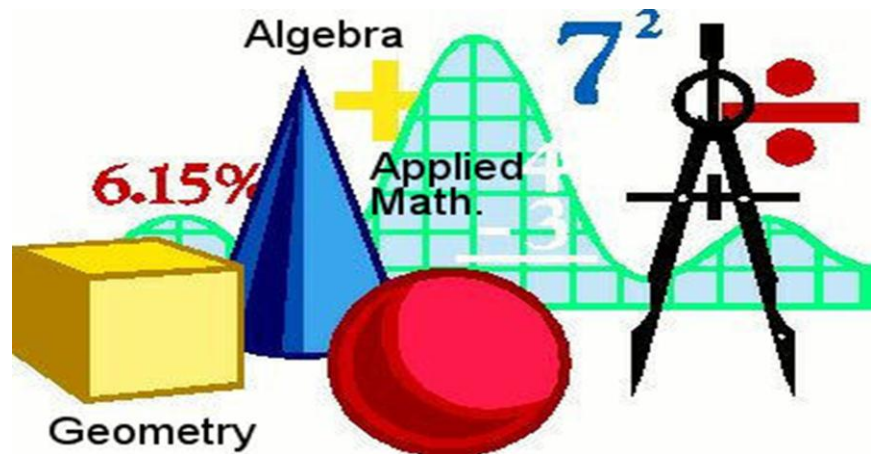# Curriculum for Mathematics Grades XI-XII (Revised in 2019)

Revised by the Provincial Review Committee for Mathematics Classes (I-XII) vide Notification No.SO (G-III)SE&L/3-910/18 Dated: 28th January 2019

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INTRODUCTION

Curriculum

The term 'Curriculum' etymologically comes from the latin root which means 'race course' where the word 'race' and 'course' are suggestive of the time and the path respectively. The curriculum, therefore, can be seen as the prescribed course of study to be covered in a specific timeframe. As a field of study, evolution of curriculum began in 1890's and the first book devoted to the theme entitled 'The Curriculum' was published in 1918 by Franklin Bobbitt.

The Importance of Mathematics

An information and technology based society requires individuals, who are able to think critically about complex issues, analyze and adapt to new situations, solve problems of various kinds and communicate their thinking effectively. The study of mathematics equips students with knowledge, skills and habits of mind that are essential for successful and rewarding participation in such a society. The more the technology is developed the greater the level of mathematical skill is required.

Mathematical structures, operations and processes provide students with a framework and tools for reasoning, justifying conclusions and expressing ideas clearly. As students identify relationships between mathematical concepts and everyday situations and make connections between Mathematics and other subjects, they develop the ability to use Mathematics to extend and apply their knowledge in other fields.

The Themes of Curriculum for Mathematics

1. The curriculum is designed to help students, to build the solid conceptual foundation in Mathematics that will enable them to apply their knowledge skillfully and further learning successfully.
2. The curriculum emphasizes on the geometrical concepts that enable the students to think logically; reason systematically, conjecture astutely and apply it in solving life problems.
3. The curriculum stresses graphics that enable the students to visualize and interpret mathematical expressions correctly rather to manipulate them 'blindly'.
4. The curriculum recognizes the benefits that current technologies can bring to the learning and doing mathematics. It therefore, integrates the use of appropriate technologies to enhance learning in an ever increasingly information–rich world.
5. It is envisages the application of MAPLE in solving Mathematical problem.
6. The curriculum serves as a catalyst for the learning of other disciplines

Objectives

1. To provide the students with sound basis for studying mathematics at higher stage.
2. To enable the students to apply Mathematics in Scientific and Technological fields.
3. To enable the students to face the challenges of the modern technological society
4. To enable the students to apply mathematical concepts specifically in solving computational problems in Natural Sciences, Social Sciences and earth Sciences
5. To enable the students to understand and use mathematical language easily and efficiently.
6. To enable the students to reason consistently and to draw correct conclusion from given hypotheses.
7. To inculcate the habit of examining any situation analytically.
8. To develops logical thinking & reasoning & creative imagination for solving problems.
9. To enable the students to identify, concretise, symbolise and use mathematical relationships in everyday life
10. To enable the students to comprehend, analyze, synthesise, evaluate and make generalizations so as to solve mathematical problems
11. To enable the students to collect, organize, represent, analyze, interpret data and make conclusions and predictions from its results
12. To enable the students to think and reason precisely, logically and critically in any given situation.
13. To enable the students to use the MAPLE to solve the mathematical problems.
14. To enable the students to use mathematical concepts in solving problem of other disciplines as well.

Rational for Revising the National Curriculum for Mathematics Grade XI–XII, 2006

The first National Curriculum was developed in 1975-76, which was reviewed in 1984-85 and then in 1994-95. The next review was taken place in the year 2000 and 2002 for science and social sciences subjects. In 2006, the standard based curriculum was developed, which is based on standards, Benchmarks and Students Learning Outcome (SLOs).

After the 18th constitutional amendment (2010), curriculum and related activities are delegated to the Provinces. In a short period, it was not possible for a province to develop a new Curriculum in the subject of Mathematics Grade XI-XII, for students of Sindh Province, so it was decided that the Curriculum 2006 be adopted after thorough review/revise in the light of ground realities, local context, emerging trends and inclusion of 21st century skills. For this purpose the School Education and Literacy Department, Government of Sindh constituted and notified a Provincial Review Committee for Mathematics grade I-XII to develop/review the Curriculum. (See annex – A)

Strands (Key Learning Areas)

The Curriculum for Mathematics Grades XI-XII (revised in 2019) is comprised of four Strands (Key Learning Areas), which are Numbers and Operations, Algebra, Measurement & Geometry and Information.

Further, 'Reasoning and Logical Thinking' is an integral part of every Strand (Key Learning Area) and it is embedded in each Strand.

Mathematics
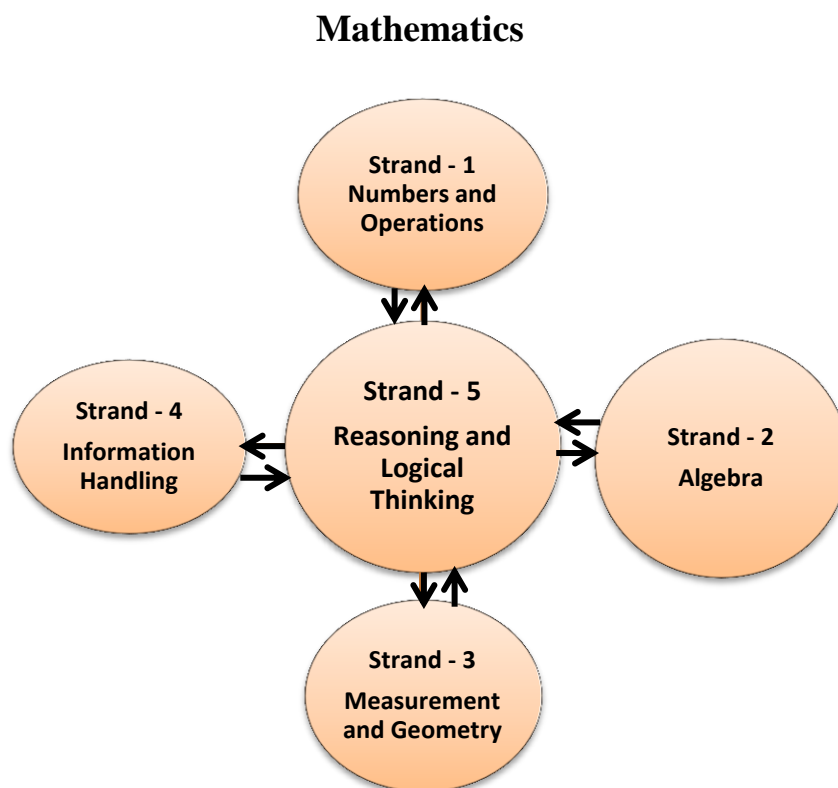
FRAMEWORK OF CURRICULUM

Each 'Strand' is further classified into standards, benchmarks, Students Learning Outcomes (SLO).The figure below indicates their linkage, given as under:
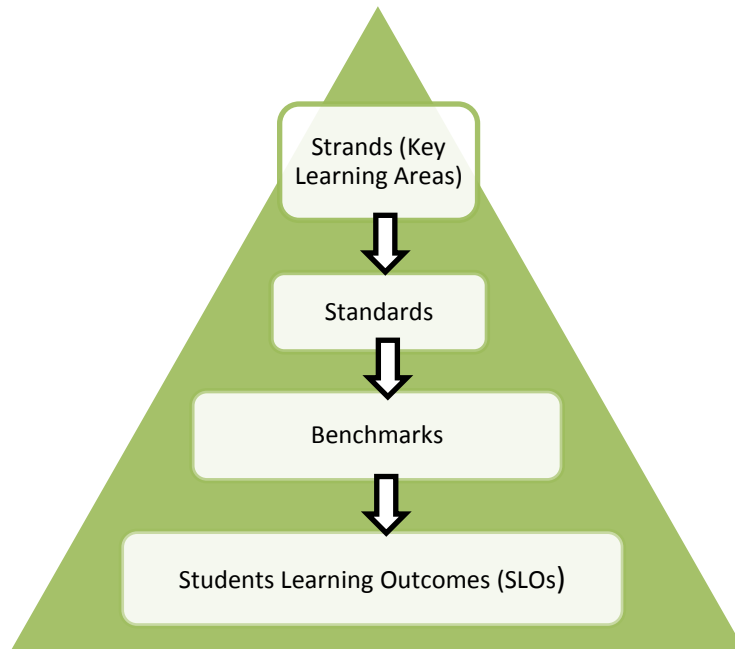
The standards in education means is that level of knowledge or skill we expect students to reach in a specific subject matter. The benchmarks, thereafter, serve as a guide indicating how competencies at a particular developmental level are to be attained in order to meet the standards. They provide indicators of expectations from students at completion of each of five developmental stages: grades I to II, III to V, VI to VIII, IX to X and XI to XII.

STANDARDS AND BENCHMARKS FOR CURRICULUM MATHEMATICS
GRADE XI & XII

NUMBERS AND OPERATIONS

Standards

The students will be able to:

- Identify numbers, ways of representing numbers and effects of operations in various situations
- Compute fluently with fractions, decimals and percents
- Manipulate different types of sequence and apply operations on matrices

Benchmarks

- Identify complex numbers and their properties and carryout basic operations on complex numbers.
- Evaluate determinant, find inverse and rank of a matrix.
- Explain and construct various sequences and series of real numbers.
- Apply principle of mathematical Induction to prove statements, identities and formulae.
- Find approximate values of the binomial expansions having indices as rational numbers
- Integrate technology to aid the process of mathematical exploration.

ALGEBRA

Standards

The students will be able to

- Analyze number patterns and interpret mathematical situations by manipulating algebraic expressions and relations,
- Model and solve contextualized problems
- Interpret functions, calculate rate of change of functions, integrate analytically and numerically, determine orthogonal trajectories of a family of curves and solve non-liner equations numerically.

Benchmarks

- Solve equations with complex coefficients.
- Solve system of homogenous and non-homogenous liner equations by appropriate method (matrix inversion, Gauss elimination, Gauss Jordan and Cramer's rule).
- Analyze attributes of functions and give their graphical representation.
- Evaluate limits of functions.
- Differentiate and integrate algebraic and transcendental functions.
- Find extreme values of functions.
- Solve ordinary differential equations of first order and first degree.
- Find orthogonal trajectories of a given family of curves.
- Find partial derivatives of a function of two variables and verify Euler theorem.
- Solve non-liner equations in one variable by numerical techniques.
- Evaluate definite integrals by numerical methods.
- Integrate technology to aid the process of mathematical exploration.

MEASUREMENTS AND GEOMETRY

Standards

The students will be able to

- Identify measurable attributes of objects, construct angles and two dimensional figures
- Analyze characteristics and properties of geometric shapes and develop arguments about their geometrical relationships.
- Recognize trigonometric identities, analyze conic sections, draw and interpret graphs of functions.

Benchmarks

- Identify vectors in space and apply vector addition, dot/cross product, scalar triple product.
- Differentiate and integrate vector functions.
- Use appropriate laws of trigonometry to solve the triangles.
- Apply trigonometric formulas to find area of triangle.
- Find radii of circles connected with triangles and prove their relationships.
- Interpret graphically the algebraic and transcendental functions
- Interpret and recognize equations of a straight line in standard form.
- Show the concurrency of right bisectors/medians/altitudes of a triangle.

- Identify and analyze conic sections (circle, parabola, ellepse and hyperbola).
- Integrate technology to aid the process of mathematical exploration.

INFORMATION HANDLING

Standard

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

Benchmarks

- Solve real life problems involving arithmetic/geometric sequence and series.
- Use partial fractions to find sum to *n* terms and to infinity the series.
- Find sum to *n* terms of arithmetic-geometric series
- Solve problems involving permutation and combination
- Use various methods to solve probability problems.
- Integrate technology to aid the process of mathematical exploration.

REASONING AND LOGICAL THINKING

Standards

The students will be able to

- Use patterns, known facts, properties and relationships to analyze mathematical situations,
- Examine real life situations by identifying, mathematically valid arguments and drawing conclusion to enhance their mathematical thinking.

Benchmarks

- Identify valid and invalid arguments.
- Apply mathematical ideas and arguments logically.
- Use graphics to optimize a situation.
- Acquire ability to apply mathematics in physical situations and use numerical techniques to find approximate solution.
- Develop and communicate logical proofs and counter examples for geometrical and mathematical statements.

CURRICULUM FOR MATHEMATICS, GRADE XI

Contents of scope	Learning outcomes/ skills
	All students will be able to

UNIT 1   COMPLEX NUMBERS

1.1 Complex Numbers and Geometrical representation of Complex number	i) 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 $i = \sqrt{-1}$ ii) Recognize a as real part of z and b as imaginary part of z. iii) Know the condition for equality of complex numbers. iv) Carryout basic operations on complex numbers v) Define $\bar{z} = a - ib$ as the complex conjugate of $z = a + ib$ vi) Define $|z| = \sqrt{a^2 + b^2}$ as the absolute value or modulus of a complex number $z = a + ib$ vii) Geometrical representation of Complex number Z as a pair of real number (a, b). viii) The order relation of complex numbers ix) Vector representation of complex numbers.

1.2 Properties of Complex	i) Describe algebraic properties of complex numbers (e.g. commutative, associative and distributive) with respect to '+' and '×'
	ii) Know additive identity and multiplicative identity for the set of complex numbers
	iii) Find additive inverse and multiplicative inverse of a complex number z
	iv) Demonstrate the following properties.
	  • $\|z\| = \|-z\| = \|\bar{z}\| = \|-\bar{z}\|$,
	  • $\bar{\bar{z}} = z, \quad z\,\bar{z} = \|z\|^2, \overline{z_1 + z_2} = \bar{z_1} + \bar{z_2}$
	  • Triangle inequality of complex numbers
	  • $\overline{z_1 z_2} = \overline{z_1}\,\overline{z_2}, \left(\overline{\frac{z_1}{z_2}}\right) = \frac{\overline{z_1}}{\overline{z_2}}$, $z_{2 \neq 0}$
	v) Find real and imaginary parts of the following type of complex numbers
	  • $(x + iy)^n$
	  • $\left(\frac{x_1 + iy_1}{x_2 + iy_2}\right)^n, x_2 + iy_2 \neq 0$
	  Where $n = \pm 1$, and ± 2

1.3 Solution of complex equations	i) Solve the simultaneous linear equation with complex coefficients. For example, $5z - (3 + i)\,w = 7 - i$ $(2 - i)z + 2iw = -1 + i$ ii) Represent the polynomial $P(z)$ as a product of linear factor. For example , $z^2 + a^2 = (z + ia)\,(z - ia)$ $z^3 - 3z^2 + z + 5 = (z + 1)(z - 2 - i)(z - 2 + i)$ iii) Solve quadratic equation of the form $pz^2 + qz + r = 0$ by completing the square, where p, q and r are real numbers and z a complex number. For example: Solve $z^2 - 2z + 5 = 0$ $\Longrightarrow (z - 1 - 2i)\,(z - 1 + 2i) = 0$ $\Longrightarrow z = 1 + 2i,\ 1 - 2i.$

UNIT 2   MATRICES AND DETERMINANTS

2.1 Matrices	i) Recall the concept of • a matrix and its notation • order of a matrix • equality of two matrices ii) Know row matrix, column matrix, square matrix, rectangular matrix, zero/null matrix, identity matrix, scalar matrix, diagonal matrix,. iii) Define upper and lower triangular matrix, transpose of a matrix, symmetric matrix and skew-symmetric matrix, Idempotent, Nilpotent, Involuntary, Periodic, Hermetion matrix and Skew Hermetion matrix of order upto 4
2.2 Algebra of Matrices	i) Carryout scalar multiplication, addition/subtraction of matrices, multiplication of matrices with real and complex entries. (3 - by - 3) ii) Show that commutative property: • holds under addition i.e. $A + B = B + A$ • does not hold under multiplication, in general iii) Verify that $(AB)^t = B^t A^t$. (3 - by - 3)
2.3 Determinants	i) Describe determinant of a square matrix, minor and cofactor of an element of a matrix. ii) Evaluate determinant of a square matrix using cofactors. iii) Define singular and non-singular matrices. iv) Describe the adjoint of a square matrix and a

	diagonal.
	v) Use adjoint method to calculate inverse of a square matrix and verify.
	vi) Verify the results $(AB)^{-1} = B^{-1}A^{-1}$
2.4 Properties of Determinants	i) State and verify the properties of determinants.
	ii) Evaluate the determinant without expansion (i.e. using properties of determinants).
2.5 Row and Column Operations	i) Describe the elementary row and column operations on matrices.
	ii) Define echelon and reduced echelon form of a matrix.
	iii) Reduce a matrix to its echelon and reduced echelon form.
	iv) Recognize the rank of a matrix.
	v) Use row operations to find the inverse and the rank of a matrix.
2.6 Solving System of Linear Equations	i) Distinguish between homogeneous and non-homogeneous linear equations in 2 and 3 unknowns.
	ii) Solve a system of three homogeneous linear equations in three unknowns.
	iii) Define a consistent and inconsistent system of linear equations and demonstrate through examples.
	iv) Solve a system of 3-by-3 non-homogeneous linear equations using:
	• matrix inversion method,
	• Cramer's rule.
	• Gauss elimination method (echelon form),
	• Gauss-Jordan method (reduced echelon form)

UNIT 3   VECTORS

3.1 Vectors in Plane	i) Define a scalar and a vector.
	ii) Give geometrical representation of a vector.
	iii) Give the following fundamental definitions using geometrical representation:
	• magnitude of a vector,
	• equal vectors,
	• negative of a vector,
	• unit vector,

	- zero/null vector, - position vector, - parallel vectors, - addition and subtraction of vectors, - triangle, parallelogram and polygon laws of addition, - scalar multiplication iv) Represent a vector in a Cartesian plane by defining fundamental unit vectors i and j. v) Recognize all above definitions using analytical representation. vi) Find a unit vector in the direction of another given vector. vii) Find the position vector of a point which divides the line segment joining two points in a given ratio. viii) Use vectors to prove simple theorems of descriptive geometry.
3.2 Vectors in Space	i) Recognize rectangular coordinate system in space. ii) Define unit vectors i, j and k. iii) Recognize components of a vector. iv) Give analytic representation of a vector. v) Find magnitude of a vector. vi) Repeat all fundamental definitions for vectors in space which, in the plane, have already been discussed.
3.3 Properties of Vector Addition	i) State and prove - commutative law for vector addition. - associative law for vector addition. ii) Prove that: **0** as the identity for vector addition. **-A** as the inverse for **A.**
3.4 Properties of Scalar Multiplication of vectors $m(n(\bar{a}))$	State and verify $m(\bar{a}) = (\bar{a})m$ - commutative law for scalar multiplication, - associative law for scalar multiplication, - distributive laws for scalar multiplication. $m(\bar{a} \pm \bar{b}) = m\bar{a} \pm m\bar{b}$
3.5 Dot or Scalar Product	i) Define dot or scalar product of two vectors and give its geometrical interpretation. ii) Prove that: $i.i = j.j = k.k = 1,$ $i.j = j.k = k.i = 0.$

	iii) Express dot product in terms of components. iv) Find the condition for orthogonality of two vectors. v) Prove the commutative and distributive laws for dot product. vi) Explain direction cosines and direction ratios of a vector. vii) Prove that the sum of the squares of direction cosines is unity. viii) Use dot product to find the angle between two vectors. ix) Find the projection of a vector along another vector. x) Find the work done by a constant force in moving an object along a given vector. xi) Solve daily life problems based on work done

3.6 Cross or Vector Product	i) Define cross or vector product of two vectors and give its geometrical interpretation.
	ii) Prove that:
	  • $i \times i = j \times j = k \times k = 0,$
	  • $i \times j = -j \times i = k,$
	  • $j \times k = -k \times j = i,$
	  • $k \times i = -i \times k = j.$
	iii) Express cross product in terms of components.
	iv) Prove that the magnitude of **A x B** represents the area of a parallelogram with adjacent sides **A** and **B**.
	v) Find the condition for parallelism of two non - zero vectors
	vi) Prove that **A** x **B** = -**B** x **A.**
	vii) Prove the distributive laws for cross product.
	viii) Use cross product to find the angle between two vectors.
	ix) Find the vector moment of a given force about a given point.
	x) Application in daily life based on Cross or Vector Product

3.7 Scalar Triple Product	i) Define scalar triple product of vectors.
	ii) Express scalar triple product of vectors in terms of components (determinantal form).
	iii) Prove that:
	  • $i \cdot j \times k = j \cdot k \times i = k \cdot i \times j = 1,$
	  • $i \cdot k \times j = j \cdot i \times k = k \cdot j \times i = -1.$
	iv) Prove that dot and cross are inter-changeable in scalar triple product.
	v) Find the volume of
	  • a parallelepiped,
	  • a tetrahedron,

	determined by three given vectors.
	vi) Define coplanar vectors and find the condition for coplanariry of three vectors.

UNIT 4   SEQUENCES AND SERIES

4.1 Sequence	i) Define a sequence (progression) and its terms. ii) Know that a sequence can be constructed from a formula or an inductive definition. iii) Recognize triangle, factorial and Pascal sequences as fractional form.
4.2 Arithmetic Sequence	i) Define an arithmetic sequence. ii) Find the nth or general term of an arithmetic sequence. iii) Solve problems involving arithmetic sequence.
4.3 Arithmetic Mean	i) Know arithmetic mean between two numbers. ii) Insert an Arithmetic Mean between two numbers iii) Insert n Arithmetic Mean between two numbers
4.4 Arithmetic Series	i) Define an arithmetic series. ii) Establish the formula to find the sum to n terms of an arithmetic series. iii) Show that sum of n arithmetic means between two numbers is equal to n times their arithmetic mean. iv) Solve real life problems involving arithmetic series.
4.5 Geometric Sequence	i) Define a geometric sequence. ii) Find the nth or general term of a geometric sequence. iii) Solve problems involving geometric sequence.
4.6 Geometric Mean	i) Know geometric mean between two numbers. ii) Insert a geometric means between two numbers. iii) Insert n geometric means between two numbers.
4.7 Geometric Series	i) Define a geometric series. ii) Find the sum of n terms of a geometric series. iii) Find the sum of an infinite geometric series. iv) Convert the recurring decimal fraction into an equivalent common fraction. v) Solve real life problems involving geometric series.
4.8 Harmonic Sequence	i) Recognize a harmonic sequence.

	ii) Find nth term of harmonic sequence.
4.9 Harmonic Mean	i) Define a harmonic mean. ii) Insert a harmonic mean between two numbers. iii) Insert n harmonic means between two numbers.

UNIT 5   MISCELLANEOUS SERIES

5.1 Evaluation of $\sum n$, $\sum n^2$ and $\sum n^3$	i) Recognize sigma ($\sum$) notation.
	ii) Find sum of
	   • 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 ($\sum n^3$).

5.2 Arithmetico - Geometric Series	i) Define arithmetic - geometric series. ii) Find sum to n terms of the arithmetic - geometric series.
5.3 Method of Differences	i) Define method of differences. ii) Apply this method to find the sum of n terms of the series whose differences of the consecutive terms are either in arithmetic or in geometric sequence.
5.4 Summation of Series using Partial Fractions	Use partial fractions to find the sum to n terms and to infinity the series of the type $\dfrac{1}{a(a+d)} + \dfrac{1}{(a+d)(a+2d)}$ + …

UNIT 6   PERMUTATION, COMBINATION AND PROBABILITY

6.1 Factorial of a Natural Number	Know Kramp's factorial notation to express the product of first n natural numbers by $n!$.

6.2 Permutation	i) Recognize the fundamental principle of counting and illustrate this principle using tree diagram.
	ii) Explain the meaning of permutation of n different objects taken r at a time and know the notation ${}^{n}P_{r}$
	iii) Prove that ${}^{n}P_{r} = n(n-1)(n-2) \ldots (n-r+1)$ and hence deduce that
	   • ${}^{n}P_{r} = \dfrac{n!}{(n-r)!}$,
	   • ${}^{n}P_{n} = n!$,
	   • $0! = 1$
	iv) Apply ${}^{n}P_{r}$ to solve problems of finding the

	number of arrangements of n objects taken r at a time(when all n objects are different and when some of them are alike).
	v) Find the arrangement of different objects around a circular permutation.
	vi) Solve daily life problems involving Permutation

6.3 Combination	i) Define combination of n different objects taken r at a time.
	ii) Prove the formula $^nC_r = \binom{n}{r} = \dfrac{n!}{r!(n-r)!}$ and deduce that
	• $\binom{n}{n} = \binom{n}{0} = 1$
	• $\binom{n}{r} = \binom{n}{n-r}$, $\binom{n}{1} = \binom{n}{n-1} = n,$
	• $\binom{n}{r} + \binom{n}{r-1} = \binom{n+1}{r}$.
	iii) Solve daily life problems involving combination.

6.4 Probability	i) Define the following:
	• statistical experiment,
	• sample space and an event,
	• mutually exclusive events,
	• equally likely events,
	• dependent and independent events,
	• exhaustive event
	• impossible event
	• simple and compound events.
	ii) Recognize the formula for probability of occurrence of an event E, that is $P(E) = \dfrac{n(E)}{n(s)}$, $0 \le P(E) \le 1$.
	iii) Apply the formula for finding probability in simple cases.
	iv) Use Venn diagrams and tree diagrams to find the probability for the occurrence of an event.
	v) Define the conditional probability.
	vi) Recognize the addition theorem (or law) of probability: $P(A \cup B) = P(A) + P(B) - P(A \cup B)$, where A and B are two events. Deduce that $P(A \cup B) = P(A) + P(B)$ where A and B are mutually exclusive events.
	vii) Recognize the multiplication theorem (or law) of probability $P(A \cap B) = P(A)P(B \mid A)$ or $P(A \cap B) = P(B)P(A \mid B)$

	where P(B | A) and P(A | B) are conditional probabilities. Deduce that P(A ∩ B) = P(A)P(B) where A and B are independent events. viii) Use theorems of addition and multiplication of probability to solve related problems from daily life.

UNIT 7   MATHEMATICAL INDUCTION AND BINOMIAL THEOREM

7.1 Mathematical Induction	i) Describe principle of mathematical. ii) Apply the principle to prove the statements, identities or formulae.
7.2 Binomial Theorem	i) Use Pascal's triangle to find the expansion of $(x + y)^n$ where n is a small positive integer. ii) State and prove binomial theorem for positive integral index. iii) Expand $(x + y)^n$ using binomial theorem and find its general term. iv) Find the specified term in the expansion of $(x + y)^n$
7.3 Binomial Series	i) Expand $(1 + x)^n$ where n is a positive integer and extend this result for all rational values of n ii) Expand $(1 + x)^n$ in ascending power of x and explain its validity/convergence for $\|x\| < 1$ where n is a rational number. iii) Determine the approximate values of the binomial expansions having indices as −ve integers or fractions. iv) Application of summation and series

UNIT 8   FUNCTIONS AND GRAPHS

8.1 Function	i) Recall
	    • function as a rule of correspondence,
	    • domain, co-domain and range of a function,
	    • one to one and onto functions.
	ii) Know linear, quadratic and square root functions

8.2 Inverse Function	Define inverse functions and demonstrate their domain and range with examples.

| 8.3 Graphical Representation of Functions | i) Sketch graphs of
  • linear functions (e.g. $y = ax + b$),
  • non-linear functions = (e.g. $y = x^2$).
  • square function ($x^2 + y^2 = a^2$)
ii) Sketch the graph of the function $y = x^n$ where n is
  • a + ve integer,
  • a - ve integer ($x \neq 0$),
  • a rational number for $x > 0$.
iii) Sketch graph of quadratic function of the form $y = ax^2 + bx + c$, a($\neq 0$) , b, c are integers.
iv) Sketch graph using factors.
v) Predict functions from their graphs (use the factor form to predict the equation of a function of the type $f(x) = ax^2 + bx + c$, if two points where the graph crosses x-axis and third point on the curve, are given |
| 8.4 Intersecting Graphs | i) Find the intersecting point graphically when intersection occurs between
  • a linear function and coordinate axes,
  • two linear functions,
  • a linear and a quadratic function.
ii) Solve, graphically, appropriate problems from daily life. |

UNIT 9   LINEAR PROGRAMMING

9.1 Introduction	Define linear programming (LP) as planning of allocation of limited resources to obtain an optimal result.
9.2 Linear Inequalities	i) Find algebraic solutions of linear inequalities in one variable and represent them on number line. ii) Interpret graphically the linear inequalities in two variables. iii) Determine graphically the region bounded by up to 3 simultaneous linear inequalities of non-negative variables and shade the region bounded by them.

9.3 Feasible Region	i) Define
	  • linear programming problem,
	  • objective function,
	  • problem constraints,
	  • decision variables.

	ii) Define and show graphically the feasible region (or solution space) of an LP problem. iii) Identify the feasible region of simple LP problems.
9.4 Optimal Solution	i) Define optimal solution of an LP problem. ii) Find optimal solution (graphical) through the following systematic procedure: • establish the mathematical formulation of LP problem, • construct the graph, • identify the feasible region, • locate the solution points, • evaluate the objective function, • select the optimal solution, • verify the optimal solution by actually substituting values of variables from the feasible region. iii) Solve real life simple LP problems.

UNIT 10 TRIGONOMETRIC IDENTITIES OF SUM AND DIFFERENCE OF ANGLES

10.1 Fundamental Law of Trigonometry	i) Recall trigonometric ratios ii) Use distance formula to establish fundamental law of trigonometry • $\cos(\alpha - \beta) = \cos \alpha \cos \beta + \sin \alpha \sin \beta$, and deduce that • $\cos(\alpha + \beta) = \cos \alpha \cos \beta - \sin \alpha \sin \beta$, • $\sin(\alpha \pm \beta) = \sin \alpha \cos \beta \pm \cos \alpha \sin \beta$, • $\tan(\alpha \pm \beta) = \dfrac{\tan\alpha \pm \tan\beta}{1 \mp \tan\alpha \tan\beta}$
10.2 Trigonometric Ratios of Allied Angles	i) Define allied angles. ii) Use fundamental law and its deductions to derive trigonometric ratios of allied angles. Express $a\sin\theta + b\cos\theta$ in the form $r\sin(\theta + \emptyset)$ where $a = r\cos\emptyset$ and $b = r\sin\emptyset$.
10.3 Double, Half and Triple Angle Identities	Derive double angle, half angle and triple angle identities from fundamental law and its deductions.
10.4 Sum, Difference and	i) Express the product (of sines and cosines) as sums

Product of sine and cosine	or differences (of sines and cosines). ii) Express the sums or differences (of sines and cosines) as products (of sines and cosines).

UNIT 11   APPLICATION OF TRIGONOMETRY

11.1 Solving Triangles	i) Solve right angled triangle when measures of
	    • two sides are given,
	    • one side and one angle are given.
	ii) Define an oblique triangle and prove
	    • the law of cosines,
	    • the law of sines,
	    • the law of tangents,
	and deduce respective half angle formulae.
	iii) Apply above laws to solve oblique triangles.

11.2 Area of a Triangle	Derive the formulae to find the area of a triangle in terms of the measures of
	
	    • two sides and their included angle,
	    • one side and two angles,
	    • three sides (Hero's formula)

11.3 Circles Connected with Triangle	i) Define circum-circle, in-circle and escribed-circle.
	ii) Derive the formulae to find
	    • circum-radius,
	    • in-radius,
	    • escribed-radii,
	    and apply them to deduce different identities.

UNIT 12   GRAPHS OF TRIGONOMETRIC AND INVERSE TRIGONOMETRIC FUNCTIONS AND SOLUTION OF TRIGONOMETRIC EQUATIONS

12.1 Period of Trigonometric Functions	i) Find the domain and range of the trigonometric functions.
	ii) Define even and odd functions.
	iii) Discuss the periodicity of trigonometric functions. Find the maximum and minimum value of a given function of the type:
	
	    • $a + b\sin\theta$,
	    • $a + b\cos\theta$,
	    • $a + b\sin(c\theta + d)$,

	• a + bcos(cθ+d), • the reciprocals of above, where *a, b, c* and *d* are real numbers.

12.2 Graphs of Trigonometric Functions	i) Recognize the shapes of the graphs of sine, cosine and tangent for all angles.
	 ii) Draw the graphs of the six basic trigonometric functions within the domain from -2π to 2π.
	 iii) Guess the graphs of sin2θ, cos2θ, sin$\dfrac{\theta}{2}$ cos $\dfrac{\theta}{2}$ etc. without actually drawing them.
	 iv) Define periodic, even/odd and translation properties of the graphs of sin θ , cosθ and tan θ , i.e., sin θ has
	     • Periodic property sin $(\theta \pm 2\pi) = \sin \theta$
	     • Odd property sin $(-\theta) = -\sin\theta = - \sin \theta$
	     • Translation property $\begin{cases} \sin (\theta - \pi) = - \sin \theta \\ \sin (\pi - \theta) = \sin \theta \end{cases}$
	 iv) Deduce sin$(\theta + 2k\pi)$= sin θ where *k* is an integer.

12.3 Solving Trigonometric Equations Graphically	i) Solve trigonometric equations of the type sinθ = k , cosθ = k and tan θ = k , using periodic, even/odd and translation properties.
	 ii) Solve graphically the trigonometric equations of the type:
	     • $\sin \theta = \dfrac{\theta}{2}$
	     • $\cos\theta = \theta$
	     • tan2θ = 2θ when $-\dfrac{\pi}{2} \le \theta \le \dfrac{\pi}{2}$

12.4 Inverse Trigonometric Functions	i) Define the inverse trigonometric functions and their domain and range.
	 ii) Find domains and ranges of
	     • principal trigonometric functions,
	     • inverse trigonometric functions.
	 iii) Draw the graphs of inverse trigonometric functions.
	 iv) Prove the addition and subtraction formulae of inverse trigonometric functions.
	 v) Apply addition and subtraction formulae of inverse trigonometric functions to verify related identities.

12.5 Solving General Trigonometric Equations	i) Solve trigonometric equations and check their roots by substitution in the given trigonometric equations so as to discard extraneous roots. ii) Use the periods of trigonometric functions to find the solution of general trigonometric equations.

CURRICULUM FOR MATHEMATICS, GRADE-XII

Contents of scope	Learning outcomes/ skills
	All students will be able to

UNIT 1   INTRODUCTION TO SYMBOLIC PACKAGE: MAPLE

1.1 Introduction	i) Recognize MAPLE environment. ii) Recognize basic MAPLE commands. iii) Use MAPLE as a calculator. iv) Use online MAPLE help.
1.2 Polynomials	Use MAPLE commands for • factoring a polynomial, • expanding an expression, • simplifying an expression, • simplifying a rational expression, • substituting into an expression.
1.3 Graphics	i) Plot a two-dimensional graph. ii) Demonstrate domain and range of a plot. iii) Sketch parametric equations. iv) Know plotting options.
1.4 Matrices	i) Recognize matrix and vector entry arrangement. ii) Apply matrix operations. iii) Compute inverse and transpose of a matrix.

UNIT 2   FUNCTIONS AND LIMITS

2.1 Functions	i) Identify through graph the domain and range of a function ii) Draw the graph of modulus function (i.e. $y = |x|$) and identify its domain and range.
2.2 Composition of Functions	i) Recognize the composition of functions. ii) Find the composition of two given functions
2.3 Inverse of Composition of Functions	Describe the inverse of composition of two given functions.
2.4 Transcendental Functions	Recognize algebraic, trigonometric, inverse trigonometric, exponential, logarithmic, hyperbolic

	(and their identities), explicit and implicit functions, and parametric representation of functions.

2.5 Graphical Representations	i) Display graphically:
	  • the explicitly defined functions like $y = f(x)$, where $f(x) = e^x$,
	         $f(x) = a^x$,
	         $f(x) = \log_a x$,
	         $f(x) = \log_e x$.
	  • the implicitly defined functions such as $x^2 + y^2 = a^2$ and $\dfrac{x^2}{a^2} + \dfrac{y^2}{b^2} = 1$, and distinguish between graph of a function and an equation.
	  • the parametric equations of functions such as $x = at^2,\ y = 2at;\ x = a\sec\theta,\ y = b\tan\theta$
	  • discontinuous functions of the type
	    $y = \begin{cases} x \text{ when } 0 \le x < 1 \\ x - 1 \text{ when } 1 \le x \le 2 \end{cases}$
	ii) Use MAPLE graphic commands for two dimensional plot of:
	  • an expression (or a function),
	  • parameterized form of a function,
	  • implicit function,
	    by restricting domain and range.
	iii) Use MAPLE package plots for plotting different types of functions

2.6 Limit of a Function	i) Identify a real number by a point on the number line.
	ii) Define and represent
	  • open interval,
	  • closed interval,
	  • half open and half closed intervals, on the number line.
	iii) Explain the meaning of phrase:
	  • x tends to zero ($x \to 0$),
	  • x tends to a ($x \to a$),
	  • x tends to infinity ($x \to \infty$).
	iv) Define limit of a sequence.
	v) Find the limit of a sequence whose nth term is given.
	vi) Define limit of a function.
	vii) State the theorems on limits of sum, difference, product and quotient of functions and demonstrate through examples.

2.7 Important Limits	i) Evaluate the limits of functions of the following types:

	$\frac{x^2 - a^2}{x - a}$, $\frac{x - a}{\sqrt{x} + \sqrt{a}}$ when $x \to a$ $\left(1 + \frac{1}{x}\right)^x$ when $x \to \infty$ $(1 + x)^{\frac{1}{x}}$, $\frac{\sqrt{x+a} - \sqrt{a}}{x}$, $\frac{a^x - 1}{x}$, $\frac{(1 + x)^n - 1}{x}$ and $\frac{\sin x}{x}$ when $x \to 0$ ii) Evaluate limits of different algebraic, exponential and trigonometric functions iii) Use MAPLE command **limit** to evaluate limit of a function.
2.8 Continuous and Discontinuous Functions	i) Recognize left hand and right hand limits and demonstrate through examples ii) Define continuity of a function at a point and in an interval. iii) Test continuity and discontinuity of a function at a point and in an interval. iv) Use MAPLE command **iscont** to test continuity of a function at a point and in a given interval. v) Application of continuity and discontinuity

UNIT 3   DIFFERENTIATION

3.1 Derivative of a Function	i) Distinguish between independent and dependent variables. ii) Estimate corresponding change in the dependent variable when independent variable is incremented (or decremented). iii) Explain the concept of a rate of change. iv) Define derivative of a function as an instantaneous rate of change of a variable with respect to another variable. v) Define derivative or differential coefficient of a function. vi) Differentiate $y = x^n$, where $n \in Z$ (the set of integers), from first principles (the derivation of power rule). vii) Differentiate $y = (ax + b)^n$, where $n = \frac{p}{q}$ and p, q are integers such that $q \neq 0$, from first principles.
3.2 Theorems on Differentiation	Prove the following theorems for differentiation. - The derivative of a constant is zero. - The derivative of any constant multiple of a function is equal to the product of that constant

	and the derivative of the function. $$\frac{d}{dx}[a\,f(x)] = a\,\frac{d}{dx}f(x)$$ • The derivative of a sum (or difference) of two functions is equal to the sum (or difference) of their derivatives. $$\frac{d}{dx}[f(x) \pm g(x)] = \frac{d}{dx}f(x) \pm \frac{d}{dx}g(x)$$ • The derivative of a product of two functions is equal to (the first function) x (derivative of the second function) plus (derivative of the first function) x (the second function). $$\frac{d}{dx}[f(x).g(x)] = f(x) . \frac{d}{dx}g(x) - g(x) . \frac{d}{dx}f(x)$$ • The derivative of a quotient of two functions is equal to Denominator times the derivative of the numerator, minus the numerator times the derivative of the denominator, all divided by the square of the denominator. $$\frac{d}{dx}\left[\frac{f(x)}{g(x)}\right] = \frac{g(x).\frac{d}{dx}f(x) - f(x).\frac{d}{dx}g(x)}{(g(x))^2}$$
3.3 Application of Theorems on Differentiation	Differentiate: • constant multiple of x^n, • sum (or difference) of functions, • polynomials, • product of functions, • quotient of two functions.
3.4 Chain Rule	i) Prove that: $\frac{dy}{dx} = \frac{dy}{du} . \frac{du}{dx}$ when $y = f(u)$ and $u = g(x)$ (Chain Rule) ii) Show that: $\frac{dy}{dx} = \frac{1}{\frac{dx}{dy}}$ iii) Use chain rule to show that $\frac{d}{dx}[f(x)]^n = n\,[f(x)]^{n-1}\,f'(x)$ iv) Find derivative of implicit function.
3.5 Differentiation of Trigonometric and Inverse Trigonometric Functions	Differentiate: • trigonometric functions (sin x, cosx, tanx, cosecx, sec x, and cot x) from first principles. • Inverse trigonometric functions (arcsinx, arccosx, arctanx, arccosecx, arcsecx, and arccotx) using differentiation formulae.

3.6 Differentiation of Exponential and Logarithmic Functions	i) Find the derivative of e^x and a^x from first principles. ii) Find the derivative of *lnx* and $\log_a x$ from first principles. iii) Use logarithmic differentiation to find derivative of algebraic expressions involving product, quotient and power.
3.7 Differentiation of Hyperbolic and Inverse Hyperbolic Functions	Differentiate: • hyperbolic functions (sinhx, coshx, tanhx, cosechx, sechx and cothx). • inverse hyperbolic functions ($\sinh^{-1}x$, cosh-^{1}x, $\tanh^{-1}x$, cosech^{-1}x, sech^{-1}x, and $\coth^{-1}x$).
	Use MAPLE command **diff** to differentiate a function.

UNIT 4   HIGHER ORDER DERIVATIVES AND APPLICATIONS

4.1 Higher Order Derivatives	i) Find higher order derivatives of algebraic, trigonometric, exponential and logarithmic functions. ii) Find the second derivative of implicit, inverse trigonometric and parametric functions. iii) Use MAPLE command **diff** repeatedly to find higher order derivative of a function.
4.2 Maclaurin's and Taylor's Expansions	i) State Maclaurin's and Taylor's theorems (without remainder terms). Use these theorems to expand sinx, cosx, tanx, $a^x, e^x, \log_a (1+ x)$ and $ln(1 + x)$. ii) Use MAPLE command **taylor** to find Taylor's expansion for a given function.
4.3 Application of Derivatives	i) Give geometrical interpretation of derivative. ii) Find the equation of tangent and normal to the curve at a given point. iii) Find the angle of intersection of the two curves. iv) Find the point on a curve where the tangent is parallel to the given line.
4.4 Maxima and Minima	i) Define increasing and decreasing functions. ii) Prove that if $f(x)$ is a differentiable function on the open interval (a , b) then

	• $f(x)$ is increasing on (a , b) if $f'(x) > 0, \ \forall \ x \in (a \ , \ b),$ • $f(x)$ is decreasing on (a, b) if $f'(x) < 0, \ \forall \ x \in (a \ , \ b),$ iii) Examine a given function for extreme values. iv) State the second derivative rule to find the extreme values of a function at a point. v) Use second derivative rule to examine a given function for extreme values. vi) Solve real life problems related to extreme value. vii) Use MAPLE command **maximize** (minimize) to compute maximum (minimum) value of a function

UNIT 5   DIFFERENTIATION OF VECTOR FUNCTIONS

5.1 Scalar and Vector Functions	i) Define scalar and vector function. ii) Explain domain and range of a vector function.
5.2 Limit and Continuity	i) Define limit of a vector function and employ the usual technique for algebra of limits of scalar function to demonstrate the following properties of limits of a vector function. • The limit of the sum (difference) of two vector functions is the sum (difference) of their limits. • The limit of the dot product of two vector functions is the dot product of their limits. • The limit of the cross product of two vector functions is the cross product of their limits. • The limit of the product of a scalar function and a vector function is the product of their limits. ii) Define continuity of a vector function and demonstrate through examples.
5.3 Derivative of Vector Function	Define derivative of a vector function of a single variable and elaborate the result: If $f(t) = f_1(t)i + f_2(t)j + f_3(t)k$, where $f_1(t), \ f_2(t) \ , \ f_3(t)$ are differentiable functions of a scalar variable t, then $\frac{df}{dt} = \frac{df1}{dt}i + \frac{df2}{dt}j + \ \frac{df3}{dt}k$
5.4 Vector Differentiation	i) Prove the following formulae of differentiation: • $\frac{da}{dt} = 0$ • $\frac{d}{dt}[f \pm g] = \frac{df}{dt} \pm \ \frac{dg}{dt}$

	• $\frac{d}{dt}[\emptyset f] = \emptyset \frac{df}{dt} + \frac{d\emptyset}{dt}f$ • $\frac{d}{dt}[f \cdot g] = f\frac{dg}{dt} + \frac{df}{dt}g$ • $\frac{d}{dt}[f \times g] = f \times \frac{dg}{dt} + \frac{df}{dt} \times g$ • $\frac{d}{dt}[\frac{f}{\emptyset}] = \frac{1}{\emptyset^2}[\emptyset\frac{df}{dt} - \frac{d\emptyset}{dt}f]$ Where **a** is a constant vector function, **f** and **g** are vector functions, and Ø is a scalar function of t. ii) Apply vector differentiation to calculate velocity and acceleration of a position vector **r**(t) = **x**(t)**i** + **y**(t)**j** + **z**(t)**k**

UNIT 6   INTEGRATION

6.1 Introduction	i) Demonstrate the concept of the integral as an accumulator. ii) Know integration as inverse process of differentiation. iii) Explain constant of integration. iv) Know simple standard integrals which directly follow from standard differentiation formulae.
6.2 Rules of Integration	i) Recognize the following rules of integration. • $\int \frac{d}{dx}[f(x)]dx = \frac{d}{dx}[\int f(x)dx] = f(x) + c$ • where c is a constant of integration. • The integral of the product of a constant and a function is the product of the constant and the integral of the function. • The integral of the sum of a finite number of functions is equal to the sum of their integrals. ii) Use standard differentiation formulae to prove the results for the following integrals: • $\int [f(x)]^n f'(x)dx$ • $\int \frac{f'(x)}{f(x)}dx$ • $\int e^x[a\,f(x) + f'(x)]\,dx$
6.3 Integration by Substitution	i) Explain the method of integration by substitution. ii) Apply method of substitution to evaluate indefinite integrals. iii) Apply method of substitution to evaluate integrals of the following types:

	• $\int \frac{dx}{a^2-x^2}$, $\int \sqrt{a^2-x^2}$, $\int \frac{dx}{\sqrt{a^2-x^2}}$ • $\int \frac{dx}{a^2+x^2}$, $\int \sqrt{a^2+x^2}$, $\int \frac{dx}{\sqrt{a^2+x^2}}$ • $\int \frac{dx}{x^2-a^2}$, $\int \sqrt{x^2-a^2}$, $\int \frac{dx}{\sqrt{x^2-a^2}}$ • $\int \frac{dx}{ax^2+bx+c}$, $\int \frac{dx}{\sqrt{ax^2+bx+c}}$ • $\int \frac{px+q}{ax^2+bx+c}\,dx$, $\int \frac{px+q}{\sqrt{ax^2+bx+c}}dx$
6.4 Integration by Parts	i) Recognize the formula for integration by parts. ii) Apply method of integration by parts to evaluate integrals of the following types: • $\int \sqrt{a^2-x^2}\,dx$, $\int \sqrt{a^2+x^2}\,dx$, $\int \sqrt{x^2-a^2}\,dx$ iii) Evaluate integrals using integration by parts.
6.5 Integration using Partial Fractions	Use partial fractions to find $\int \frac{f(x)}{g(x)}\,dx$, where $f(x)$ and $g(x)$ are algebraic functions such that $g(x) \neq 0$
6.6 Definite Integrals	i) Define definite integral as the limit of a sum. ii) Describe the fundamental theorem of integral calculus and recognize the following basic properties: • $\int_a^a f(x)dx = 0,$ • $\int_a^b f(x)dx = \int_a^b f(y)dy,$ • $\int_a^b f(x)dx = -\int_b^a f(x)dx,$ • $\int_a^b f(x)dx = \int_a^c f(x)dx + \int_c^b f(x)dx, a<c<b$ • $\int_{-a}^a f(x)dx = \begin{cases} 2\int_0^a f(x)dx & \text{when } f(-x) = f(x) \\ 0 & \text{when } f(-x) = -f(x) \end{cases}$ iii) Extend techniques of integration using properties to evaluate definite integrals. iv) Represent definite integral as the area under the curve. v) Apply definite integrals to calculate area under the curve vi) Use MAPLE command **int** to evaluate definite and indefinite integrals.

UNIT 7   PLANE ANALYTIC GEOMETRY- STRAIGHT LINE

7.1 Division of a Line Segment	i) Recall distance formula to calculate distance between two points given in Cartesian plane. ii) Recall Mid-Point formula iii) Find coordinates of a point that divides the line segment in given ratio (internally and externally). iv) Show that the medians and angle bisectors of a triangle are concurrent.
7.2 Slope (Gradient) of a Straight Line	i) Define the slope of a line. ii) Derive the formula to find the slope of a line passing through two points. iii) Find the condition that two straight lines with given slopes may be • parallel to each other, • perpendicular to each other.
7.3 Equation of a Straight Line Parallel to Co-ordinate Axes	Find the equation of a straight line parallel to • y-axis and at a distance a from it, • *x*-axis and at a distance b from it.
7.4 Standard Form of Equation of a Straight Line	i) Define intercepts of a straight line. Derive equation of a straight line in • slope-intercept form, • point-slope form, • two-point form, • intercepts form, • symmetric form, • normal form. ii) Show that a linear equation in two variables represents a straight line. iii) Reduce the general form of the equation of a straight line to the other standard forms.
7.5 Distance of a Point From a Line	i) Recognize a point with respect to position of a line. ii) Find the perpendicular distance from a point to the given straight line. iii) Find the distance between two parallel lines.
7.6 Angle Between Lines	i) Find the angle between two coplanar intersecting straight lines. ii) Find the equation of family of lines passing through the point of intersection of two given lines.

	iii) Calculate angles of the triangle when the slopes of the sides are given.
7.7 Concurrency of Straight Lines	i) Find the condition of concurrency of three straight lines. ii) Find the equation of median, altitude and right bisector of a triangle. iii) Show that • three right bisectors, • three medians, • three altitudes, of a triangle are concurrent.
7.8 Area of a Triangular Region	Find area of a triangular region whose vertices are given.
7.9 Homogenous Equation	i) Recognize homogeneous linear and quadratic equations in two variables. ii) Investigate that the 2nd degree homogeneous equation in two variables x and y represents a pair of straight lines through the origin and find acute angle between them.

UNIT 8   CIRCLE

8.1 Conics	Define conics and demonstrate members of its family i.e. circle, parabola, ellipse and hyperbola.
8.2 Circle and its standard form of Equation	Define circle and derive its equation in standard form i.e. $(x - h)^2 + (y - k)^2 = r^2$.
8.3 General Form of an Equation of a Circle	Recognize general equation of a circle $x^2 + y^2 + 2gx + 2fy + c = 0$ and find its centre and radius.
8.4 Equation of Circle determined by a given condition	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.
8.5 Tangent and Normal	i) Find the condition when a line intersects the circle.

	ii) Find the condition when a line touches the circle. iii) Find the equation of a tangent to a circle in slope form. iv) Find the equations of a tangent and a normal to a circle at a point. v) Find the length of tangent to a circle from a given external point. vi) Prove that two tangents drawn to a circle from an external point are equal in length.
8.6 Properties of Circle	Prove analytically the following properties of a circle. - Perpendicular from the centre of a circle on a chord bisects the chord. - Perpendicular bisector of any chord of a circle passes through the centre of the circle. - Line joining the centre of a circle to the midpoint of a chord is perpendicular to the chord. - Congruent chords of a circle are equidistant from its centre and its converse. - Measure of the central angle of a minor arc is double the measure of the angle subtended by the corresponding major arc. - An angle in a semi-circle is a right angle. - The perpendicular at the outer end of a radial segment is tangent to the circle. - The tangent to a circle at any point of the circle is perpendicular to the radial segment at that point.

UNIT 9   PARABOLA, ELLIPSE AND HYPERBOLA

9.1 Parabola	Define parabola and its elements (i.e. focus, directrix, eccentricity, vertex, is, focal chord and latus rectum).
9.2 General Form of Equation of a Parabola	Derive the general form of an equation of a parabola.
9.3 Standard Form of Equation of Parabola	i) Derive the standard equations of parabola, sketch their graphs and find their elements. ii) Find the equation of a parabola with the following given elements: focus and vertex,

	• focus and directrix, • vertex and directrix. • vertex and points
9.4 Equations of Tangent and Normal of Parabola	i) Recognize tangent and normal to a parabola. ii) 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. iii) Find the equation of a tangent and a normal to a parabola at a point.
9.5 Application of Parabola	i) Solve suspension and reflection problems related to parabola.
9.6 Ellipse	i) Define ellipse and its elements (i.e. centre, foci, vertices, covertices, directrices, major and minor axes, eccentricity, focal chord and latera recta). ii) Explain that circle is a special case of an ellipse.
9.7 Standard Form of Equation of an Ellipse	i) Derive the standard form of equation of an ellipse and identify its elements. ii) Find the equation of an ellipse with the following given elements • major and minor axes, • two points, • foci, vertices or lengths of a latera recta, • foci, minor axes or length of a latus rectum. iii) Convert a given equation to the standard form of equation of an ellipse, find its elements and draw the graph.
9.8 Equations of Tangent and Normal of an Ellipse	i) Recognize tangent and normal to an ellipse. ii) Find points of intersection of an ellipse with a line including the condition of tangency. iii) Find the equation of a tangent in slope form. iv) Find the equation of a tangent and a normal to an ellipse at a point.
9.9 Hyperbola	i) Define hyperbola ii) Define elements of hyperbola (i.e. centre, foci, vertices, directrices, transverse and conjugate axes, eccentricity, focal chord and latera recta).
9.10 Standard Form of Equation of Hyperbola	i) Derive the standard form of equation of a hyperbola and identify its elements. ii) Find the equation of a hyperbola with the following given elements: • transverse and conjugate axes with centre at

	origin, • two points, • eccentricity, latera recta and transverse axes, • focus, eccentricity and centre, • focus, centre and directrix. iii) Convert a given equation to the standard form of equation of a hyperbola, find its elements and sketch the graph.
9.11 Equation of Tangent and Normal of a Hyperbola	i) Recognize tangent and normal to a hyperbola. ii) Find: • points of intersection of a hyperbola with a line including the condition of tangency, • the equation of a tangent in slope form. iii) Find the equation of a tangent and a normal to a hyperbola at a point.
9.12 Translation and Rotation of Axes	i) Define translation and rotation of axes and demonstrate through examples. ii) Find the equations of transformation for • translation of axes, • rotation of axes. iii) Find the transformed equation by using translation or rotation of axes. iv) Find new origin and new axes referred to old origin and old axes. v) Find the angle through which the axes be rotated about the origin so that the product term xy is removed from the transformed equation.

UNIT 10   DIFFERENTIAL EQUATIONS

10.1 Introduction	Define ordinary differential equation (DE), order of a DE, degree of a DE, solution of a DE – general solution and particular solution.
10.2 Formation of Differential Equations	Demonstrate the concept of formation of a differential equation.
10.3 Solution of Differential Equation	i) Solve differential equations of first order and first degree of the form: • separable variables, • homogeneous equations, • equations reducible to homogeneous form. ii) Solve real life problems related to differential equations.

10.4 Orthogonal Trajectories	i) Define and find orthogonal trajectories (rectangular coordinates) of the given family of curves. ii) Use MAPLE graphic commands to view the graphs of given family of curves and its orthogonal trajectories.

UNIT 11   PARTIAL DIFFERENTIATION

11.1 Differentiation of Function of Two Variables	i) Define a function of two variables. ii) Define partial derivative. iii) Find partial derivatives of a function of two variables.
11.2 Euler's Theorem	i) Define a homogeneous function of degree n. ii) State and prove Euler's theorem on homogeneous functions. iii) Verify Euler's theorem for homogeneous functions of different degrees (simple cases). iv) Use MAPLE command **diff** to find partial derivatives.

UNIT 12   INTRODUCTION TO NUMERICAL METHODS

12.1 Numerical Solution of Non-linear Equations	i) Describe importance of numerical methods. ii) Explain the basic principles of solving a non-linear equation in one variable. iii) Calculate real roots of a non-linear equation in one variable by • bisection method, • regula-falsi method, • Newton-Raphson method. iv) Use MAPLE command **fsolve** to find numerical solution of an equation and demonstrate through examples.
12.2 Numerical Quadrature	i) Define numerical quadrature. Use • Trapezoidal rule, • Simpson's rule, to compute the approximate value of definite integrals without error terms. ii) Use MAPLE command **trapezoid** for trapezoidal rule and **simpson** for Simpson's rule and demonstrate through examples.

UNIT-WISE TIME DISTRIBUTION

Unit-Wise Time Distribution Grade-XI

Unit	Title	Period (40 minute each)
1.	Complex Numbers	12
2.	Matrices and Determinants	48
3.	Vectors	24
4.	Sequences and Series	20
5.	Miscellaneous Series	08
6.	Permutation, Combination and Probability	24
7.	Mathematical Induction and Binomial Theorem	20
8.	Functions and Graphs	24
9.	Linear Programming	12
10.	Trigonometric Identities of Sum and Difference of Angles	24
11.	Application of Trigonometry	24
12.	Graphs of Trigonometric and Inverse Trigonometric Functions and Solution of Trigonometric Equations	40
	Total	280

Unit-Wise Time Distribution Grade-XII

Unit	Title	Period (40 minute each)
1.	Introduction to Symbolic Package: MAPLE	12
2.	Functions and Limits	32
3.	Differentiation	32
4.	Higher Order Derivatives and Applications	16
5.	Differentiation of Vector Functions	12
6.	Integration	48
7.	Plane Analytic Geometry- Straight Line	32
8.	Circle	12
9.	Parabola, Ellipse and Hyperbola	32
10.	Differential Equations	18
11.	Partial Differentiation	10
12.	Introduction to Numerical Methods	24
	Total	280

TEACHING AND LEARNING RESOURCES

1. Guidelines to Textbook Authors

Textbooks aimed at lower levels tend to be inclined more towards learning features than those at higher levels. However, in textbooks writing generally the following aspects may be taken into considerations

- All exercises of the textbook may contain maximum number of applied problem (more than 50 %)
- Each topic be explained clearly with solved real life problem
- Add at least one solved example of the topic with application of MAPLE
- ***The text book should be in line with the weightage, of the topics, areas of curriculum and Students Learning Outcome (SLO) of the Reviewed curriculum.***
- The authors should continuously focus on the standards and benchmarks and Students Learning Outcome (SLO).
- The author must bring himself to mental level of the students s/he is writing for.
- The span of the text book be fairly reasonable. Use previous concepts and extend for the higher one.
- The material be cramped to make it more digestible, it may be chunked into smaller parts with headings.
- The textbook must provide accurate and up-to-date information.
- The text material be arranged in a logical manner i.e. simple to complex, familiar to unfamiliar and concrete to abstract.
- The text material must be free from ambiguities and errors (both conceptual and typographical).
- The content provided in the text book should not develop wrong and confusing concepts.
- The text be clear and concise. It may not convey any meaning other than the one intended in the curriculum SLO
- Special attention be paid to geometrical notions; every table; line drawings and graphs and diagrams should be labeled appropriately.
- Footnotes and side notes may be inserted whenever necessary, and website related to the topic be highlighted for further studies.
- Workout/solved examples should be lucid with solutions in details, giving reasons related to particular ensuing problems in the exercise.
- A simple and brief exercise be given on the previous work related to the topic in order to maintain continuity.

- List of symbols and index be given at the end of the book to facilitate the students and the teachers.
- The authors should go through relevant curriculum and the guidelines to the authors before developing the textbooks
- The authors are requested to provide the answers of the questions given in the exercises of the books so that discrepancies are avoided.
- Objective type, multiple choice questions (MCQs) may be given at the end of every chapter.
- Miscellaneous exercise may also be given at the end of each chapter.
- Emphasis should be on applications of the concepts and techniques developed in the text rather than on the memorization system.

2. Guidelines for the Teachers' Manual

Ideally the teachers' manual should come with the textbook. The manual is aimed at informing teachers how the textbook is written and how best to use it to facilitate student learning. It can be seen as a means of helping teachers to develop professionally. It should provide detailed explanation of key concepts and the way to teach a particular topic. Its basic features are as below

The teachers' manual should:

- Be easy to understand and use.
- Help teachers develop instructional material, strategies, teach the text in class and extend activities.
- Given sequenced instructions for each activity.
- Include teaching learning resources and identify the sources.
- Establish a question bank (having questions different from text) and suggest interactive quizzes corresponding to each unit.
- Involve variety of updated and relevant teaching strategies and rationale for their use.
- Explain how to implement each teaching strategy.
- Identify constraints and strength of each strategy or activity.
- Identify resources needed for teaching strategies and extension of activities
- Expand and develop teachers' rationale of knowledge and skills.
- Identify assessment strategies.
- Orientation of authors and reviewers be arranged for a better cohesion.
- Teachers manual should be made available along with the textbook.
- Real life examples be given for the concepts, i.e. use of matrices. Connectivity of various stations/cities, manufacturing of different products, census data etc.

3. General Guidelines to Textbook Board

- Orientation sessions/workshops may be arranged for respective teachers to apprize them of the curriculum and relevant textbook.
- The Text Book Boards must ensure that the relevance of the curriculum and textbooks is maintained, the language should be simple and the material be students' friendly.
- The Textbook Boards should arrange the orientation sessions for authors and reviewers for better understanding of the curriculum
- The reviews of the textbooks be periodically conducted by senior and more qualified teachers and published for improvement of the textbooks.

4. The Web-Based Resources

A + Math	http://www.aplusmath.com/
AAA Math	http://www.aaamath.com
Academic Info-Mathematics	http://www.academicinfo.com.net/math.html
Algebra Buster	http://www.algebra-online.com
Algebra Helper	http://www.algebrahelp.com/index.jsp
Class zone	http://www.classzone.com/math_middle.cfm
Click on Bricks	http://kathyschrock.net/clickon brickindex2.html
Cool Math	http://www.coolmath.com/
Discovery School(Mathematics)	http://school.discovery.com/lessonplans/math.html
Frank Potter's Science Gems-Mathematics	http://www.sciencegems.com/math.html
Funbrain	http://www.funbrain.com/numbers.html
Geometry	http://www.mathleague.com/help/geometry/geometry.html
Internet Mathematics Library	http://www.mathforum.org/library
MAPLE	http://www.maplesoft.com
Math Archives	http://www.archives.math.utk.edu
Math Glossary	http://harcourtschool.com/glossary/math_advantage
Math Goodies	http://www.mathgoodies.com
Math World	http://www.mathworld.wolfram.com
Math2	http://www.math2.org/
MATHEMATICA	http://www.wolfram.com/products/mathematica/index.html
Mathematical Interactivities	http://mathematics.hellam.net/
Math Stories	http://mathstroies.com
Mega Mathematics	http://www.c3.lanl.gov/mega-math/
Purplemath	http://www.purplemath.com/internet.html
S.O.S. Mathematics	http://www.sosmath.com
Superkids Educational Software Review	http://www.superkids.com/aweb/tools/math/index.shtml
Teaching made Easier	http://www.teachingmadeasier.com/math.html
The mathWorks (MATLAB)	http://www.mathworks.com
webmath	http://www.webmath.com

ASSESSMENT AND EVALUATION

1. Assessment in Mathematics

It should be kept in mind that in mathematics a single type of assessment can frustrate students, diminish their self-confidence and make them feel anxious about the subject. In reality the understanding of mathematical concepts encompasses a broad range of abilities. Examples of various templates to assess different abilities are mentioned below

Assessment must include by focusing on a student's ability to:

- Communicate mathematically.
- Reason and analyze, and to think and act in positive ways.
- Comprehend the key concepts.
- Evaluate the effectiveness of using different strategies to address the sample problem.
- Use a variety of strategies to problem solving and to make mathematical connections.
- Discriminate between relevant and irrelevant attributes of a concept in selecting examples.
- Integrate it to make sense of mathematical concepts and procedures.
- Use real life situations for developing reasoning in mathematics.

2. Instructions for HSC Examinations

The examining institutions or bodies include all Boards of Intermediate and Secondary Education for the conduct of HSC examinations in the subject of Mathematics. These may follow instructions as given below.

- The question papers should be balanced in all respects. Following table, showing weightage to difficulty level of questions, is suggested to be a practicable criterion for a balanced question paper of Mathematics.

Difficulty Level of Questions	Weightage
Easy	16%
Average	68%
Difficult	16%

- The questions given in textbook may not be given in the examination paper as it is
- The Question involving solution by MAPLE must be given in MCQs and CRQs

3. Unit-Wise Weightage for Examination Papers

Unit-Wise Weightage Grade-XI

| Unit	Title	Weightage (%)
1.	Complex Numbers	6
2.	Matrices and Determinants	15
3.	Vectors	10
4.	Sequences and Series	6
5.	Miscellaneous Series	3
6.	Permutation, Combination and Probability	8
7.	Mathematical Induction and Binomial Theorem	8
8.	Functions and Graphs	9
9.	Linear Programming	5
10.	Trigonometric Identities of Sum and Difference of Angles	8
11.	Application of Trigonometry	7
12.	Graphs of Trigonometric and Inverse Trigonometric Functions and Solution of Trigonometric Equations	15
	Total	100

Unit-Wise Weightage Grade-XII

Unit	Title	Weightage (%)
1.	Introduction to Symbolic Package: MAPLE	4
2.	Functions and Limits	11
3.	Differentiation	11
4.	Higher Order Derivatives and Applications	4
5.	Differentiation of Vector Functions	4
6.	Integration	16
7.	Plane Analytic Geometry- Straight Line	12
8.	Circle	5
9.	Parabola, Ellipse and Hyperbola	11
10.	Differential Equations	8
11.	Partial Differentiation	4
12.	Introduction to Numerical Methods	10
	Total	100

Area-Wise Weightage for Examination Papers

Grade - XI

Allocation of Areas
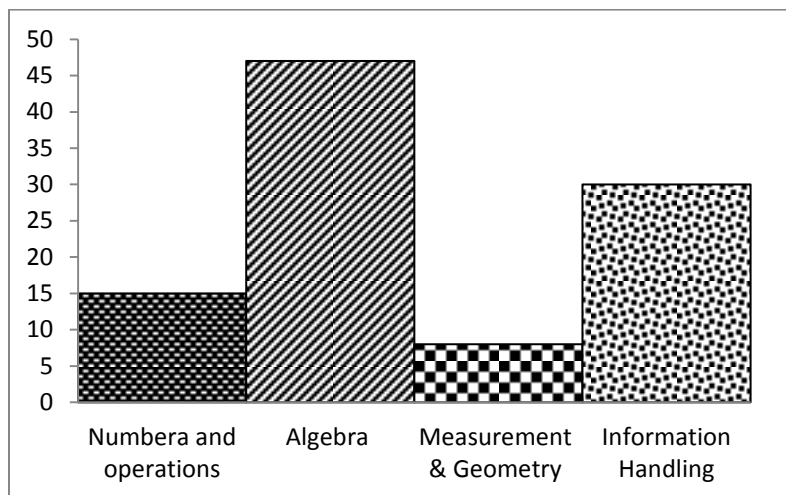
Assessment weightage

Area	Weightage (%)
Numbers & Operations	15
Algebra	47
Measurement &Geometry	8
Information Handling	30

Grade-XII

Allocation of Areas
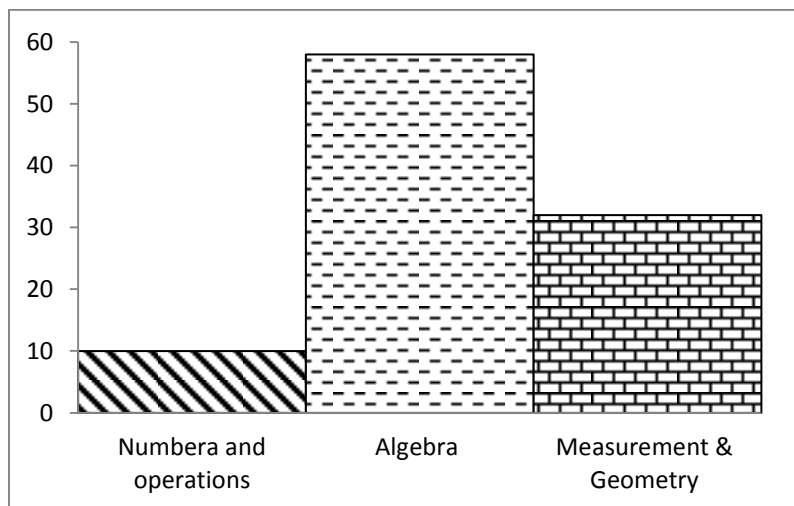
Assessment weightage

Area	Weightage (%)
Numbers & Operations	10
Algebra	58
Measurement &Geometry	32

MEMBERS OF PROVINCIAL REVIEW COMMITTEE SINDH FOR MATHEMATICS GRADE I-XII 2018

1. Mr. Abdul Saleem   Chairman
   Professor
   Mehran University of Engineering & Technology, Jamshoro.
   0334-3328975

2. Mr. Muhammad SaghirShaikh   Member
   Consultant (TPM)
   Reform Support Unit (RSU) Karachi. 03313501305.

3. Mr. ArjanLal S. Sudheria   Member
   Subject Specialist (Rtd)
   Sindh Textbook Board Sindh Jamshoro. 0333-3932099

4. Mr. Syed Afaq Ahmed   Member
   Assistant Professor
   Darsano Channo Karachi. 0336-2715375

5. Mr. Muhammad Waseem   Member
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6. Mr. Afzal Ahmed   Member
   Deputy Director
   Directorate of Curriculum Assessment and Research Sindh Jamshoro.
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7. Mr. Mahfooz Channa   Member as
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   03003248316

8. Mr. Asrar Ahmed   Member as
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   0333-2782133

9. Mr. Aftab Ali   Member/
   Deputy Director   secretary
   Directorate of Curriculum Assessment and Research Sindh Jamshoro.
   0333-2653528

CURRICULUM FOR MATHEMATICS GRADES I-XII 2006 DEVELOPMENT TEAM

1. Team of Curriculum Writers

Professor Dr. Muhammad Tahir Chairman (Sciences) National Curriculum Council Ministry of Education, Islamabad	Dr. Malik Muhammad Yousuf Assistant Professor Department of Mathematics Quid-i-Azam, Islamabad
Mr. Saleemullah Assistant Director (Academics)/ Lecturer in Mathematics Federal Directorate of Education, Islamabad	Ms. Tayyaba Saqib Head of mathematics Department The City School, Capital Campus Islamabad

2. Team of Advisors

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Professor Dr. Muhammad Aslam Butt Department of Mathematics Lahore University of Management Sciences (LUMS), LAHORECANTT	Professor Dr. Syed Arif Kamal Chairman Mathematics Department University of Karachi KARACHI
Professor Dr. Gulzar Ali Khan Chairman Mathematics Department University of Peshawar PESHAWAR	Professor Dr. Muhammad Shafiq Baig Chairman Mathematics Department University of Azad Jammu & Kashmir MUZAFFARABAD (AJ&K)
Dr. Malik Muhammad Yousaf Assistant Professor Department of Mathematics Quaid-i-Azarn University, ISLAMABAD	

3. Panel of Experts

Professor Dr. Shaban Ali Bhatti Chairman Mathematics Department University of the Punjab, LAHORE	Professor Dr. B.A Saleemi Dean Faculty of Basic & Applied Sciences Air University, PAF Complex, ISLAMABAD
Professor Dr.Ghazala Sadiq Head Department of Humanities and Basic Sciences Institute of Space Technology, ISLAMABAD	Professor Dr. Aftab Khan Dean/Chairman Department of Mathematics Karakuram International University Northern Areas, GILGIT
Professor Dr. Muhammad Aslain Chairman Statistics Department Quaid-i-Azam University, ISLAMABAD	Professor Dr. Faqir Muhammad Chairman Department of Mathematics &Statistics Allama 1qbal Open University, ISLAMABAD
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Mr. Abdul Wahid Hashini Directing Officer, Habib Bank MDI Blue Area, ISLAMABAD	Mr. Muhammad Sharif Ghauri Assistant Professor (R) Islamia College Railway Road, LAHORE

4. Names of College/School Teachers who Contributed

Dr. Akhtar Hussain, Ch Bashir Ahmad, Mr. Abdul Rahim, Mr. Abdul Rashid Mughal, Mr. Abdul Rashid, Mr .Abid Masood, Mr. Aftab Tariq, Mr. Anwar ul Haq, Mr. Asif Javed Ahmad, Mr. Iftikhar Ahmad Cheema, Mr. Javed Iqbal, Mr. Khalid Mehmood, Mr. Mehboob Ahmad, Mr. Muaeed Rabbani, Mr. Muhammad Abbas Haral, Mr. Muhammad Arif, Mr. Muhammad Bukhtiar, Mr. Muhammad Islam Chohan, Mr. Muhammad Khaliq Nazir, Mr. Muhammad MudassarNiaz, Mr. Muhammad Naeern Mughal, Mr. Muhammad Rafaaq Siddiqui, Mr. Muhammad Rafiq, Mr. Muhammad Saeed Akhtar, Mr. Muhammad Safdar, Mr. Muhammad Saleem Iqbal, Mr. Muhammad Salim Chishti, Mr. Muhammad Siddique, Mr. Muhammad Zahir Ahmad, Mr. Mumtaz Hussain, Mr. Mushtaq Ahmad, Dr. Naveed Jamil Malik, Mr. Nadeem. Safdar, Mr. Nasrullah Khan, Mr. Obaidur Rehman, Mr. Riaz Ahmad Bhatti, Mr. Sajad Akhtar Mughal, Mr. Sardar Muhammad, Mr. Sarwar Nazir, Mr. Shafi Sial, Mr. Shaukat Hussain, Mr. Tariq Ehsan, Dr. Tehsin Jaffar, Mr. Walayat Shah, Mr. Zaheer

Ahmad, Mr. Zakir Ulah Butt, Mr. Zulfiqar Ali, Ms. Arntul Hanif Javeed, Ms. Aneela Ajaib, Ms. Asfa Naseem, Ms.Farhat Mansoor, Ms. Hafsa Jabeen, Ms. Mamunah Butt, Ms. Nabeela Azad, Ms. Naheed Jamal, Ms. Nasira Qureshi, Ms.Rehana Farhat, Ms. Rubina Rahat, Ms. Sadia Ahmad, Ms. Saeeda Nasrin Butt, Ms. Saeeda Parveen, Ms. Sajida Javed, Ms. Saijadia Akram, Ms. Shafaat, Ms. Shagufta Tayyab, Ms. Shaista Batool, Ms. Talat Abbas, Sayyeda Moghees Bokhari, Syed Intizar Abbass and Syed Sadaat Hassan.

GOVERNMENT OF SINDH
SCHOOL EDUCATION & LITERACY DEPARTMENT
Karachi, dated: 28th January, 2019

NOTIFICATION

NO.SO(G-III)SE&L/3-910/18: School Education & Literacy Department, Government of Sindh, is pleased to notify the Provincial Review Committees for Mathematics Class I-XII.

The composition of the committees shall be as under:

COMMITTEE FOR MATHEMATICS (I-XII)
CURRICULUM DEVELOPMENT / REVIEW AND TEXT BOOK REVIEW

1.	Mr. Abdul Saleem Professor, Mehran University of Engineering & Technology, Jamshoro. 0334-3328975	Chairman
2.	Mr. Muhammad Saghir Shaikh Consultant (TPM), Reform Support Unit (TPM) Karachi. 0331-3501305	Member
3.	Mr. Arjun Lal Sudhana Subject Specialist (Rtd), Sindh Textbook Board, Jamshoro. 0333-3932099	
4.	Mr. Syed Afaq Ahmed Assistant Professor, Darsano Channo Karachi. 0336-2715375	Member
5.	Mr. Muhammad Waseem Assistant Professor Government Degree Boys College Kohsar, Latifabad, Hyderabad. 0337-8036509	Member
6.	Ms. Attia Bhutto Lecturer, Govt. Zubaida College, Hyderabad. 0333-1030148	Member
7.	Mr. Aftab Ali Deputy Director, Directorate of Curriculum, Assessment & Research @ Jamshoro. 0333-2653528	Member/ Secretary
8.	Two working teachers from concerned level.	Member

(QAZI SHAHID PERVEZ)
SECRETARY TO GOVERNMENT OF SINDH

NO.SO(G-III)SE&L/3-910/18:   Karachi, dated:28 January, 2016

A copy is forwarded for information & necessary action to:

1. The Principal Secretary to Governor Sindh, Karachi.
2. The Principal Secretary to Chief Minister, Sindh.
3. The Chairman, Sindh Textbook Boar, Government of Sindh, Jamshoro.
4. The Executive Director, Sindh Teacher Education Department Authority
5. The Director General, (PITE) Sindh, Shaheed Benazirabad.
6. The Deputy Secretary (Staff) to Chief Secretary Sindh, Karachi.
7. The Chairpersons and Members concerned.
8. The Directorate of Curriculum Assessment & Research Sindh @ Jamshoro.
9. PS to Minister, Education & Literacy Department, Govt. of Sindh, Karachi.
10. PS to Secretary, School Education & Literacy Department, Govt. of Sindh, Karachi.
11. PS to Head of Curriculum Wing, School Education & Literacy Department.
12. Office Order File.
13. Official Website.

(ABID HUSSAIN LEGHARI)
Section Officer (G-III)

Tel:	022-9213406
Fax:	022-2771179
Email:	dcarsindh@gmail.com

Government of Sindh
School Education & Literacy Department
Directorate of Curriculum, Assessment and Research
Sindh Jamshoro

No. DCAR / DD (Maths) / 485 / 2019   Dated: 01-08-2019

To,

1.	Mr. Abdul Saleem Professor, Mehran University Sindh Jamshoro. 0334-3328975	Chairman
2.	Mr. Muhammad Saghir Shaikh Consultant (TPM), Reform Support Unit (RSU) Karachi. 0331-3501305	Member
3.	Mr. Arjan Lal S. Sudheria Subject Specialist (Rtd) Sindh Textbook Board Sindh Jamshoro. 0333-3932099	Member
4.	Mr. Syed Afaq Ahmed Assistant Professor, Darsano Channo Karachi. 0336-2715375	Member
5.	Mr. Muhammad Waseem Assistant Professor, Government Degree Boys College Kohsar, Latifabad, Hyderabad.0337-8036509	Member
6.	Mr. Mahfooz Channa Associate Professor, Government Degree Boys College Kohsar, Latifabad, Hyderabad. 03003248316	Member as Working Teacher
7.	Mr. Asrar Ahmed Lecturer, Govt. Degree College & Post Graduate Center Latifabad-11, Hyderabad. 0333-2782133	Member as Working Teacher
8.	Mr. Afzal Ahmed Deputy Director, Directorate of Curriculum Assessment and Research Sindh Jamshoro. 0333-2695539	Member
9.	Mr. Aftab Ali Deputy Director, Directorate of Curriculum Assessment and Research Sindh Jamshoro. 0333-2653528	Member/ Secretary

Subject: Review of Curriculum for Mathematics 2006 Grade XI-XII

The Directorate of Curriculum Assessment and Research Sindh Jamshoro is organizing the six days review meeting of curriculum for Mathematics 2006 Grade XI-XII from 19-24 August, 2019 on 9:00am to 4:00pm at DETRC Hyderabad regarding subject mentioned above and you are nominated as chairman/member/secretary of committee for Review Mathematics (I-XII) Curriculum Development Review and Text Book Review. Notified by the School Education & Literacy Department. The ToRs of the review are already mentioned given below.

       We would like to invite you to attend the review meeting on the above venue, date(s) and time.

The ToRs of the review of curriculum are:
1. Review the National Curriculum 2006 and suggest changes in it in the light of Provincial needs/ requirements and context.
2. Share innovative ideas for improving curriculum as according to future need
3. Ensure the alignment/progression among Competency, Standards, Benchmarks and Students Learning Outcomes
4. Identify the gaps between topics and give suggestions to fill identified gaps
5. Review the assessment guideline as according to bloom taxonomy in term of Formation, Summative and Authentic assessment
6. Review the guideline for textbook authors
7. Suggest the classroom activity based on Life skill and sportsmanship against SLOs
8. Explore and give the list of web links and teaching resources for teaching of particular topics
9. Alignment with 21st century Skills

Ghulam Asghar Memon
Director

Cc to:
1. The P.S. to Secretary, School Education & Literacy Department Karachi
2. Dr. Fozia Khan, Chief Advisor, Curriculum Wing, Government of Sindh, Karachi.
3. Concern Principal/ Government Degree Boys College Kohsar Latifabad Hyderabad /GECE Darsano Channo Karachi/ Govt. Degree College & Post Graduate Center Latifabad-11, Hyderabad /DD, DETRC Hyderabad/ Chair Social Sciences Department, Mehran University Sindh Jamshoro _____
4. Account Officer, DCAR Sindh Jamshoro
5. Office File

The End