLO: M-04-A-26] Solve real-world word problems involving fractions by identifying appropriate operations.	[SLO: M-05-A-19] Solve real-world word problems involving fractions.	---	[SLO: M-07-A-12] Solve real-world word problems involving operations on rational numbers.	[SLO: M-08-A-09] Solve real-world word problems involving calculation with decimals and fractions.
---	[SLO: M-02-A-33] Know and recognise that tenths arise by dividing an object into ten equal parts and in dividing single digit numbers and quantities by ten (using concrete and pictorial representations).	[SLO: M-03-A-25] Know and recognise that hundredths arise by dividing an object, single digit numbers and quantities into hundred equal parts.	[SLO: M-04-A-27] Recognise, read, write decimal numbers and identify the place value of decimal numbers with up to three decimal places.	---	---	---	[SLO: M-08-A-10] Identify and differentiate between decimal numbers as terminating (non-recurring) and non-terminating (recurring).
---	---	[SLO: M-03-A-26] Identify that tenths arise by dividing an object, single digit	[SLO: M-04-A-28] Recognise the result of dividing 1 or 2-digit number by 10	---	---	---	---

		number and quantities into ten equal parts (e.g., $2/10 = 0.2$)*	and 100 and identifying the value of digits in the answer as ones, tenths and hundredths (e.g., $24/100 = 0.24$)				
---	---	---	<p>[SLO: M-04-A-29] Express</p> <ul style="list-style-type: none"> -a decimal number (up to three decimal places) as a fraction whose denominator is 10, 100 and 1000. -a given fraction in its decimal equivalent (tenths, hundredths or thousandths) when the; <ul style="list-style-type: none"> (i) denominator of the fraction is 10, 100 or 1000. (ii) denominator of a fraction is not 10, 100, or 1000 but can be converted to 10, 100 or a 1000. <p>[SLO: M-04-A-30] Recognise and write a quarter, a half and three quarters (i.e., $\frac{1}{2}$,</p>	[SLO: M-05-A-20] Convert fractions to decimals and vice versa.	---	---	---

			$\frac{1}{4}$, $\frac{3}{4}$. to its decimal equivalents.				
---	---		[SLO: M-04-A-31] Compare and order decimal numbers with up to two decimal places.	[SLO: M-05-A-21] Compare and order numbers up to three decimal places using signs >, < and = sign and in ascending and descending order.	---	---	---
---	---		[SLO: M-04-A-32] Round decimal numbers (with up to three decimal places) to the nearest whole number and to one and two decimal places.	[SLO: M-05-A-22] Reinforce rounding decimal numbers (with up to three decimal places) to the nearest whole number and to tenth and hundredth.	---	---	---
---	---	---	[SLO: M-04-A-33] Add and subtract 3-digit numbers with up to two decimal places.	[SLO: M-05-A-23] Add and subtract numbers up to three decimal places.	---	---	---
---	---	---	[SLO: M-04-A-34] Multiply and divide a 2-digit number with one decimal place by: <ul style="list-style-type: none"> a 1-digit number. 	[SLO: M-05-A-24] Multiply numbers up to two decimal places by: <ul style="list-style-type: none"> up to 2-digit whole numbers 	---	---	---

			<ul style="list-style-type: none"> a 2-digit number 	<ul style="list-style-type: none"> 3-digit numbers with up to two decimal places. <p>[SLO: M-05-A-25] Divide numbers up to two decimal places by</p> <ul style="list-style-type: none"> up to 2-digit whole numbers 2-digit numbers with one decimal place. 			
---	---	---	<p>[SLO: M-04-A-35] Multiply and divide a 2-digit number with one decimal place by 10 and 100.</p>	<p>[SLO: M-05-A-26] Multiply and divide a number up to two decimal places by 10, 100 and 1000.</p>	---	---	---
---	---	---	<p>[SLO: M-04-A-36] Use appropriate operations to solve real-world word problems including 2-digit numbers with one decimal place (including money, quantities and measures).</p>	<p>[SLO: M-05-A-27] Use appropriate operations to solve real-world word problems including numbers up to two decimal places (including money, quantities and measures).</p>	---	---	---

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---	---	---	[SLO: M-04-A-38] Recognise the percent symbol (%) and understand that percent is the 'number of parts per hundred'.		---	---	---
---	---	---	---	[SLO: M-05-A-29] Express percentages as a fraction with denominator 100 and as a decimal number. [SLO: M-05-A-30] Use equivalences	[SLO: M-06-A-11] Express one quantity as a percentage of another, compare two quantities by percentage and increase or decrease a quantity by a	---	---

				between simple fractions, decimals and percentages in real world contexts.	given percentage.		
---	---	---	---	<p>[SLO: M-05-A-31] Solve real-world word problems involving conversion of percentage, fraction and decimal numbers.</p> <p>[SLO: M-05-A-32] Solve problems which require knowing percentage and decimal equivalents of $\frac{1}{2}$, $\frac{1}{4}$, $\frac{1}{5}$, $\frac{2}{5}$, $\frac{4}{5}$ and those fractions with a denominator of a multiple of ten or 25.</p>	<p>[SLO: M-06-A-12] Solve real-world word problems involving percentage.</p>	---	---

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---	---	---	---	---	<p>[SLO: M-06-A-14]</p> <p>Calculate ratio of two numbers (up to 3-digit) and simplify ratios.</p>	<p>[SLO: M-07-A-15]</p> <p>Calculate increase and decrease in a ratio based on change in quantities.</p>	---
---	---	---	---	---	<p>[SLO: M-06-A-15]</p> <p>Explain and calculate continued ratio.</p>	---	---

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---	---	---	---	---	---	[SLO: M-07-A-16] Explain and calculate direct and inverse proportion and solve real-world word problems related to direct and inverse proportion.	[SLO: M-08-A-11] Calculate direct and inverse and compound proportion and solve real-world word problems related to direct, inverse and compound proportion. (using table, equation and graph)
---	---	---	---	---	---	[SLO: M-07-A-17] Identify and differentiate between selling price, cost price, loss, discount, profit percentage and loss	[SLO: M-08-A-12] Explain and calculate profit percentage, loss percentage and discount.

						percentage.	
---	---	---	---	---	---	[SLO: M-07-A-18] Explain income tax, property tax, general sales tax, value-added tax, zakat and ushr.	[SLO: M-08-A-13] Explain and calculate profit/markup, principal amount and markup rate.
---	---	---	---	---	---	---	[SLO: M-08-A-14] Explain insurance, partnership and inheritance.
---	---	---	---	---	---	[SLO: M-07-A-19] Solve real world word problems involving profit, loss, discount, commission, tax, zakat and ushr.	[SLO: M-08-A-15] Solve real world word problems involving profit %, loss %, discount, profit, markup, insurance, partnership and inheritance.
---	---	---	---	[SLO: M-05-A-34] Recognise and use square numbers and	[SLO: M-06-A-17] Recognise and	[SLO: M-07-A-20] Recognise and	---

				cube numbers, and the notation for squared (²) and cubed (³)	calculate squares of up to 2-digit numbers.	calculate squares of numbers up to 3-digits.	
---	---	---	---	---	---	[SLO: M-07-A-21] Find the square roots of perfect squares of (up to 3-digit) natural numbers, fractions and decimals.	[SLO: M-08-A-16] Find the square root of natural numbers, common fractions and decimal numbers (up to 6-digit).
---	---	---	---	---	---	[SLO: M-07-A-22] Solve real-world word problems involving squares and square roots.	[SLO: M-08-A-17] Solve real-world word problems involving squares and square roots.
---	---	---	---	---	--	---	[SLO: M-08-A-18] Recognise perfect cubes and find: -cubes of up to 2-digit numbers

								- cube roots of up to 5-digit numbers which are perfect cubes
---	---	---	---	---	---	---	---	[SLO: M-08-A-19] Solve real-world word problems involving cubes and cube roots.
---	---	---	---	---	[SLO: M-06-A-18] Use language, notation and Venn Diagrams to represent different types of sets and their elements. (finite, infinite, empty, singleton and universal set)	[SLO: M-07-A-23] Use language, notation and Venn Diagrams to represent different sets and their elements. (natural numbers, whole numbers, integers, even numbers, odd numbers, prime numbers)	[SLO: M-08-A-20] Describe sets using language (tabular, descriptive and set-builder notation) and Venn diagrams	
---	---	---	---	---	---	---	[SLO: M-07-A-24] Identify and differentiate between:	[SLO: M-08-A-21] Find the power set (P) of set A where A has up

						<ul style="list-style-type: none"> • subset and superset • proper and improper • equal and equivalent • disjoint and overlapping. 	to four elements.
---	---	---	---	---	---	<p>[SLO: M-07-A-25] Describe and perform operations on sets (union, intersection, difference and complement).</p> <p>[SLO: M-07-A-26] Verify the following: $A \cap A^c = \emptyset$ $A \cup A^c = U$ $(A \cup B)^c = A^c \cap B^c$ $(A \cap B)^c = A^c \cup B^c$.</p>	<p>[SLO: M-08-A-22] Describe operations on sets and verify commutative, associative, distributive laws with respect to union and intersection.</p>
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							Verify De Morgan's laws and represent through Venn Diagram.
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Domain B: Algebra

Grade 1	Grade 2	Grade 3	Grade 4	Grade 5	Grade 6	Grade 7	Grade 8
Benchmarks: Students will be able to analyse and complete geometrical and number patterns; find the missing number or operation in a number sentence.			Benchmarks: Students will be able to analyse and complete number patterns; find the missing number or operation in a number sentence.		Benchmarks: Students will be able to recognise and manipulate number patterns, use letters to represent numbers, expand, simplify, factorise, evaluate and manipulate algebraic expressions, use algebraic identities, interpret and plot graphs of linear equations, solve linear and simultaneous linear equations and linear inequalities and apply all of these concepts in real life context.		
Student Learning Outcomes							

[SLO: M-01-B-01] Identify and extend the next shape in patterns with 2 or 3 orientations.	[SLO: M-02-B-01] Complete geometrical patterns (e.g., on a square grid) according to one or two of the following orientations: Shape, size or colour.	---	---	---	---	---	---
[SLO: M-01-B-02] Identify and extend patterns using 2-D and 3-D shapes as well as through pictorial illustrations.	[SLO: M-02-B-02] Explore patterns in a variety of ways using 2-D and 3-D shapes.	---	---	---	---	---	---
---	[SLO: M-02-B-03] Identify and extend repeating, increasing and decreasing number patterns. (for e.g., on a number line or on a hundreds chart)	[SLO: M-03-B-01] Recognise and extend a given number pattern in increasing and decreasing order.	[SLO: M-04-B-01] Using a pattern rule, describe the pattern found in a given table or chart.	[SLO: M-05-B-01] Using a pattern rule, describe the pattern found in a given table or chart.	[SLO: M-06-B-01] Recognise simple patterns from various number sequences.	[SLO: M-07-B-01] Recall recognizing simple patterns from various number sequences.	[SLO: M-08-B-01] Differentiate between an arithmetic sequence and a geometric sequence.
---	---	---	[SLO: M-04-B-02] Complete the given increasing and decreasing number patterns.	[SLO: M-05-B-02] Identify and apply the pattern rule of a given increasing and decreasing pattern	[SLO: M-06-B-02] Continue a given number sequence and find: -term to term rule	[SLO: M-07-B-02] Recall how to continue a given number	[SLO: M-08-B-02] Find terms of an arithmetic sequence using:

				to: -extend the pattern for the next three terms -determine missing elements in a given pattern.	-position to term rule	sequence and find: -term to term rule -position to term rule	-term to term rule -position to term rule
---	---	---	---	---	---	[SLO: M-07-B-03] Find terms of a sequence when the general term (nth term) is given.	[SLO: M-08-B-03] Construct the formula for the general term (nth term) of an arithmetic sequence.
---	---	---	---	---	[SLO: M-06-B-03] Solve real life problems involving number sequences and patterns.	[SLO: M-07-B-04] Solve real life problems involving number sequences and patterns.	[SLO: M-08-B-04] Solve real life problems involving number sequences and patterns.
---	---	[SLO: M-03-B-02] Find the missing number or operation in a number sentence (e.g., $20 + w = 100$).	[SLO: M-04-B-03] Identify and write expressions or number sentences to represent problems that may involve	---	---	---	---

			unknowns.				
---	---	---	[SLO: M-04-B-04] Identify and use relationships in a well-defined pattern (e.g., describe the relationship between adjacent terms and generate pairs of whole numbers given a rule).	---	---	---	---
---	---	---	---	---	[SLO: M-06-B-04] Explain the term algebra as an extension of arithmetic, where letters, numbers and symbols are used to construct algebraic expressions.	[SLO: M-07-B-05] Students will know Muhammad bin Musa Al-Khwarizmi as the founding father of Algebra. [SLO: M-07-B-06] Recall variables as a quantity which can take various numerical	[SLO: M-08-B-05] Recall the difference between: → open and close sentences → expression and equation → equation and inequality

						<p>values.</p> <p>[SLO: M-07-B-07]</p> <p>Recognise open and close sentences, like and unlike terms, variable, constant, expression, equation and inequality.</p> <p>[SLO: M-07-B-08]</p> <p>Recognise polynomials as algebraic expressions in which the powers of variables are whole numbers.</p>	
---	---	---	---	---	---	<p>[SLO: M-07-B-09]</p> <p>Identify a monomial, a binomial and a trinomial as a</p>	---

						polynomial.	
---	---	---	---	---	[SLO: M-06-B-05] Evaluate algebraic expressions by substitution of variables with numerical values.	[SLO: M-07-B-10] Add and subtract two or more polynomials.	[SLO: M-08-B-06] Recall the addition and subtraction of polynomials.
---	---	---	---	---	[SLO: M-06-B-06] Manipulate simple algebraic expressions using addition and subtraction.	[SLO: M-07-B-11] Find the product of: - monomial with monomial - monomial with binomial/trinomial - binomials with binomial/trinomial	[SLO: M-08-B-07] Recall the multiplication of polynomials.
---	---	---	---	---	---	---	[SLO: M-08-B-08] Divide a polynomial of degree up to 3

							by -a monomial -a binomial
---	---	---	---	---	[SLO: M-06-B-07] Simplify algebraic expressions.	[SLO: M-07-B-12] Simplify algebraic expressions (by expanding products of algebraic expressions by a number, a variable or an algebraic expression) involving addition, subtraction, and multiplication division.	[SLO: M-08-B-09] Simplify algebraic expressions involving addition, subtraction, multiplication and division.
---	---	---	---	---	---	[SLO: M-07-B-13] Explore the following algebraic identities and use them to expand expressions:	[SLO: M-08-B-10] Recognise the following algebraic identities and use them to expand expressions:

						$(a + b)^2 = a^2 + b^2 + 2ab$ $(a - b)^2 = a^2 + b^2 - 2ab$ $(a + b)(a - b) = a^2 - b^2$	$(a + b)^2 = a^2 + b^2 + 2ab$ $(a - b)^2 = a^2 + b^2 - 2ab$ $(a + b)(a - b) = a^2 - b^2$
---	---	---	---	---	---	---	<u>[SLO: M-08-B-11]</u> Apply algebraic identities to solve problems like $(103)^2$, $(1.03)^2$, $(99)^2$, 101×99 .
---	---	---	---	---	---	<u>[SLO: M-07-B-14]</u> Factorize algebraic expressions (by taking out common terms and by regrouping) <u>[SLO: M-07-B-15]</u> Factorize quadratic	<u>[SLO: M-08-B-12]</u> Factorize the following types of expressions: <ul style="list-style-type: none"> • $ka + kb + kc$ • $ac + ad + bc + bd$ • $a^2 \pm 2ab + b^2$ • $a^2 - b^2$ • $a^2 \pm 2ab + b^2 - c^2$

						expressions (by middle term breaking method).	
---	---	---	---	---	---	---	<p>[SLO: M-08-B-13] Manipulation of algebraic expressions $(a + b)^3 = a^3 + 3a^2b + 3ab^2 + b^3$ $(a - b)^3 = a^3 - 3a^2b + 3ab^2 - b^3$</p>
---	---	---	---	---	[SLO: M-06-B-08] Recognise and construct linear equations in one variable.	[SLO: M-07-B-16] Construct linear equations in two variables such as; $ax + by = c$, where a and b are not zero.	[SLO: M-08-B-14] Construct simultaneous linear equations in two variables.
---	---	---	---	---	[SLO: M-06-B-09] Solve linear	[SLO: M-07-B-17]	[SLO: M-08-B-15]

					equations involving integers, fractions and decimal coefficients.	Recall solving linear equations in one variable.	Solve simultaneous linear equations in two variables using: <ul style="list-style-type: none"> - elimination method - substitution method - graphical method division and factorisation method
---	---	---	---	---	[SLO: M-06-B-10] Solve real-world problems involving linear equations.		[SLO: M-08-B-16] Solve real-world word problems involving two simultaneous linear equations in two variables.
---	---	---	---	---	---	---	[SLO: M-08-B-17] Identify base, index/ exponent and its value.
---	---	---	---	---	---	---	[SLO: M-08-B-18]

								<p>Deduce and apply the following laws of Exponents/Indices:</p> <ul style="list-style-type: none"> -Product Law -Quotient Law -Power Law
---	---	---	---	---	---	---	---	<p>[SLO: M-08-B-19] Solve simple linear inequalities i.e., $ax > b$ or $cx < d$ $ax + b < c$ $ax + b > c$</p> <p>[SLO: M-08-B-20] Represent the solution of linear inequality on the number line.</p>
---	---	---	---	---	---	---	<p>[SLO: M-07-B-18] Introduction to Cartesian coordinate system.</p>	---

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---	---	---	---	---	---	<p>[SLO: M-07-B-20]</p> <p>Recognise and state the equation of a horizontal line and a vertical line.</p>	<p>[SLO: M-08-B-21]</p> <p>Recognise the gradient of a straight line. Recall the equation of horizontal and vertical lines i.e., $y = c$ and $x = a$</p>
---	---	---	---	---	---	<p>[SLO: M-07-B-21]</p> <p>Find values of 'x' and 'y'</p>	<p>[SLO: M-08-B-22]</p> <p>Find the value of 'y' when 'x' is</p>

							from the graph.	given from the equation and vice versa.
---	---	---	---	---	---	---	---	[SLO: M-08-B-23] Plot graphs of linear equations in two variables i.e., $y = mx$ and $y = mx + c$
---	---	---	---	---	---	---	---	[SLO: M-08-B-24] Interpret the gradient/ slope of the straight line.
---	---	---	---	---	---	---	---	[SLO: M-08-B-25] Determine the y-intercept of a straight line.

Domain C: Measurement

Grade 1	Grade 2	Grade 3	Grade 4	Grade 5	Grade 6	Grade 7	Grade 8
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<p>Benchmarks: Students will be able to measure, compare and order lengths (Kilometres/metres/ centimetres), mass (kilograms/grams/milligrams), and capacity (litres/ millilitres); read, write and compare time (hours and minutes); measure area and perimeter using square grids.</p> <p>They would also solve problems involving mass, length, weight/mass, capacity, and time (including addition and subtraction).</p>	<p>Benchmarks: Students will be able to measure, compare and convert lengths, mass, capacity and time from one standard unit to another; read, write and convert time in 24 hour and 12 hour notation.</p> <p>They would also solve problems involving length, mass/weight, capacity and time; solve problems involving perimeter and area of parallelogram, triangle, square, rectangle and rectilinear shapes.</p>	<p>Benchmarks: Students will be able to convert between different units of measure, solve problems involving speed, distance, time, area and perimeter of 2D shapes, surface area and volume of 3D shapes and apply the Pythagorean Theorem.</p>
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Student Learning Outcomes

<p>[SLO: M-01-C-01] Use mathematical language to compare the height/length of two or more objects.</p> <p>[SLO: M-01-C-02] Measure and compare the length of objects using non-standard units.</p>	<p>[SLO: M-02-C-01] Compare the lengths of different objects using standard units of length (metre and centimetre) using <, >, and = signs.</p>	---	---	---	---	---	---
---	<p>[SLO: M-02-C-02] Recognise and use the standard units of</p>	<p>[SLO: M-03-C-01] Recognise and use the standard units of length</p>	---	---	---	---	---

	length (metre and centimetre) to measure and record the length of different objects.	(kilometre, metre, centimetre and millimetre) to measure and record the length of different objects.					
---	---	---	[SLO: M-04-C-01] Convert units of length from larger to smaller units (Kilometre, metre, centimetre and millimetre).	[SLO: M-05-C-01] Convert units of length from larger to smaller and vice versa.	---	[SLO: M-07-C-01] Convert different units of distance.	---
---	[SLO: M-02-C-03] Add and subtract lengths, given in the same units to solve real-world word problems.	[SLO: M-03-C-02] Add and subtract lengths, given in the same units to solve real-world word problems.	[SLO: M-04-C-02] Convert, add and subtract lengths, to solve real-world word problems.	[SLO: M-05-C-02] Convert, add and subtract lengths, to solve real-world word problems.	---	---	---
[SLO: M-01-C-03] Use mathematical language to compare the mass of two or more objects. [SLO: M-01-C-04] Measure and compare the mass of objects using non-standard units.	[SLO: M-02-C-04] Compare the mass of different objects using standard units of mass (kilogram and gram) using $<$, $>$, and $=$ signs.	---	---	---	---	---	---

---	[SLO: M-02-C-05] Recognise and use the standard units of mass (Kilograms and grams) to measure and record the mass of different objects.	[SLO: M-03-C-03] Recognise and use the standard units of mass (Kilograms, grams and milligrams) to measure and record the mass of different objects.	---	---	---	---	---
---	---	---	[SLO: M-04-C-03] Convert units of mass from larger to smaller units (kilogram and gram).	[SLO: M-05-C-03] Convert units of mass from larger to smaller and vice versa.	---	---	---
---	[SLO: M-02-C-06] Add and subtract mass, given in the same units to solve real-world word problems.	[SLO: M-03-C-04] Add and subtract mass, given in the same units to solve real-world word problems.	[SLO: M-04-C-04] Convert, add and subtract mass to solve real-world word problems.	[SLO: M-05-C-04] Convert, add and subtract mass to solve real-world word problems.	---	---	---
[SLO: M-01-C-05] Use mathematical language to compare the capacity of two or more objects.	[SLO: M-02-C-07] Compare the capacity of different objects using standard units of capacity (litre and millilitre) using $<$, $>$, and $=$ signs.	---	---	---	---	---	---
[SLO: M-01-C-06] Measure and	[SLO: M-02-C-08] Recognise and use the	[SLO: M-03-C-05] Recognise and use the	[SLO: M-04-C-05] Convert units of	[SLO: M-05-C-05] Convert units of	---	---	---

compare the capacity of objects using non-standard units	standard units of capacity (litre and millilitre) to measure and record the capacity of different objects.	standard units of capacity (litre and millilitre) to measure and record the capacity of different objects.	capacity from larger to smaller units (litre and millilitre).	capacity from larger to smaller and vice versa.			
[SLO: M-01-C-07] Read and write temperature to the nearest appropriate unit i.e., (°C) using pictorial representations and relating temperature scale to number line.	[SLO: M-02-C-09] Read and write temperature to the nearest appropriate unit i.e., (°C) using pictorial representations and relating temperature scale to number line. [SLO: M-02-C-10] Compare and order temperature using <, >, and = signs.	[SLO: M-03-C-06] Read and write temperature to the nearest appropriate unit i.e., (°C) using pictorial representations and relating temperature scale to number line. [SLO: M-03-C-07] Compare and order temperature using <, >, and = signs.	[SLO: M-04-C-06] Recognise the other temperature measuring scales; Kelvin, Celsius and Fahrenheit		---	---	---
---	[SLO: M-02-C-11] Add and subtract capacities given in the same units to solve real-life word problems.	[SLO: M-03-C-08] Add and subtract capacities given in the same units to solve real-life word problems.	[SLO: M-04-C-07] Convert, add and subtract capacities to solve real-life word problems.	[SLO: M-05-C-06] Convert, add and subtract capacities to solve real-life word problems.	---	----	----
[SLO: M-01-C-08] Read and write time	[SLO: M-02-C-12] Read and write time	[SLO: M-03-C-09] Read and write time in	[SLO: M-04-C-08] Read and write time	---	---	---	---

<p>in hours (o'clock) from analogue clock and digital clock.</p> <p>[SLO: M-01-C-09] Show time in an hour on an analogue clock.</p>	<p>in hours and minutes (with five minute intervals, half past, quarter past and quarter to) from analogue and digital clocks.</p> <p>[SLO: M-02-C-13] Show time in hours and minutes on an analogue clock.</p>	<p>hours and minutes from analogue and digital clocks.</p>	<p>from digital and analog clocks in 12-hour and 24-hour format.</p>				
---	---	<p>[SLO: M-03-C-10] Recognise and use a.m. and p.m.</p>	---	---	---	---	---
---	<p>[SLO: M-02-C-14] Recognise intervals of time (for instance to estimate/give a rough calculation of the time taken by particular events or tasks)</p>	---	<p>[SLO: M-04-C-09] Convert larger units to smaller units of time (hours, minutes, seconds, years, months, weeks and days).</p> <p>[SLO: M-04-C-10] Calculate duration of different events using start time and end time.</p>	<p>[SLO: M-05-C-07] Convert larger units to smaller units of time and vice versa.</p>	---	<p>[SLO: M-07-C-02] Convert 12 hour clock to 24 hour clock and vice versa.</p> <p>[SLO: M-07-C-03] Convert between different units of time and speed.</p>	----

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---	---	---	---	---	---	[SLO: M-07-C-05] Solve real-world word problems involving distance, time and average speed. [SLO: M-07-C-06] Differentiate between uniform and average speeds.	---
[SLO: M-01-C-10] Name days of the week and months of the Solar and Islamic year.	[SLO: M-02-C-15] Use Solar and Islamic Calendar to find a particular day/date in real-life situations.	[SLO: M-03-C-12] Read and write days and dates from the Solar Calendar.	---	---	---	---	---

---	[SLO: M-02-C-16] Recognise perimeter and area.	[SLO: M-03-C-13] Recognise and identify the units of measurement of area and perimeter and find the perimeter and area of 2-D figures (Squares and rectangles) and irregular figures (figures covers either $\frac{1}{2}$ or 1 square unit only) on a square grid.	[SLO: M-04-C-12] Identify the units of measurement for perimeter and area, [SLO: M-04-C-13] Differentiate between the perimeter and area of a square, rectangular and rectilinear shapes. [SLO: M-04-C-14] Apply formulas to find the perimeter and area of squares, rectangles and rectilinear shapes.	[SLO: M-05-C-09] Recognise that the shapes with the same area can have different perimeters and vice versa. [SLO: M-05-C-10] Calculate the area of parallelograms and triangles.	[SLO: M-06-C-01] Calculate the area of; a path (inside or outside) a rectangle or square, parallelogram, triangle and trapezium.	[SLO: M-07-C-07] Calculate the area and perimeter of the shaded/unshaded region in composite shapes. [SLO: M-07-C-08] Calculate the circumference and area of a circle.	[SLO: M-08-C-01] State the Pythagoras theorem and use it to solve right angled triangles. [SLO: M-08-C-02] Calculate the arc length and the area of the sector of a circle.
---	---	---	---	[SLO: M-05-C-11] Solve real life word problems involving perimeter and area of square and rectangular regions.	[SLO: M-06-C-02] Solve real life word problems involving perimeter and area.	---	[SLO: M-08-C-03] Solve real life word problems using Pythagoras theorem.

---	---	---	---	---	[SLO: M-06-C-03] Calculate the surface area and volume of cube and cuboids.	[SLO: M-07-C-09] Calculate the surface area and volume of any simple 3-D shape including right prisms and cylinders.	[SLO: M-08-C-04] Calculate the surface area and volume of the pyramid, sphere, hemisphere and cone.
---	---	---	---	---	---	[SLO: M-07-C-10] Convert between standard units of area (m ² , cm ² , mm ² and vice versa) and volume (m ³ , cm ³ and mm ³ and vice versa)	---
---	---	---	---	---	[SLO: M-06-C-04] Solve real life word problems involving the surface area and volume of cubes and cuboids.	[SLO: M-07-C-11] Solve real life word problems involving the surface area and volume of right prisms and cylinders.	[SLO: M-08-C-05] Solve real life word problems involving the surface area and volume pyramid, sphere, hemisphere and cone.

Domain D: Geometry

Grade 1	Grade 2	Grade 3	Grade 4	Grade 5	Grade 6	Grade 7	Grade 8
<p>Benchmarks: Students will be able to use properties to describe and compare three-dimensional shapes (cube, cuboid, cone, cylinder, sphere, prism and pyramids) and relate those with two dimensional shapes; differentiate and classify polygons.</p> <p>Identify parallel and perpendicular lines; reflective symmetry, right angles and angles smaller and larger than a right angle; positions, directions and movements, centre, radius, and diameter of a circle.</p>			<p>Benchmarks: Students will be able to use properties to describe and compare quadrilaterals; identify three dimensional shapes and relate three dimensional shapes with their two dimensional representations.</p> <p>They will also identify and draw types of angles up to 180 degrees and lines of symmetry in 2-D shapes; compare and order angles by size; identify circumference of a circle.</p>		<p>Benchmarks: Students will be able to construct lines, angles of different measure, bisectors of angles, line segments, triangles and quadrilaterals ,use the properties of triangles ,quadrilaterals, polygons and circles to calculate unknown angles and lengths, apply facts of congruence and similarity and analyse and apply concepts of symmetry and transformations from two and three-dimensional perspectives.</p>		
Student Learning Outcomes							
[SLO: M-01-D-01] Recognise and identify 2-D shapes (Rectangle, square, circle and triangle) with respect to their characteristics (i.e., sides and corners).	[SLO: M-02-D-01] Recognise, identify and draw 2-D shapes (Rectangle, square, circle, triangle, semi-circle and quarter-circle) with respect to their characteristics.	[SLO: M-03-D-01] Differentiate and classify polygons with respect to their attributes (pentagon, hexagon, octagon and decagon).	---	[SLO: M-05-D-01] Recognise, compare and classify types of quadrilaterals and their characteristics (parallel sides, equal sides, equal angles, right angles, lines of symmetry etc).	---	[SLO: M-07-D-01] Recognise quadrilaterals and their characteristics (parallel sides, equal sides, equal angles,	---

	[SLO: M-02-D-02] Identify pairs of perpendicular and parallel lines.			(Square, rectangle, parallelogram, rhombus, trapezium and kite).		right angles, lines of symmetry etc). (Square, rectangle, parallelogram, rhombus, trapezium and kite) [SLO: M-07-D-02] Differentiate between convex and concave polygons.	
[SLO: M-01-D-02] Recognise and identify 3-D Shapes (cube, cuboid, cone, cylinder and sphere) with respect to their characteristics.	[SLO: M-02-D-03] Recognise, identify 3-D shapes in different orientations. [SLO: M-02-D-04] Make 3-D Shapes using varied modelling materials (cube, cuboid, cone, cylinder, sphere,) with respect to their characteristics.	[SLO: M-03-D-02] Identify and differentiate between prisms and pyramids with respect to their attributes.	---	[SLO: M-05-D-02] Recognise and draw nets of prisms and pyramids.	[SLO: M-06-D-01] Recognise and identify 3-D shapes (i.e., cube, cuboid, cone, cylinder, sphere, hemisphere and cone) with respect to their characteristics.	---	---

<p>[SLO: M-01-D-03] Describe the position, movement and direction of an object including moving in a straight line using positional language (for instance: inside, outside, above, below, over, under, far, near, before, after, straight, backward, right and left).</p>	<p>[SLO: M-02-D-05] Describe the position, direction and movement of an object including moving clockwise, anti-clockwise, quarter, half and three quarters turns using appropriate positional language (for instance: inside, outside, above, below, over, under, far, near, before, after, beside, between, left, right and in front of, quarter turn, half turn, three quarter turns, clockwise, anti-clockwise, behind etc).</p> <p>[SLO: M-02-D-06] Recognise turn as a rotation.</p>	<p>[SLO: M-03-D-03] Describe the movement of objects (i.e., slide and rotation).</p>	<p>---</p>	<p>---</p>	<p>[SLO: M-06-D-02] Reflect an object using grid paper and compass and find the line of reflection by construction.</p>	<p>[SLO: M-07-D-03] Translate an object and give precise description of transformation</p>	<p>[SLO: M-08-D-01] Rotate an object and find the centre of rotation by construction. [SLO: M-08-D-02] Enlarge a figure (with the given scale factor) and find the centre and scale factor of enlargement.</p>
<p>---</p>	<p>[SLO: M-02-D-07] Identify and differentiate between a straight and curved</p>	<p>[SLO: M-03-D-04] Recognise point, line, ray and line segment; and draw and measure</p>	<p>[SLO: M-04-D-01] Recognise and identify parallel and non-parallel lines.</p>	<p>---</p>	<p>[SLO: M-06-D-03] Identify and differentiate</p>	<p>[SLO: M-07-D-04] Know that the perpendicular</p>	<p>---</p>

	line. [SLO: M-02-D-08] Identify horizontal and vertical lines.	line segments.			between parallel lines, perpendicular lines and transversal.	distance from a point to a line is the shortest distance to the line.	
---	---	[SLO: M-03-D-05] Identify the centre, radius and diameter of a circle.	[SLO: M-04-D-02] Describe the radius, diameter and circumference of a circle.	---	---	[SLO: M-07-D-05] Describe the properties of a circle; centre, radius, diameter, chord, arcs, major and minor arc, semi-circle and segment of a circle.	[SLO: M-08-D-03] Describe chord, arcs, major and minor arc, semi-circle, segment of a circle, sector, central angle, secant, tangent and concentric circles.
---	[SLO: M-02-D-09] Identify quarter turns.	[SLO: M-03-D-06] Recognise and Identify quarter turns and identify quarter turns as right angles (and vice versa). [SLO: M-03-D-07] Identify half and 3-quarter turns (clockwise	[SLO: M-04-D-03] Recognise and identify acute, right and obtuse angles. [SLO: M-04-D-04] Compare and order angles up to 180 degrees by size.	[SLO: M-05-D-03] Identify - angles at a point on a straight line and half a turn (180 degrees). - angles at a point and 1 whole turn (360 degrees). [SLO: M-05-D-04]	[SLO: M-06-D-04] Identify adjacent angles and find unknown angles related to parallel lines and transversals. (corresponding, alternate and	[SLO: M-07-D-06] Calculate unknown angles in quadrilaterals using the properties of quadrilaterals. (square,	---

		and anti-clockwise) as two and three right angles respectively.	[SLO: M-04-D-05] Measure and draw angles (using a protractor) within 180 degrees.	Describe and calculate complementary and supplementary angles.	vertically opposite angles)	rectangle, parallelogram, rhombus, trapezium and kite).	
---	---	---	---	---	---	[SLO: M-07-D-07] Understand the relationship between interior and exterior angles of polygons and between opposite interior and exterior angles in a triangle. [SLO: M-07-D-08] Calculate the interior and exterior angles of a polygon and the sum of interior angles of a polygon.	---
---	---	[SLO: M-03-D-08] Identify reflective	[SLO: M-04-D-06] Recognise and draw	[SLO: M-05-D-05] Explore, identify and	[SLO: M-06-D-05]	[SLO: M-07-D-09]	---

		symmetry in 2-D shapes.	lines of symmetry in 2-D shapes and complete symmetrical figures with respect to a given line of symmetry.	draw lines of symmetry in 2-D shapes and complete symmetrical figures with respect to a given line of symmetry.	Recognise rotational symmetry, find the point of rotation and order of rotational symmetry.	Recognise identity and draw lines of symmetry in 2-D shapes and rotate objects using rotational symmetry; and find the order of rotational symmetry.	
---	---	---	---	[SLO: M-05-D-06] Identify and describe different types of triangles; with respect to sides and angles. Calculate and measure unknown angles in a triangle.	---	[SLO: M-07-D-10] Calculate unknown angles in a triangle.	---
---	---	---	---	---	[SLO: M-06-D-06] Construct angles of specific measures (30, 45, 60, 75, 90, 105 and 120) and bisect angles using a compass. [SLO: M-06-D-	[SLO: M-07-D-11] Construct different types of triangles. (equilateral, isosceles, scalene, acute-angled, right-angled and obtuse-angled)	[SLO: M-08-D-04] Construct a triangle when: -three sides (SSS) -two sides and included angle (SAS) -two angles and included

					<p><u>07]</u> Construct a perpendicular (from a point on the line and outside the line) and a perpendicular bisector.</p>	<p>side - a right-angled triangle when hypotenuse and one side (HS) are given. [SLO: M-08-D-05] Construct different types of quadrilaterals (square, rectangle, parallelogram, trapezium, rhombus and kite). [SLO: M-08-D-06] Draw angle and line bisectors to divide angles and sides of triangles and quadrilaterals.</p>
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Domain E: Statistics and Probability

Grade 1	Grade 2	Grade 3	Grade 4	Grade 5	Grade 6	Grade 7	Grade 8
<p>Benchmarks: Read and interpret data from pictographs, bar graphs, tally charts, block graphs and Carroll diagrams. Organise and represent data using pictographs, bar graphs, tally charts, block graphs and Carroll diagrams to answer questions.</p>			<p>Benchmarks: Read and interpret data from tables, pictographs, bar graphs, tally charts, block graphs, line graphs, pie charts and Carroll diagrams.</p>		<p>Benchmarks: Students will be able to collect, classify and tabulate statistical data, interpret, construct and use statistical graphs, calculate and interpret measures of central tendency and solve problems using various concepts</p>		

Describe the probability of an event.

Organise and represent data using tables, pictographs, bar graphs, tally charts, block graphs, line graphs, pie charts and Carroll diagrams to answer questions.

Solve problems in context in relation to averages of quantities, measures and numbers. Describe the probability of an event; represent the probability of an event including real world problems.

pertaining to Experimental and Theoretical Probability.

Student Learning Outcomes

<p>[SLO: M-01-E-01] Read and interpret data using pictographs, block graphs and tally charts. (including real-world problems)</p>	<p>[SLO: M-02-E-01] Read and interpret data using pictographs, bar graphs and tally charts and; represent data using tally charts. (including real-world problems)</p>	<p>[SLO: M-03-E-01] Represent data; read and interpret data using Carroll Diagrams. (including real-world problems)</p>	<p>[SLO: M-04-E-01] Draw, read and interpret horizontal and vertical single and double bar graphs. (including real-world problems)</p>	<p>[SLO: M-05-E-01] Draw, read and interpret bar and line graphs. Interpret pie charts. (including real-world problems)</p>	<p>[SLO: M-06-E-01] Draw, read and interpret horizontal and vertical multiple bar graphs and pie charts. (including real-world problems)</p>	<p>[SLO: M-07-E-01] -Recognise drawing and interpreting of bar graphs, line graphs and pie charts. -Differentiate between a histogram and a bar graph. -Construct and compare histograms for both discrete and continuous data with equal interval range. -Select and justify the most appropriate graph(s) for a given data set and draw simple conclusions based on the shape of the graph.</p>	<p>[SLO: M-08-E-01] Select and justify the most appropriate graph(s) for a given data set and draw simple conclusions based on the shape of the graph.</p>
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---	---	---	---	[SLO: M-05-E-02] Find the average of given quantities, measures and numbers in a data. [SLO: M-05-E-03] Solve real world word problems related to averages involving quantities, measures and numbers.	[SLO: M-06-E-03] Calculate the mean, median and mode for ungrouped data and solve related real-world problems.	[SLO: M-07-E-03] Calculate the mean, median and mode for ungrouped data and the mean for grouped data and solve related real-world problems; Compare, choose and justify the appropriate measures of central tendency for a given set of data.	[SLO: M-08-E-03] Calculate range, variance and standard deviation for ungrouped data and solve related real-world problems.

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[SLO: M-01-E-02] Describe the likelihood that everyday events will occur, using mathematical language (i.e., impossible, less likely and more likely).	[SLO: M-02-E-02] Describe the likelihood that everyday events will occur, using mathematical language (i.e., impossible, less likely, more likely, unlikely and certain).	[SLO: M-03-E-02] Describe the likelihood that everyday events will occur, using mathematical language (i.e., impossible, possible, less likely, more likely, equally likely, unlikely and certain).	M-04-E-02 Describe the outcome of a simple probability experiment (spinner and dice), using mathematical language (i.e., impossible, less likely, more likely, equally likely, unlikely and certain).	[SLO: M-05-E-04] Explain experiments and outcomes; and represent the probability (using a fraction) that an event will occur, in simple games and probability experiments (including real-world word problems).	[SLO: M-06-E-04] Explain experiments, outcomes, sample space, events, equally likely events and probability of a single event. Differentiate the outcomes that are equally likely and not equally likely	[SLO: M-07-E-05] \Explain and compute the probability of; certain events, impossible events and complement of an event. (including real-world word problems).	[SLO: M-08-E-05] Explain and compute the probability of; mutually exclusive, independent, simple combined and equally likely events. (including real-world

					to occur. (including real-world word problems).		word problems). [SLO: M-08-E-06] Perform probability experiments (for example tossing a coin, rolling a die, spinning a spinner etc. for certain number of times) to estimate probability of a simple event [SLO: M-08-E-07] Compare experimental and theoretical probability in simple events.
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Cross Cutting Themes

The idea of Science, Technology, Engineering, The Arts and Mathematics (STEAM) is an overarching idea for how to break up the study of Math into core disciplinary knowledge (that students need to learn in order to pass examination at each grade level) and cross cutting themes (interdisciplinary connections and recurring ideas that are best reinforced in every chapter in order to promote student critical thinking and curiosity, but that is not expected to be assessed in standardised exams).

Cross-cutting themes must be appropriately included into every chapter of schools textbooks that are aligned with these standards. This does not mean that every subcomponent of every theme must be included in every chapter, rather that where connections are appropriate and would enhance the study of the core disciplinary knowledge these should be incorporated.

Science, Technology and Engineering: applications of mathematics to create solutions that improve standards of living and the connections of mathematics with the natural world.

Arts: What can be understood about the nature of mathematics from the fine arts, performing arts and the humanities.

Mathematics: theoretical understandings/big ideas in mathematics and mathematical practices, and their mutual overlaps in the methods of mathematical inquiry.

Science, Technology and Engineering

Applications of Mathematics

- **The interconnectedness of Mathematics and Science**

- The symbolic language of mathematics is extremely valuable for expressing scientific ideas unambiguously.
- Mathematics provides the rules for analysing scientific ideas and data rigorously.
- The accuracy and reliability of mathematical theories and principles serve as a basis for scientific discovery and understanding.
- Science provides mathematics with interesting problems to investigate, and mathematics provides science with powerful tools to use in analysing data.

- **Mathematics has a wide range of applications in science, engineering and technology.**

- Mathematics is often used as a tool in the sciences, such as physics, chemistry, and biology, to describe and explain phenomena in the natural world.
 - Mathematical models and equations are used to make predictions and test hypotheses in scientific research.
 - Engineers use mathematical concepts and techniques to solve practical problems and design systems and structures.
 - Engineers use mathematical models to simulate and analyse the behaviour of systems, and to optimise their designs.
- Engineers also use mathematical tools to analyse and control complex systems and processes.
- Mathematical methods and techniques are used to analyse and optimise the performance of a wide variety of technological

systems and devices, including communication systems, control systems, and manufacturing processes.

Arts

Nature of Mathematics

1. Mathematics is a product of the exploration of structure, patterns and relationships.

- As a theoretical discipline, mathematics is driven by abstract concepts and generalisation. This mathematics is drawn out of ideas, and develops through linking these ideas and developing new ones.
- As an applied discipline, mathematicians focus their attention on solving problems and discovering relationships that originate in the world of experience.
- The results of theoretical and applied mathematics often influence each other.

2. Mathematics uses a variety of methods to make claims.

- Mathematics uses multiple strategies and multiple representations to revise and produce new knowledge.
- The new knowledge is presented in the form of theorems that have been built from axioms and logical mathematical arguments and a theorem is only accepted as true when it has been proven.
- Mathematics relies on logic rather than on observation as its standard of validity and accuracy, yet employs observation, simulation, and even experimentation as means of discovering new ideas, theories and principles.

3. Mathematical knowledge is open to revision and refinement.

- Mathematics has a history that includes the refinement of, and changes to, theories, ideas, and beliefs over time.

- Mathematics is critiqued and verified by people within particular cultures through justification or proof that is communicated

to oneself and others.

- The body of knowledge that makes up mathematics is not fixed; it has grown during human history and is growing at an increasing rate.

4. Mathematics is a human endeavour.

- Mathematical knowledge is a result of human endeavour, imagination and creativity.

- Mathematics can be produced by each and every person.

- Mathematics is not created arbitrarily, but arises from activity with already existing mathematical objects, and from the needs of science and daily life.

- Individuals and teams from many nations and cultures have contributed to mathematics and to advances in mathematical applications in science, engineering and technology.

- Mathematicians' backgrounds, theoretical commitments, and fields of endeavour influence the nature of their findings.

- Technological advances have influenced the progress of mathematics and mathematics has influenced advances in technology.

- Mathematical ideas impact society and culture, and cultural and societal factors influence the development of mathematics.

5. Mathematics is worthwhile, beautiful and often useful.

- Mathematics today is a diverse discipline that deals with data, measurements, and observations from science; with inference,

deduction, and proof; and with mathematical models of natural phenomena, of human behaviour, and of social systems.

- Mathematics empowers us to better understand the information-laden world in which we live by equipping us with critical thinking skills.
- Mathematics reveals hidden patterns that help us understand the natural world around us.
- The patterns and structures that exist in mathematics are considered to be aesthetically pleasing and beautiful, much like works of art.
- Mathematics is a language that is understood and used globally, making it a bridge between cultures and disciplines.

Mathematics

A. Mathematical Knowledge (these themes represent big ideas in mathematics which are applied across the conceptual SLOs)

● Quantity, Measurement and Approximation

- Quantities and values can be used to describe key features and behaviours of objects such as functions.
- Measurements can be represented in equivalent ways using different units. For example, degrees and radians can be used for angles to facilitate ease of calculation.
- Approximation of numbers adds uncertainty or inaccuracy to calculations, leading to potential errors but can be useful when handling extremely large or small quantities.
- When quantities change, a useful measurement to make is the “Rate of Change” which gives us an idea of how much one quantity is dependent on the other.

- **Abstraction and Generalization**

- Mathematical situations and structures can be translated and represented abstractly using variables, expressions, and equations.

- Extending results from a specific case to a general form can allow us to apply them to a larger system.

- **Patterns, Relationships and Modelling systems**

- Patterns can be identified in behaviours which can give us insight into appropriate strategies to model or solve them.

- Relationships can be described and generalizations made for mathematical situations that have numbers or objects that repeat

in predictable ways.

- Modelling real-life situations allows for prediction, analysis and interpretation and can be used to provide effective solutions to real-life problems.

- Predictions based on models have limited precision and reliability due to the assumptions and approximations inherent in

models.

- **Representation and Equivalence**

- Any number, measure, numerical expression, algebraic expression, or equation can be represented in an infinite number of

ways that have the same value.

- Different but equivalent representations of objects such as visual, symbolic, verbal, contextual and physical representations,

can reveal different characteristics of the same relationship.

- Different representations enable quantities to be compared and used for computational purposes with ease and accuracy.

- **Space**

- Objects in space can be oriented in an infinite number of ways, and an object's location in space can be described quantitatively.

- Objects in space can be transformed in an infinite number of ways, and those transformations can be described and analyzed mathematically.

- **Logic, Validity and Justification**

- Logic is a powerful tool for justifying what we discover through measurement and observation.

- Logic is a method of reasoning and a system of principles used to build arguments, reach conclusions and explain the validity of these conclusions.

- Considering the reasonableness and validity of results helps us to make informed, unbiased decisions.

B. Mathematical Practices (these themes are also embedded in the conceptual SLOs but will primarily be implemented through teaching and learning practices elaborated in this curriculum guide)

- **Problem-solving**

- Understand the meaning of a problem and look for entry points to its solution.

- Analyze givens, constraints, relationships, and goals.

- Make conjectures about the form and meaning of the solution and plan a solution pathway.

- Employ different problem solving strategies in order to gain insight into its solution.

These can include:

- Considering analogous problems
 - Trying special cases and simpler forms of the original problem
 - Finding patterns or structure and looking for general methods
 - Listing all possibilities and eliminating options based on constraints
 - Making educated guesses and using trial and error
 - Visualising the problem using different diagrams
 - Working backwards
- Monitor and evaluate progress and check answers to problems using a different method.
 - Understand the approaches of others to solving complex problems and identify correspondences between different approaches.
- **Communication and reasoning**
- While constructing arguments, understand and use stated assumptions, clear definitions, and previously established results, considering the units involved and attending to the meaning of quantities and symbols.
 - Make conjectures and build a logical progression of statements to explore the truth of the conjectures.
 - Analyse situations by breaking them into cases, and recognize and use counterexamples.
 - Justify conclusions, communicate them to others, and respond to the arguments of others.
 - Ask useful questions to clarify or improve the arguments.

- Compare the effectiveness of two plausible arguments, distinguish correct logic or reasoning from that which is flawed, and

explain the flaw in an incorrect argument.

● **Mathematical modelling**

- Apply mathematical knowledge to solve problems arising in everyday life, society, and the workplace.

- Make choices, assumptions and approximations to simplify a complicated situation.

- Identify variables in the situation and select those that represent essential features.

- Formulate a model by creating and selecting geometric, graphical, tabular, algebraic, or statistical representations that describe relationships between the variables.

- Analyse these relationships mathematically to draw conclusions

- Interpret the mathematical results in the context of the original situation.

- Validate the conclusions by comparing them with the situation, and improve the model if it has not served its purpose.

● **Use appropriate tools strategically**

- Able to use tools, including technological tools, to explore and deepen their understanding of concepts, solve mathematical

problems, test conjectures and justify interpretations.

- Be familiar with the different kinds of non-technological tools available such as pencil and paper, concrete models, ruler, protractor and calculator.

- Be familiar with the different kinds of technological tools available such as graphical calculators, dynamic graphing software, spreadsheets, simulations, apps, and dynamic geometry software.

- Make sound decisions about when each of these tools might be helpful, recognizing both the insight to be gained and their limitations.

Progression Grid

Domain A: Numbers and Algebra

Number system is a system of representing numbers in mathematics. Students deal with various types of numbers for solving mathematics formulas and calculation, data processing and handling complex topics like algebra and geometry.

Algebra is one of the oldest branches in the history of mathematics that deals with number theory, geometry, and analysis. It is the study of mathematical symbols and the rules for manipulating these symbols in formulas; it is a unifying thread of almost all of mathematics. Algebra includes almost everything right from solving elementary equations to the study of abstractions. Also, there are several algebra equations, formulas and identities present in algebra.

Standard 1: The students will be able to:

- compare the properties of numbers and number systems, including the rational and real numbers, and understand complex numbers as solutions to quadratic equations that do not have real solutions.
- understand vectors and matrices as systems that have some of the properties of the real number system.

- use number-theory arguments to justify relationships involving whole number
- analyse and interpret mathematical situations by manipulating algebraic expressions and relations,
- model and solve contextual problems,
- interpret functions, calculate rate of change of functions, apply differentiation, integrate analytically,
- utilise integration, solve simple ordinary differential equations, solve nonlinear equations numerically by simple iterative formula.

Domain A: Numbers and Algebra

Grade 9	Grade 10	Grade 11	Grade 12
<p>Benchmark I: Students will be able to identify Real Numbers and their properties to carry out basic operations.</p> <p>Benchmark II: Students will be able to add, subtract, and multiply matrices, evaluate the determinant of matrices to find the inverse of matrices, solve simultaneous linear equations using matrices,</p> <p>Benchmark III: Students will be able to use Venn diagrams to demonstrate and describe operations of sets</p>		<p>Benchmark I: Students will be able to Identify complex numbers and their properties to carry out basic operations.</p> <p>Benchmark II: Students will be able to perform matrix algebra, evaluate determinant and solve homogeneous and non-homogeneous linear equations.,</p> <p>Benchmark III: Students will be able to demonstrate Arithmetic, geometric and harmonic sequence, their means and sum of series and apply them in real world problems.</p>	

and apply in real life situations. Express functions, inverse functions, and composite functions

Benchmark IV: Students will be able to simplify, factorise and manipulate Algebraic Fractions, Identify and rationalise surds, and factorise algebraic expressions

Benchmark V: Students will be able to solve linear equations, a system of two linear equations with two variables and solve linear inequalities.

Benchmark VI: Students will be able to solve Quadratic equations by using different methods and solve real world situations by formulating a quadratic equation

Benchmark VII: Students will be able to plot and interpret the Graphs in practical situations such as travel graphs, conversion graphs and speed time graphs.

Benchmark IV: Students will be able to apply the principle of Mathematical Induction to prove statements, identities, and formulae, and find approximate values of the binomial expansions having indices as rational numbers.

Benchmark V: Students will be able to divide polynomials, apply factor theorem, remainder theorem, factorise cubic polynomial and resolve an algebraic fraction into partial fractions

Benchmark VI: Students will be able to analyse attributes of quadratic equations and solve quadratic equations, and quadratic inequalities, in one unknown

Benchmark VII: Students will be able to plot and interpret the Graphs of functions. Fundamental transcendental functions, their domain and range. Evaluate limits of different algebraic, exponential, and trigonometric functions

Benchmark VIII: Students will be able to differentiate and integrate a function with the emphasis on practical applications.

Benchmark IX: Students will be able to find Solution of differential equations and apply first-order separable ordinary differential equations of degree one.

Benchmark X: Students will be able to solve nonlinear equations in one variable and definite integral by numerical methods.

Student Learning Outcomes

Real Numbers

- [SLO: M-09-A-01]: Explain, with examples, that civilizations throughout history have systematically studied living things [e.g., the history of numbers from Sumerians and its development to the present Arabic system.
- [SLO: M-09-A-02]: Describe the set of real numbers as a combination of rational and irrational numbers

Complex Number

- [SLO: M-10-A-01]: Identify complex numbers, complex conjugate, absolute value or modulus of a complex number
- [SLO: M-10-A-02]: Apply algebraic properties and perform basic operations on complex numbers
- [SLO: M-10-A-03]: Demonstrate additive identity and multiplicative identity for the set of complex numbers
- [SLO: M-10-A-04]: Find additive inverse and multiplicative

Complex Number

- [SLO: M-11-A-01] Recall complex number z represented by an expression of the form $z = a + ib$ or of the form (a, b) where a and b are real numbers and $i = \sqrt{-1}$
- [SLO: M-11-A-02] Recognize a as a real part of z and b as an imaginary part of z .
- [SLO: M-11-A-03]: Know the condition for equality of complex numbers.
- [SLO: M-11-A-04]: Carry out basic operations on complex numbers

- [SLO: M-09-A-03]: Demonstrate and verify the properties of equality and inequality of real numbers
- [SLO: M-09-A-04]: Apply laws of indices to simplify radical expressions
- [SLO: M-09-A-05]: Express a number in scientific notations and vice versa.
- [SLO: M-09-A-06]: Describe logarithm of a number
- [SLO: M-09-A-07]: Differentiate between common and natural logarithm

inverse of a complex number z .

- [SLO: M-10-A-05]: Demonstrate the following properties of a complex number z .

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

$$\bar{\bar{z}} = z, z\bar{z} = |z|^2$$

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

- [SLO: M-10-A-06]: Find real and imaginary parts of complex numbers of the type $(x+iy)^n$, $\left[\frac{x_1+iy_1}{x_2+iy_2}\right]^n$,

$$x_2 + iy_2 \neq 0$$

Where $n = \pm 1$ and ± 2

- [SLO: M-10-A-07]: Explain, with

- [SLO: M-11-A-05]: Define $z = a - ib$ as the complex conjugate of $z = a + ib$.
- [SLO: M-11-A-06]: Define $z = a^2 + b^2$ as the absolute value or modulus of a complex number $z = a + ib$

Solution of equations

- [SLO: M-11-A-07] i) Solve the simultaneous linear equations with

- [SLO: M-09-A-08]:
Apply laws of logarithm to real life situations such as growth and decay, loudness of sound.

- [SLO: M-09-A-09]:
Apply concepts of rational numbers to real word problems (such as inventory (stock taking), temperature, banking, measures of gain and loss, sources of income and expenditure).

examples, how mathematical models and equations are often used to make predictions and test hypotheses in science. [e.g, In physics, mathematical equations are used to describe the motion of objects and the behaviour of energy and matter. In chemistry, mathematical models are used to predict the behaviour of chemical reactions and the properties of molecules. In biology, mathematical models are used to predict the growth and spread of populations

complex coefficients. For example,

$$\begin{cases} 5z - (3+i)w = 7-i, \\ (2-i)z + 2iw = -1+i. \end{cases}$$

- [SLO: M-11-A-08]:
Write the polynomial $P(z)$ as a product of linear factors. For example,

$$\begin{aligned} z^2 + a^2 &= (z + ia)(z - ia) \\ z^3 - 3z^2 + z + 5 &= \\ &(z + 1)(z - 2 - i)(z - 2 + i) \end{aligned}$$

- [SLO: M-11-A-09]:
Solve quadratic equation of the form

$2pz + qz + r = 0$
by completing squares, where p, q, r are real numbers and z a complex number. For example

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

	<p>and the spread of disease.]</p> <ul style="list-style-type: none"> ● SLO: M-10-A-08]: Solve the simultaneous linear equations with complex coefficients, ● [SLO: M-10-A-09]: Apply the Geometric interpretation of a complex number ● [SLO: M-10-A-10]: Apply the geometric interpretation of the modulus of a complex number. ● [SLO: M-10-A-11]: Apply the geometric interpretation of algebraic operations. ● [SLO: M-10-A-12]: Solve quadratic equations of the form ax^2 	$(z - 1 - 2i)(z - 1 + 2i) = 0$ $z = 1 + 2i, 1 - 2i$ <ul style="list-style-type: none"> ● [SLO: M-11-A-10]: Explain the polar coordinates system. ● [SLO: M-11-A-11]: Describe the polar representation of a complex number. ● [SLO: M-11-A-12]: Apply the operations with complex numbers in polar representation. ● [SLO: M-11-A-13]: Demonstrate simple equations and in-equations involving complex numbers in polar form. ● [SLO: M-11-A-14]: Apply concepts of complex numbers to real world problems (such as cryptography, wave phenomena, 	
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	<p>a is not equal to 0 by factorization, quadratic formula, completing square and graphs.</p> <ul style="list-style-type: none">• [SLO: M-10-A-13]: Draw the graphs of the quadratic function. $y = a^2$ a is not equal to 0• [SLO: M-10-A-14]: Establish relationship between roots and coefficients of quadratic equations.• [SLO: M-10-A-15]: Form a quadratic equation when roots are given.• [SLO: M-10-A-16]: Find discriminant of a given quadratic equation.• [SLO: M-10-A-17]: Identify the nature of	<p>calculate voltage, current, circuits, the velocity and pressure of the fluid).</p>	
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	<p>roots of a quadratic equation through discriminant.</p> <ul style="list-style-type: none">• [SLO: M-10-A-18]: Solve a pair of linear and quadratic equations simultaneously.• [SLO: M-10-A-19]: Solve word problems involving quadratic equations.• [SLO: M-10-A-20]: Solve quadratic inequalities in one unknown.• [SLO: M-10-A-21]: Apply the concept of quadratic equations, and quadratic inequalities, to real world problems (such as in physics, engineering, and finance, i.e. calculating max and		
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	<p>min heights in projectile motion, determining the max price on a company's budget, stability of population, growth of business, the relationship between hours worked and amount earned etc.).</p>		
	<p>Matrices and determinants</p> <ul style="list-style-type: none"> • [SLO: M-10-A-22]: Display information in the form of matrix of order 2. • [SLO: M-10-A-23]: Solve situations involving sum, difference, and product of two matrices 	<p>Matrices & Determinants</p> <ul style="list-style-type: none"> • [SLO: M-11-A-15]: Apply matrix operations (addition/subtraction and multiplication of matrices) with real and complex entries. • [SLO: M-11-A-16]: Evaluate determinants of 3×3 matrix by using cofactors and 	

	<ul style="list-style-type: none"> ● [SLO: M-10-A-24]: Calculate the product of the scalar quantity and a matrix ● [SLO: M-10-A-25]: Evaluate the determinant and inverse of a matrix of order 2×2. ● [SLO: M-10-A-26]: Solve the simultaneous linear equations in two variables using matrix inversion method and Cramer's rule ● [SLO: M-10-A-27]: Explain, with examples, how mathematics plays a key role in the development of new scientific theories 	<p>properties of determinants.</p> <ul style="list-style-type: none"> ● [SLO: M-11-A-17]: Use row operations to find the inverse and the rank of a matrix. ● [SLO: M-11-A-18]: Explain a consistent and inconsistent system of linear equations and demonstrate through examples ● [SLO: M-11-A-19]: Solve a system of 3 by 3 nonhomogeneous linear equations by using matrix inversion method and Cramer's Rule. ● [SLO: M-11-A-20]: Solve a system of three homogeneous linear equations in three unknowns using the 	
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	<p>and technologies. [e.g., Mathematical models and simulations are used to design and optimize new materials and drugs, and to understand the behaviour of complex systems such as the human brain.]</p> <ul style="list-style-type: none"> • [SLO: M-10-A-28]: Apply concepts of matrices to real world problems (such as engineering, economics, computer graphics, and physics). 	<p>Gaussian elimination method.</p> <ul style="list-style-type: none"> • [SLO: M-11-A-21]: Apply concepts of matrices to real world problems such as (graphic design, data encryption, seismic analysis, cryptography, transformation of geometric shapes, social network analysis). 	
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<p>Sets and Functions</p> <ul style="list-style-type: none"> • [SLO: M-09-A-10]: Describe mathematics as the study of pattern, structure, and relationships. • [SLO: M-09-A-11]: Identify sets and apply operations on three sets (Subsets, overlapping sets and disjoint sets), using Venn diagrams. • [SLO: M-09-A-12]: Solve problems on classification and cataloging by using Venn diagrams for Scenarios involving two sets and three sets. Further application of sets • [SLO: M-09-A-13]: Verify and apply 	<p>Functions and Graphs</p> <ul style="list-style-type: none"> • [SLO: M-10-A-29]: Recognize notation and determine the value of a function. • [SLO: M-10-A-30]: Identify types of functions (into, onto, one-to-one, injective, surjective and bijective) by using Venn diagrams. • [SLO: M-10-A-31]: Explain operations on, and compositions of, functions. • [SLO: M-10-A-32]: Find the inverse of a given function. • [SLO: M-10-A-33]: Formulate composite functions as defined by $gf(x) = f(g(x)).$ 	<p>Sequences and Series</p>	<p>Functions and Graphs</p> <ul style="list-style-type: none"> • [SLO: M-12-A-01]: Recall <ul style="list-style-type: none"> • function as a rule of correspondence, • domain, co-domain and range of a function, • one to one and onto functions. • [SLO: M-12-A-02]: Know linear, quadratic and square root functions. Inverse Function • [SLO: M-12-A-03]: Define inverse functions and demonstrate their domain and range with examples. <p>Graphical Representation of Functions</p> <ul style="list-style-type: none"> • [SLO: M-12-A-04]: Sketch graphs of
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<p>properties/laws of union and intersection of three sets through analytical and Venn diagram method</p> <ul style="list-style-type: none"> • [SLO: M-09-A-14]: Apply concepts from set theory to real world problems (such as in demographic classification, categorising products in shopping malls and music playlist by genre) Relation • [SLO: M-09-A-15]: Explain product, Binary Relations and its domain and range. • [SLO: M-09-A-16] Recognise that a relation can be represented by table, order pair and graphs. 	<ul style="list-style-type: none"> • [SLO: M-10-A-34]: Apply concepts from functions to real world problems (such as finance, transportation, and sales.) <p>Graphs of basic Functions</p> <ul style="list-style-type: none"> • [SLO: M-10-A-35]: Plot graphs of constant function, identity function, linear function and absolute valued functions • [SLO: M-10-A-36]: Solve absolute value equations and inequalities in one variable and express the solution as a range of values on a number line. 	<p>Arithmetic Sequence and Arithmetic Mean</p> <ul style="list-style-type: none"> • [SLO: M-11-A-22]: Solve problems by analysing arithmetic sequences and series up to n terms. <p>Geometric Sequence and Mean</p> <ul style="list-style-type: none"> • [SLO: M-11-A-23]: Solve problems by analysing geometric sequences and series up to n terms. • [SLO: M-11-A-24]: Identify a sequence as arithmetic or geometric sequence up to n terms. • [SLO: M-11-A-25]: Solve problems by analysing harmonic sequences and series up to n terms. 	<ul style="list-style-type: none"> • linear functions (e.g. $y = ax + b$), • non-linear functions (e.g. $2y = x$). • [SLO: M-12-A-05]: Plot the graph of the function $y = x^n$ here n is <ul style="list-style-type: none"> • a + ve integer, • a - ve integer ($x \neq 0$), • a rational number for $x > 0$ • [SLO: M-12-A-06]: Plot graph of quadratic function of the form $y = ax^2 + bx + c$ $a(\neq 0)$, b, c are integers. • [SLO: M-12-A-07]: Draw graph using factors.
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	<ul style="list-style-type: none"> • [SLO: M-10-A-37]: Apply concepts of absolute valued functions to real-world problems (such as to calculate energy wave, magnitude and distance). • [SLO: M-10-A-38]: Apply concepts from functions to real world problems (such as finance, transportation, and sales.) 	<p>Miscellaneous Series</p> <ul style="list-style-type: none"> • [SLO: M-11-A-26]: Find sum of: <ul style="list-style-type: none"> • the first n natural numbers ($\sum n$), • the squares of the first n natural numbers ($\sum n^2$), • the cubes of the first n natural numbers ($\sum n^3$). • [SLO: M-11-A-27]: Recognize the arithmetic geometric sequence, determine its general term, find sum to n terms and sum to infinite number of terms, using sigma notation. • [SLO: M-11-A-28]: Identify leasing of 	<ul style="list-style-type: none"> • [SLO: M-12-A-08]: Predict functions from their graphs (use the factor form to predict the equation of a function of the type $f(x) = a(x - p)(x - q)$ (if two points where the graph crosses <i>x axis</i> and third point on the curve, are given). Intersecting Graphs • [SLO: M-12-A-09]: Find the intersecting point graphically when intersection occurs between <ul style="list-style-type: none"> • a linear function and coordinate axes, • two linear functions, • a linear and a quadratic function.
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		<p>motor vehicles, down payment, motor vehicle insurance, processing charges, repayment in monthly instalments.</p> <ul style="list-style-type: none"> • [SLO: M-11-A-29]: Solve problems related to leasing of motor vehicle under different conditions. • [SLO: M-11-A-30]: Apply concepts from sequence and series to real world problems (such as simple interest on loan, investment, depreciation, Investment planning on compound interest, projectile motion, gaming strategy, health care management, web 	<ul style="list-style-type: none"> • [SLO: M-12-A-10]: Solve, graphically, appropriate problems from daily life. • [SLO: M-12-A-11]: Classify the functions as algebraic and transcendental functions • [SLO: M-12-A-12]: Describe various transcendental functions, such as: <ul style="list-style-type: none"> • Trigonometric functions, • Inverse trigonometric functions, • Logarithmic function, • Exponential function <p>Logarithmic function</p>
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		<p>page design, traffic modelling).</p>	<ul style="list-style-type: none"> • [SLO: M-12-A-13]: Demonstrate an understanding of logarithms. • [SLO:M-12-A-14]: Derive and apply product, quotient, and power laws of logarithms <p>Exponential function</p> <ul style="list-style-type: none"> • [SLO: M-12-A-15]: Graph and analyse exponential and logarithmic function Apply the concept of exponential function to find compound interest • [SLO: M-12-A-16]: Solve problems that involve exponential and logarithmic Equations • [SLO: M-12-A-17]: Identify the domain
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			<p>and range of fundamental transcendental functions. Graphical Representation</p> <ul style="list-style-type: none">• [SLO: M-12-A-18]: Draw the graph of modulus function• [SLO: M-12-A-19]: Interpret the relation between a one-one function and its inverse through a graph.• [SLO: M-12-A-20]: Demonstrate the transformations of a graph through horizontal shift, vertical shift, and scaling. <p>Limit of a Function</p> <ul style="list-style-type: none">• [SLO: M-12-A-21]: Demonstrate and find the limit of a
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			<p>sequence and a function.</p> <ul style="list-style-type: none">• [SLO: M-12-A-22]: State and apply theorems on limit of sum, difference, product and quotient of functions to algebraic, exponential and trigonometric functions. <p>Continuous and Discontinuous Functions</p> <ul style="list-style-type: none">• [SLO: M-12-A-23]: Demonstrate and test Continuity, discontinuity of a function at a point and in an interval.• [SLO: M-12-A-24]: Apply concepts of transcendental functions, limit of a function and its
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			<p>continuity to real world problems such as (growth and decay, finance, economics, surveying, navigation, astronomy, growth rate of sales, rate of change in sales, predicting long-term stock prices).</p> <ul style="list-style-type: none">• [SLO: M-12-A-25]: Calculate inflation over a period of time.• [SLO: M-12-A-26]: Calculate depreciation with the help of straight-line method, sum of years digit method and production unit method
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		<p>Mathematical Induction</p> <ul style="list-style-type: none"> • [SLO: M-11-A-31]: Describe a mathematical argument, identify the base case, induction of hypothesis and a precise conclusion. • [SLO: M-11-A-32]: Apply the principle of mathematical induction to prove statements, identities, divisibility of numbers and summation formulae. • [SLO: M-11-A-33]: Evaluate and justify conclusions, communicating a position clearly in an appropriate mathematical form in daily life. <p>Binomial Theorem</p>	<p>Gradient of a curve</p> <ul style="list-style-type: none"> • [SLO: M-12-A-27]: Recognize the meaning of the tangent to a curve at a point. • [SLO: M-12-A-28]: Calculate the gradient of a curve at a point. • [SLO: M-12-A-29]: Identify the derivative as the limit of a difference quotient. • [SLO: M-12-A-30]: Calculate the derivative of a given function at a point. • [SLO: M-12-A-31]: Estimate the derivative as rate of change of velocity,
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		<ul style="list-style-type: none"> • [SLO: M-11-A-34]: State and apply the Binomial Theorem to expand expressions of the form $(a + b)^n$ where n is a positive integer. • [SLO: M-11-A-35]: Describe Binomial Theorem as expansion of binomial powers restricted to the set of natural numbers. • [SLO: M-11-A-36]: Calculate binomial coefficients using Pascal's triangle. • [SLO: M-11-A-37]: Expand using the binomial theorems, and use appropriate techniques to simplify the expression • [SLO: M-11-A-38]: Find an approximate value using binomial 	<p>temperature and profit.</p> <p>Derivative of a Function</p> <ul style="list-style-type: none"> • [SLO: M-12-A-32]: Recognize the derivative function. • [SLO: M-12-A-33]: Find the derivative of a square root function. • [SLO: M-12-A-34]: Find the derivative of a quadratic function. • [SLO: M-12-A-35]: State the connection between derivatives and continuity. <p>Differentiation Rules</p> <ul style="list-style-type: none"> • [SLO: M-12-A-36]: State, prove and apply the constant rule, the coefficient rule, the
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		<p>theorem Applications of Binomial Theorem</p> <ul style="list-style-type: none"> • [SLO: M-11-A-39]: Use binomial theorem to find the remainder when a number to some large exponent is divided by a number. • [SLO: M-11-A-40]: Use binomial theorem to find the last digit of a number, test the divisibility by a number and compare two large numbers. • [SLO: M-11-A-41]: Apply concepts of Mathematical induction and binomial theorem to real world problems such as (puzzles, domino effects, Pascal's triangle, Economic forecasting, 	<p>power rule, the sum and difference rule, the product rule, the quotient rule for differentiation.</p> <ul style="list-style-type: none"> • [SLO: M-12-A-37]: Extend the power rule to functions with negative exponents. • [SLO: M-12-A-38]: Combine the differentiation rules to find the derivative of a polynomial or rational function. • [SLO: M-12-A-39]: Apply rates of change to displacement, velocity and acceleration of an object moving along a straight line. <p>Further on Differentiation</p> <ul style="list-style-type: none"> • [SLO: M-12-A-40]:
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		<p>Rankings, Variable subletting)</p>	<p>Find the derivative of trigonometric and inverse trigonometric functions.</p> <ul style="list-style-type: none"> • [SLO: M-12-A-41]: <p>Find the derivative of exponential functions.</p> <ul style="list-style-type: none"> • [SLO: M-12-A-42]: <p>Find the derivative of logarithmic functions.</p> <ul style="list-style-type: none"> • [SLO: M-12-A-43]: <p>Apply differentiation to state the increasing and decreasing functions.</p> <ul style="list-style-type: none"> • [SLO: M-12-A-44]: <p>Apply differentiation to find equations of tangent and normal to a curve at a point.</p> <ul style="list-style-type: none"> • [SLO: M-12-A-45]: <p>Apply concepts of Differentiation to real</p>
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			<p>world problems such as (profits on diminishing returns, environmental factors, financial investments, population growth, spread of diseases, movement of particles, time-speed in transportation, structural stress, material required viz a viz changes in construction).</p> <p>Higher-Order Derivatives</p> <ul style="list-style-type: none"> • [SLO: M-12-A-46]: <p>Find higher order derivatives of algebraic, implicit, parametric, trigonometric, inverse-trigonometric, exponential and logarithmic functions.</p> <p>Applications of Derivatives</p> <ul style="list-style-type: none"> • [SLO: M-12-A-47]: <p>Describe the ability to approximate functions</p>
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			<p>locally by linear functions. (Linear approximations of square root functions, trigonometric functions)</p> <ul style="list-style-type: none"> • [SLO: M-12-A-48]: Explain differentials and draw a graph that illustrates the use of differentials to approximate the change in a quantity. • [SLO: M-12-A-49]: Calculate the relative error and percentage error in using a differential approximation. (Volume of a cube and sphere) <p>Extreme Values</p> <ul style="list-style-type: none"> • [SLO: M-12-A-50]: Illustrate Global extrema (absolute extrema) and local
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			<p>extrema (relative extrema)</p> <ul style="list-style-type: none">• [SLO: M-12-A-51]: Find the extreme values by applying the second derivative test.• [SLO: M-12-A-52]: Explain how to find the critical points of a function over a closed interval.• [SLO: M-12-A-53]: Describe how to use critical points to locate absolute extrema over a closed interval.• [SLO: M-12-A-54]: Apply derivatives to real-world problems to find the maximum and the minimum values of a function
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			<p>under certain conditions.</p> <ul style="list-style-type: none"> • [SLO: M-12-A-55]: Apply the concept of higher order derivatives to real life problems (such as transportation devices, cars, planes, roller coasters, rate of spread of a disease, rate of improvement of performance in psychology, automobiles, radar guns, economics).
			<p>Integration I</p> <ul style="list-style-type: none"> • [SLO: M-12-A-56]: Find the general antiderivative of a given function. • [SLO: M-12-A-57]: Recognize and use the terms and

			<p>notations for antiderivatives.</p> <ul style="list-style-type: none">● [SLO: M-12-A-58]: State the power rule for integrals.● [SLO: M-12-A-59]: State and apply the properties of indefinite integrals.● [SLO: M-12-A-60]: State the definition of the definite integral.● [SLO: M-12-A-61]: Explain the terms integrand, limits of integration, and variable of integration.● [SLO: M-12-A-62]: State and apply the properties of definite integrals.● [SLO: M-12-A-63]: State and apply Fundamental Theorem of Calculus
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			<p>to evaluate the definite integrals.</p> <ul style="list-style-type: none">● [SLO: M-12-A-64]: Describe the relationship between the definite integral and net area.● [SLO: M-12-A-65]: Find the area of a region bounded by a curve and lines parallel to axes, or between a curve and a line, or between two curves.● [SLO: M-12-A-66]: Find Volume of revolution about one of the axes.● [SLO: M-12-A-67]: Demonstrate trapezium rule to estimate the value of a definite integral.● [SLO: M-12-A-68]: Apply concepts of
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			Integration to real world problems such as (volume of a container, consumer surplus and producer surplus, growth rate of a population, investment return time period, drug dosage required by integrating the concentration).
<p>Factorization:</p> <ul style="list-style-type: none"> • [SLO: M-09-A-17]: Identify common factors, trinomial factoring, concretely, pictorially and symbolically. • [SLO: M-09-A-18]: Factorize quadratic and cubic algebraic expressions: <ul style="list-style-type: none"> • $a^4 + a^2b^2 + b^4$ or $a^4 + a^2b^2 + b^4$ 	<p>Algebraic Fractions:</p> <ul style="list-style-type: none"> • [SLO: M-10-A-39]: Describe rational expressions • [SLO: M-10-A-40]: Factorize and simplify rational expressions. • [SLO: M-10-A-41]: Demonstrate manipulation of algebraic fractions. 	<p>Division of polynomial:</p> <ul style="list-style-type: none"> • [SLO: M-11-A-42]: Divide a polynomial of degree up to 4 by a linear and quadratic polynomial to identify quotient and remainder. Remainder Theorem and Factor Theorem: • [SLO: M-11-A-43]: Demonstrate and apply remainder theorem 	

<ul style="list-style-type: none"> • $x^4+px + q$ • $ax^2+bx + c$ • $(ax^2+bx + c)(ax^2 + bx + d)$ • $(x + a)(x + b)(x + c)$ • $(x + a)(x + b)(x + c)(x + d)$ • $a^3+3a^2b+3ab^2+b^3$ • $a^3-3a^2b+3ab^2-b^3$ • $a^3\pm b^3$ <ul style="list-style-type: none"> • [SLO: M-09-A-19]: Find highest common factor and least common multiple of algebraic expressions and know relationship of LCM and HCF • [SLO: M-09-A-20]: Find square root of algebraic expression by factorization and division • [SLO: M-09-A-21]: Apply the concepts of factorization of 	<ul style="list-style-type: none"> • [SLO: M-10-A-42]: Perform operations on rational expressions (limited to numerators and denominators that are monomials, binomials, or trinomials). • [SLO: M-10-A-43]: Apply the concept of rational equations (limited to numerators and denominators that are monomials, binomials, or trinomials) to real world problems (such as the amount of work a person can do in certain amount of time, rates, and work) 	<ul style="list-style-type: none"> • [SLO: M-11-A-44]: Analyse and apply factor theorem to factorise a cubic polynomial • [SLO: M-11-A-45]: Apply concepts of remainder and factor theorem to real world problems (such as polynomial regression, signal processing, and coding theory). 	
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<p>quadratic and cubic algebraic expressions to real world problems (such as engineering, physics, and finance.)</p>			
<p>Linear Equations and Inequalities in one variable:</p> <ul style="list-style-type: none"> • [SLO: M-09-A-22]: Solve linear equations and inequalities with rational coefficients and represent the solution set on a real line • [SLO: M-10-A-23]: Solve two linear inequalities with two unknowns simultaneously 	<p>Linear Inequalities in two variables:</p> <ul style="list-style-type: none"> • [SLO: M-10-A-44]: Solve two linear inequalities with two unknowns simultaneously • [SLO: M-10-A-45]: Interpret and Identify regions in plane bounded by two linear inequalities in two unknowns. <p>Quadratic Equations</p> <ul style="list-style-type: none"> • [SLO: M-10-A-46]: Solve quadratic 		

	<p>equations by using the methods of:</p> <ul style="list-style-type: none"> • factorization, • completing squares, and • quadratic formula. <ul style="list-style-type: none"> • [SLO: M-10-A-47]: Solve problems of “changing the subject of formula”. • [SLO: M-10-A-48]: Solve fractional equations that can be reduced to quadratic equations. • [SLO: M-10-A-49]: Solve real world situations by formulating a quadratic equation 		
	<p>Plotting and Interpreting the Graphs</p>		<p>Mechanics Kinematics of motion in a straight line</p>

- [SLO: M-10-A-50]: Draw graphs of functions of the form $y = ax$ (Including the sums of few of these and taking n as a rational number)
- [SLO: M-10-A-51]: Solve a system of one linear and one quadratic equation graphically and interpret the solution.
- [SLO: M-10-A-52]: Discover exponential growth/decay of a practical phenomenon through its graph.
- [SLO: M-10-A-53]: Determine the gradients of curves through tangents.
Curves sketching

- [SLO: M-12-A-69]: Recognise distance and speed as scalar quantities, and displacement, velocity and acceleration as vector quantities.
- [SLO: M-12-A-70]: Sketch and interpret displacement–time graphs and velocity–time graphs
- [SLO: M-12-A-71]: use differentiation and integration with respect to time to solve simple problems concerning displacement, velocity and acceleration
- [SLO: M-12-A-72]: use appropriate formulae for motion with constant

- [SLO: M-10-A-54]: Identify, sketch and interpret graphs of the Linear functions
- [SLO: M-10-A-55]: Identify, sketch and interpret graphs of the Nonlinear functions such as Quadratic, Cubic, Reciprocal, and Exponential.
- [SLO: M-10-A-56]: Sketch graph of the function $y = x^n$ where n is a + ve integer, - ve integer, rational number for $x > 0$
- [SLO: M-10-A-57]: Apply concepts of sketching and interpreting graph to real life problems (such as in tax payment, income

acceleration in a straight line

- [SLO: M-12-A-73]: Apply the concept of mechanics to real life problems (such as motion of vehicles on roads, Projectile motion, free fall motion, relative motion animation)

Integration II Techniques of Integration

- [SLO: M-12-A-74]: Utilise trigonometric relationships to evaluate integrals.
- [SLO: M-12-A-75]: Integrate functions involving the exponential and logarithmic functions.
- [SLO: M-12-A-76]: Identify when to use

	and salary problems and cost and profit analysis)		<p>integration by parts to solve integration problems.</p> <ul style="list-style-type: none">• [SLO: M-12-A-77]: Apply the integration-by-parts formula for definite integrals.• [SLO: M-12-A-78]: Solve integration problems involving trigonometric substitution• [SLO: M-12-A-79]: Integrate a rational function using the method of partial fractions.• [SLO: M-12-A-80]: Apply concepts of integration to real life word problems (such as area between curves, average value of a function, distance velocity,
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			<p>acceleration, growth rate of population, moment of inertia, vector calculus to measure sensor network).</p>
			<p>Differential Equations</p> <ul style="list-style-type: none"> • [SLO: M-12-A-81]: Identify and construct first order differential equations from practical situations. Solution of Differential Equation • [SLO: M-12-A-82]: Solve separable differential equations of first order and first degree of y separable variable equations y Homogeneous equations

			<ul style="list-style-type: none"> • [SLO: M-12-A-83]: Apply concepts of first order differential equations to real life word problems (such as population growth and decay, Cooling/Warming law, flow of electricity, series circuits, economics and finance, radioactive decay).
			<p>Numerical Solution of Nonlinear Equations</p> <ul style="list-style-type: none"> • [SLO: M-12-A-84]: Analyse the searching of roots of an equation by graphical means and/or searching for the sign change.

			<ul style="list-style-type: none">• [SLO: M-12-A-85]: Explain the basic principles of solving a nonlinear equation in one variable.• [SLO: M-12-A-86]: Calculate real roots of a nonlinear equation in one variable by bisection method, regular-falsi method, Newton Raphson method.• [SLO: M-12-A-87]: Apply concepts of nonlinear equations to real life word problems (such as chemical reactions, regulation of heart beats, electronic circuits, and cryptography).
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Domain B: Geometry

Geometry is the most practical branch of mathematics that deals with shapes and sizes of figures and their properties. The basic elements of geometry are points, lines, angles, surfaces and solids. Develops reasoning and problem-solving skills by applying properties of lines, triangles, quadrilaterals, and circles. length, perimeter, area, circumference, surface area, and volume to solve real-world problems.

Standard 2: The students will be able to:

- apply characteristics and properties of angles, triangles, parallelograms and circles to develop arguments about their geometric relationships.
- solve problems involving coordinate geometry, plane analytical geometry and vectors.

- recognize trigonometric identities, analyze conic sections, draw and interpret graphs of functions.

Grade 9	Grade 10	Grade 11	Grade 12
<p>Benchmark I: Students will be able to use and interpret Cartesian coordinates in two dimensions and solve problems involving coordinate geometry</p> <p>Benchmark II: Students will be able to Identify vectors in plane and apply vector addition, dot/ cross product, scalar product,</p> <p>Benchmark III: Students will be able to find volume and surface area of composite solids and solve problems using the relationship between areas of similar figures and volume of different solids</p> <p>Benchmark IV: Students will be able to apply characteristics and properties of angles, triangles, parallelograms and circles to develop arguments about their geometric relationships.</p> <p>Benchmark V: Students will be able to use trigonometric identities to verify relationships between trigonometric ratios. Apply appropriate laws and formulae of trigonometry to solve the triangles and relevant problems.</p> <p>Benchmark VI: Students will be able to calculate unknown angles and solve problems by using the properties of circles</p>			<p>Benchmark I: Students will be able to interpret and solve plane analytical geometry problem situations</p> <p>Benchmark II: Students will be able to Identify vectors in space and apply vector addition, dot/ cross product, scalar product, differentiate and integrate vector functions.</p> <p>Benchmark III: Students will be able to Identify and analyse conic sections (circle, parabola, ellipse and hyperbola) and solve related problems.</p> <p>Benchmark IV: Students will be able to apply trigonometric identities and formulas to solve relevant situations and draw graphs of trigonometric and inverse trigonometric functions.</p>

Student Learning Outcomes

Coordinate Geometry

- [SLO: M-09-B-01]:
Derive distance formula by locating the position of two points in coordinate plane
- [SLO: M-09-B-02]:
Calculate the midpoint of a line segment
- [SLO: M-09-B-03]:
Find the gradient of a straight line when coordinates of two points are given
- [SLO: M-09-B-04]:
Find the equation of a straight line in the form $y = mx + c$
- [SLO: M-09-B-05]:
Find the gradient of

Analytical Geometry Concurrency of Straight lines

- [SLO: M-12-B -01]:
Find the condition of concurrency of three straight lines.
- [SLO: M-12-B -02]:
Find the equation of median, altitude and right bisector of a triangle.
- [SLO: M-12-B -03]:
Show that
 - three right bisectors,
 - three medians,
 - three altitudes of a triangle are concurrent.

Area of a Triangular Region

<p>parallel and perpendicular lines</p> <ul style="list-style-type: none"> • [SLO: M-09-B-06]: Apply distance and midpoint formulas to solve real life situations such as physical measurements or distances between locations. • [SLO: M-09-B-07]: Apply concepts from coordinate Geometry to real world problems (such as, aviation and navigation, landscaping, map reading, longitude and latitude). • [SLO: M-09-B-08]: Derive equation of a straight line in slope-intercept form, 			<ul style="list-style-type: none"> • [SLO: M-12-B -04]: Find the area of a triangular region whose vertices are given. <p>Homogeneous Equations</p> <ul style="list-style-type: none"> • [SLO: M-12-B -05]: Recognize homogeneous linear and quadratic equations in two variables. • [SLO: M-12-B -06]: Investigate that the 2nd degree homogeneous equation in two variables \bar{z} and \bar{z} represents a pair of straight lines through the origin and finds an acute angle between them.
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point-slope form,
two-point form,
intercepts form,
symmetric form,
normal form.

- [SLO: M-09-B-09]:
Show that a linear equation in two variables represents a straight line and reduce the general form of the equation of a straight line to the other standard forms.

Angle Between Lines

- [SLO: M-09-B-10]:
Find the angle between two coplanar intersecting straight lines.
- [SLO: M-09-B-11]:
Find the equation of the family of lines

- [SLO: M-12 -B -07]:
Apply concepts of analytical geometry to real life world problems (such as aviation, to track stars, distance between planets and satellites, space science and engineering).

passing through the point of intersection of two given lines.

- [SLO: M-09-B-12]: Calculate angles of the triangle when the slopes of the sides are given.

Logic

- [SLO: M-09-B-13]: Differentiate between a mathematical statement and its proof.
- [SLO: M-09-B-14]: Differentiate between an axiom, conjecture and theorem.
- [SLO: M-09-B-15]: Formulate simple deductive proofs [algebraic proofs that require showing the LHS to be equal to

<p>the RHS. E.g., showing</p> $(x - 3)^2 + 5 = x^2 - 6x$			
	<p>Vectors in Plane</p> <ul style="list-style-type: none"> • [SLO: M-10-B-01]: Introduce rectangular coordinate system in plane. • [SLO: M-10-B-02]: Represent vectors as directed line segment • [SLO: M-10-B-03]: Express a vector in terms of two non-zero and non-parallel coplanar vectors. • [SLO: M-10-B-04]: Express a vector in terms of position vector • [SLO: M-10-B-05]: Express translation by a vector 	<p>Vectors in Space</p> <ul style="list-style-type: none"> • [SLO: M-11-B-01]: Recognize rectangular coordinate system in space. • [SLO: M-11-B-02]: Recognize: unit vectors \bar{i}, \bar{j} and \bar{k}. components of a vector. • [SLO: M-11-B-03]: Find the magnitude of a vector. • [SLO: M-11-B-04]: Repeat all fundamental mathematical operations for vectors in space which, in the plane, have already been discussed. • [SLO: M-11-B-05]: Demonstrate and prove 	<p>Vector Valued Function:</p> <ul style="list-style-type: none"> • [SLO: M-12-B -08]: Explain the need for a vector valued function. • [SLO: M-12-B -09]: Construct vector valued function. • [SLO: M-12-B-10]: Identify domain and range of vector valued functions. • [SLO: M-12-B -11]: Identify difference between scalar and vector valued functions Derivative of Vector Function • [SLO:M-12-B-12]: Explain derivative of a vector function of a

	<ul style="list-style-type: none"> • [SLO: M-10-B-06]: Find the magnitude of a vector. • [SLO: M-10-B-07]: Add and subtract vectors, • [SLO: M-10-B-08]: Multiply a vector by a scalar • [SLO: M-10-B-09]: Solve geometrical problems involving the use of vectors • [SLO: M-10-B-10]: Apply concepts from geometrical problems involving the use of vectors (such as parallel and perpendicular lines in geometrical shapes, vector projectile motion, crosswinds aviation, military 	<p>properties of Vector Addition</p> <ul style="list-style-type: none"> • Commutative law for vector addition. • Associative law for vector addition. • 0 as the identity for vector addition. • $-\bar{z}$ as the inverse for \bar{z}. • Dot or Scalar Product • [SLO: M-11-B-06]: Explain dot or scalar product of two vectors and give its geometrical interpretation. • [SLO: M-11-B-07]: Express dot product in terms of components. • [SLO: M-11-B-08]: Find the condition for orthogonality of two vectors. • [SLO: M-11-B-09]: Use dot product to find the angle between two vectors. 	<p>single variable and elaborate the result: If $f(t) = f_1(t)i + f_2(t)j + f_3(t)k$</p> <p>Where $f_1(t), f_2(t), f_3(t)$ are differentiable functions of a scalar variable t, then</p> <p>are differentiable functions of a scalar variable t, then</p> $\frac{df}{dt} = \frac{df_1}{dt}i + \frac{df_2}{dt}j + \frac{df_3}{dt}k$ <ul style="list-style-type: none"> • [SLO: M-12-B -13]: Apply vector differentiation to calculate velocity and acceleration of a position vector $f(t) = x(t)i + y(t)j$ • [SLO: M-12 -B -14] Apply concepts of vector valued
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	usage, designing roller coasters).	<ul style="list-style-type: none"> ● [SLO: M-11-B-10]: Find the projection of a vector along another vector. ● [SLO: M-11-B-11]: Find the work done by a constant force in moving an object along a given vector. ● [SLO: M-11-B-12]: Solve daily life problems based on vectors. Cross or Vector Product ● [SLO: M-11-B-13]: Explain the cross or vector product of two vectors and give its geometrical interpretation. ● [SLO: M-11-B-14]: Apply a cross product to find the angle between two vectors. ● [SLO: M-11-B-15]: Solve situations in daily 	functions to real life word problems (such as engineering and transportation).
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life based on Cross or dot
Vector Product.

Scalar Triple Product

- [SLO: M-11-B-16]: Describe scalar triple product of vectors.
- [SLO: M-11-B-17]: Express scalar triple product of vectors in terms of components (determinant form).
- [SLO: M-11-B-18]: Prove that:
 - $i \cdot j \times k = j \cdot i \times k$
 - $i \cdot k \times j = j \cdot i \times k$Prove that dot and cross are inter-changeable in scalar triple product.
- [SLO: M-11-B-19]: Find the volume of
 - a parallelepiped,
 - tetrahedron, determined by three given vectors.
- [SLO: M-11-B-20]: Define coplanar vectors

		<p>and find the condition for planarity of three vectors.</p> <ul style="list-style-type: none"> • [SLO: M-11-B-21]: Apply concepts of vectors in space to real world problems such as (design and execute optimal navigation paths in transportation and logistics, graphing complex 3D motion, vector operations in engineering and computer graphics, practical proficiency for work, flux, and circulation). 	
<p>Similar Figures</p> <ul style="list-style-type: none"> • [SLO: M-09-B-16]: Identify similarity of polygons. Area and Volume of Similar Figures • [SLO: M-09-B-17]: Solve problems using 			

the relationship between areas of similar figures and volume of different solids

Geometrical Properties of regular polygons, Triangles and Parallelograms

- [SLO: M-09-B-18]: Solve real life problems that involve the properties of regular polygons, triangles and parallelograms (such as building architectural structures, fencing, tiling, painting, carpeting a room).

Loci

<ul style="list-style-type: none"> [SLO: M-09-B-19]: Solve real life 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 			
<p>Trigonometry</p> <ul style="list-style-type: none"> [SLO: M-09-B-20]: Identify angles in standard position, expressed in degrees and radians 	<p>Application of Trigonometry</p> <ul style="list-style-type: none"> [SLO: M-10-B-11]: Extend sine and cosine functions to 	<p>Fundamental Law of Trigonometry</p> <ul style="list-style-type: none"> [SLO: M-11-B -22]: Establish fundamental law of trigonometry: 	<p>Inverse Trigonometric Functions</p> <ul style="list-style-type: none"> [SLO: M-12-B-15]: Find domains and ranges of principal trigonometric

- [SLO: M-09-B-21]: Apply Pythagoras' theorem and the sine, cosine and tangent ratios for acute angles to find a side or of an angle of a right-angled triangle.
- [SLO: M-09-B-22]: Solve real life trigonometric problems in two dimensions involving angles of elevation and depression.

Trigonometric Identities

- [SLO: M-09-B-23]: Prove the trigonometric identities and apply them to show different trigonometric relations.

angles between 90° and 180°

- [SLO: M-10-B-12]: Solve problems using the laws of sine, cosine and the area formulas for any triangle.
- [SLO: M-10-B-13]: solve simple trigonometric problems in three dimensions
- [SLO: M-10-B-14]: Apply concepts of trigonometry to real life world problems (such as video games, flight engineering, navigation, sound waves)

- [SLO: M-11-B -23]: Apply fundamental law and its deductions to derive: Trigonometric ratios of allied angles, double angle, half angle and triple angle identities
- [SLO: M-11-B -24]: Express the product (of sines and cosines) as sums or differences (of sines and cosines).

Trigonometric Functions

- [SLO: M-11-B -25]: Find the domain and range of the trigonometric functions
- [SLO: M-11-B -26]: Discuss even, odd functions and the periodicity of trigonometric functions
- [SLO: M-11-B -27]: Find the maximum and minimum value of a

functions, inverse trigonometric functions. Graphs of Inverse Trigonometric Functions

- [SLO: M-12-B-16]: Draw the graphs of the inverse trigonometric functions of cosine, sine, tangent, secant, cosecant and cotangent within the domain from -2π to 2π .

Inverse trigonometric identities and solution of trigonometric equations

- [SLO: M-12-B-17]: State, prove and apply the addition and subtraction formulae of inverse

- [SLO: M-09-B-24]: Solve real life problems involving trigonometric identities.

Bearing

- [SLO: M-09-B-25]: Interpret and use three figure bearings.
- [SLO: M-09-B-26]: Solve problems involving bearing.
- [SLO: M-09-B-27]: Apply the concepts of trigonometry

given function of the type:

- $a + b\sin\theta$,
- $a + b\cos\theta$
- $a + b\sin(c\theta + d)$,
- $a + b\cos(c\theta + d)$
- the reciprocals of above, where a, b, c and d are real numbers.

Graphs of Trigonometric Functions

- [SLO: M-11-B-28]: Graph and analyse the trigonometric functions sine, cosine, and tangent to solve problems,
- [SLO: M-11-B -29]: Explain the properties of graphs of $\sin\theta$, $\cos\theta$ and $\tan\theta$.
- [SLO: M-11-B -30]: Apply the concepts of trigonometric functions, identities, graphs,

trigonometric functions

- [SLO: M-12-B-18]: Solve trigonometric equations of the type $\sin\theta = k$, $\cos\theta = k$ and $\tan\theta = k$,

using periodic, even/odd and translation properties.

- [SLO: M-12-B-19]: Solve graphically the trigonometric equations of

the type: $\sin\theta = \frac{\theta}{2}$,
 $\cos\theta = \theta$, $\tan\theta = 2\theta$
 where $-\frac{\pi}{2} < \theta < \frac{\pi}{2}$

- [SLO: M-12-B -20]: Use the periods of trigonometric functions to find the general solution of

		<p>periodicity, even odd functions, extreme values to real world problems such as (distance, elevation, and direction of tall structures, navigation and mapping, lengths of irregular shapes, graphs to visualize and predict patterns in data, frequency and periodic length of Ferris wheel, forces on a see-saw or lever, the ideal angle for solar panel placement).</p>	<p>the trigonometric equations.</p> <ul style="list-style-type: none"> • [SLO: M-12 -B -21] Apply concepts of inverse trigonometric functions to real lifeworld problems (such as mechanical engineering, architecture to find the height of the building, angle of elevation and depression, identifying the angle of bridges to build scale models).
	<p>Chords and Arcs of a Circle</p> <ul style="list-style-type: none"> • [SLO: M-10-B-15]: Solve problems by using the property of a circle: One and only one circle can pass 		<p>CONICS</p> <ul style="list-style-type: none"> • [SLO: M-12-B -22]: Demonstrate conics and members of its family i.e. circle, parabola, ellipse and hyperbola.

	<p>through three non-collinear points.</p> <ul style="list-style-type: none"> • [SLO: M-10-B-16]: 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. • [SLO: M-10-B-17]: Solve problems by using the property of a circle: Perpendicular from the centre of a circle on a chord bisects it. • [SLO: M-10-B-18]: Solve problems by using the property of circle: If two chords of a circle are congruent then they 		<p>Circle, Equation of a Circle</p> <ul style="list-style-type: none"> • [SLO: M-12-B -23]: Derive and apply equation of a circle in standard form i.e. $(\bar{x} - h)^2 + (\bar{y} - \bar{k})^2 = \bar{r}^2$ • [SLO: M-12-B -24]: 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. <p>Tangent and Normal</p> <ul style="list-style-type: none"> • [SLO: M-12-B -25]: Find the condition when:
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	<p>will be equidistant from the centre</p> <ul style="list-style-type: none"> • [SLO: M-10-B-19]: Solve problems by using the property of a circle: Two chords of a circle which are equidistant from the centre are congruent. • [SLO: M-10-B-20]: Solve problems by using the property of circle: If two arcs of a circle (or of congruent circles) are congruent then the corresponding chords are equal. • [SLO: M-10-B-21]: Solve problems by using the property of circle: If two chords of a circle (or of congruent circles) are equal, then their corresponding arcs 		<p>a line intersects the circle. a line touches the circle.</p> <ul style="list-style-type: none"> • [SLO: M-12-B -26]: Find the equation of a tangent: to a circle in slope form and a normal to a circle at a point. • [SLO: M-12-B -27]: Find the length of tangent to a circle from a given external point. <p>Parabola</p> <ul style="list-style-type: none"> • [SLO: M-12-B -28]: Derive and apply the standard equation of a parabola. • [SLO: M-12-B -29]: sketch their graphs and find their elements.
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	<p>(minor, major or semi-circular) are congruent.</p> <ul style="list-style-type: none"> • [SLO: M-10-B-22]: Solve problems by using the property of circle: Equal chords of a circle (or of congruent circles) subtend equal angles at the centre (at the corresponding centres). • [SLO: M-10-B-23]: Solve problems by using the property of circle: If the angles subtended by two chords of a circle (or congruent circles) at the centre (corresponding centres) are equal, the chords are equal. • [SLO: M-10-B-24]: Apply concepts of 		<ul style="list-style-type: none"> • [SLO: M-12-B -30]: Find the equation of a parabola with the following given elements: focus and vertex, focus and directrix, vertex and directrix. <p>Equations of Tangent and Normal</p> <ul style="list-style-type: none"> • [SLO: M-12-B-31]: Find the condition when a line is tangent to a parabola at a point and hence write the equation of a tangent line in slope form. • [SLO: M-12-B-32]: Find the equation of a tangent and a normal to a parabola at a point. <p>Ellipse</p>
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chords and arcs of a circle to real life world problems (such as decorative features, rainbow, bridges, roller coaster track).

Tangent and Angles of a Circle

- [SLO: M-10-B-25]: 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.
- [SLO: M-10-B-26]: Solve problems by using the property of a circle: The tangent to a circle and the radial segment joining the point of contact

- [SLO: M-12-B-33]: Derive and apply the standard form of equation of an ellipse and identify its elements.
- [SLO: M-12-B-34]: Convert a given equation to the standard form of equation of an ellipse, find its elements and draw the graph.

Equations of Tangent and Normal

- [SLO: M-12-B -35]: Find points of intersection of an ellipse with a line including the condition of tangency.
- [SLO: M-12-B-36]: Find the equation of

	<p>and the centre are perpendicular to each other.</p> <ul style="list-style-type: none"> • [SLO: M-10-B-27]: Solve problems by using the property of circle: The two tangents drawn to a circle from a point outside it, are equal in length. • [SLO: M-10-B-28]: 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. • [SLO: M-10-B-29]: Solve problems by using the property of circle: The measure of 		<p>a tangent to an ellipse in slope form.</p> <ul style="list-style-type: none"> • [SLO: M-12-B -37]: Find the equation of a tangent and a normal to an ellipse at a point. <p>Standard Form of Equation of Hyperbola</p> <ul style="list-style-type: none"> • [SLO: M-12-B -38]: Derive and apply the standard form of equation of a hyperbola and identify its elements. • [SLO: M-12-B -39]: 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
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	<p>a central angle of a minor arc of a circle is double that of the angle subtended by the corresponding major arc.</p> <ul style="list-style-type: none"> • [SLO: M-10-B-30]: Solve problems by using the property of a circle: Any two angles in the same segment of a circle are equal. • [SLO: M-10-B-31]: 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. 		<p>axes, focus, eccentricity and centre, focus, centre and directrix.</p> <p>Equations of Tangent and Normal</p> <ul style="list-style-type: none"> • [SLO: M-12-B-40]: Find points of intersection of hyperbola with a line including the condition of tangency. • [SLO: M-12-B-41]: Find the equation of a tangent to a hyperbola in slope form. • [SLO: M-12-B-42]: Find the equation of a tangent and a normal to a hyperbola at a point. • [SLO:M-12 -B-43]: Apply concepts of
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	<ul style="list-style-type: none"> • [SLO: M-10-B-32]: Solve problems by using the property of circle: The opposite angles of any quadrilateral inscribed in a circle are supplementary. • [SLO: M-10-B-33]: Apply concepts of tangents and angles of a circle to real life world problems (such as architecture, monuments, pyramids) 		<p>conics to real life world problems (such as suspension and reflection problems related to parabola, Satellite system, elliptic movement of electrons in the atom around the nucleus, radio system use as hyperbolic functions, flashlights, conics in architecture).</p>
<p>Construction of Triangle</p> <ul style="list-style-type: none"> • [SLO: M-09-B-28]: Construct a triangle having given two sides and the included angle. • [SLO: M-09-B-29]: Construct a triangle 	<p>Practical Geometry of Circles</p> <ul style="list-style-type: none"> • [SLO: M-10-B-34]: Locate the centre of a given circle. • [SLO: M-10-B-35]: Draw a circle passing 		

having given one side and two of the angles.

- [SLO: M-09-B-30]: Construct a triangle having given two of its sides and the angle opposite to one of them (with all the three possibilities).
- [SLO: M-09-B-31]: Draw angle bisectors, perpendicular bisectors, medians, altitudes of a given triangle and verify their concurrency.

through three given noncollinear points.

- [SLO: M-10-B-36]: Complete the circle:
 - by finding the centre,
 - without finding the centre, when a part of its circumference is given.

Tangent to the Circle

- [SLO: M-10-B-37]: Draw a tangent to a given arc, without using the centre, through a given point P when P is
 - the middle point of the arc,
 - at the end of the arc,
 - outside the arc.
- [SLO: M-10-B-38]: Draw a tangent to a given circle from a point P when P lies

	<ul style="list-style-type: none">• on the circumference• outside the circle• [SLO: M-10-B-39]: Draw two tangents to a circle meeting each other at a given angle.• [SLO: M-10-B-40]: Apply concepts of practical geometry of a circle to real life world problems (such as athletic tracks, recreational parks, ferris wheels, mechanical machines)		
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RATIONALE

Mathematics is the study of order, relation and pattern. From its origins in counting and measuring it has evolved in highly sophisticated and elegant ways to become the language now used to describe much of the modern world. Statistics is concerned with collecting, analysing, modelling and interpreting data in order to investigate and understand real-world phenomena and solve problems in context. Together, mathematics and statistics provide a framework for thinking and a means of communication that is powerful, logical, concise and precise. Statistics is used to describe and analyse phenomena involving uncertainty and variation. For these reasons this domain provides a foundation for further studies in disciplines in which mathematics and statistics have important roles. It is also advantageous for further studies in the health and social sciences. In summary, the curriculum is designed for students whose future pathways may involve mathematics and statistics and their applications in a range of disciplines at the tertiary level. In the 2006 National curriculum, the percentage of statistical concepts as compared to O-level and A-level is not appropriate therefore concepts of normal distribution are added to the SLOs of Grade XII and Permutation/Combination are shifted to grade XI.

Domain C: Information Handling

Standard-3 The students will be able to collect, organize, analyze, display and interpret data/ information.

Grade 9	Grade 10	Grade 11	Grade 12
Benchmark I: Students will be able to find measures of central tendency and dispersion to draw conclusion, construct and interpret cumulative frequency curve, measure correlation using scatter diagram, Benchmark II: Students will be able to predict the outcomes of single and combined events using diagrams,		Benchmark I: Benchmark II: Students will be able to solve problems involving permutations and combinations	

find probability and recognize probabilities of compound events.

Student Learning Outcomes

Frequency Distribution

- [SLO: M-09-C -01]: Construct a grouped frequency table, histogram (with unequal class intervals) and frequency polygon

Measure of Central Tendency

- [SLO: M-09-C -02]: Calculate the mean modal class and median of a grouped frequency distribution
- [SLO: M-09-C -03]: Solve real life situations involving mean, weighted mean,

Cumulative Frequency Distribution and measures of dispersion

- [SLO: M-10-C-01]: Construct cumulative frequency table, cumulative frequency polygon or Ogive
- [SLO: M-10-C-02]: Interpret the median, quartiles, deciles, percentiles, and inter quartile range from cumulative frequency curve.
- [SLO: M-10-C-03]: Interpret and analyse box and whisker plots
Correlation

median, and mode for given data (such as allocation of funds in different projects, forecasting future demographics, marketing, forecasting government budgets).

- [SLO: M-10-C-04]: Construct and interpret data from scatter diagrams and also draw lines of best fit
- [SLO: M-10-C-05]: Measure correlation using scatter diagram

Measure of Dispersion

- [SLO: M-10-C-06]: Calculate the range, standard deviation and variance for grouped data.
- [SLO: M-10-C-07]: Use the mean and standard deviation to compare two sets of data
- [SLO: M-10-C-08]: Solve real life situations involving variance, and standard deviation for grouped data

	<ul style="list-style-type: none"> • [SLO: M-10-C-09]: Apply concepts from measures of dispersion to solve real life situations (such as determining the consistency of data, checking variability in forecasting, manufacturing, finance, economics). 		
<p>Probability</p> <ul style="list-style-type: none"> • [SLO: M-09-C -04]: Calculate the probability of a single event and the probability of event not occurring • [SLO: M-09-C -05]: Solve real life problems involving probability 	<p>Probability of Combined Events</p> <ul style="list-style-type: none"> • [SLO: M-10-C-10]: Calculate the probability of combined events using, where appropriate: sample space diagrams, possibility diagram, tree diagrams, Venn diagrams. 	<p>Permutation and Combination</p> <ul style="list-style-type: none"> • [SLO: M-11-C-01]: Explain and solve problems that involve the fundamental counting principle. • [SLO: M-11-C-02]: Explain and Solve problems that involve permutations. • [SLO: M-11-C-03]: Explain and Solve 	

Relative and expected frequencies

- [SLO: M-09-C -06]: Calculate relative frequency as an estimate of probability.
- [SLO: M-09-C -07]: Calculate expected frequencies.
- [SLO: M-09-C -08]: Solve real life problems involving relative and expected frequencies.

- [SLO: M-10-C-11]: 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)
- [SLO: M-10-C-12]: Apply the Multiplication law of probability to solve problems involving independent and dependent events (trading, flipping a coin, such as 2 cards being drawn 1 by 1 with replacement and without replacement etc.)

problems that involve combinations.

- [SLO: M-11-C -04]: Apply the concepts of permutation and combination to real world problems such as (cryptography, estimating the odds of winning a lottery, calculating the number of possible DNA sequences or protein structures, choosing different sets of songs for certain occasions)



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