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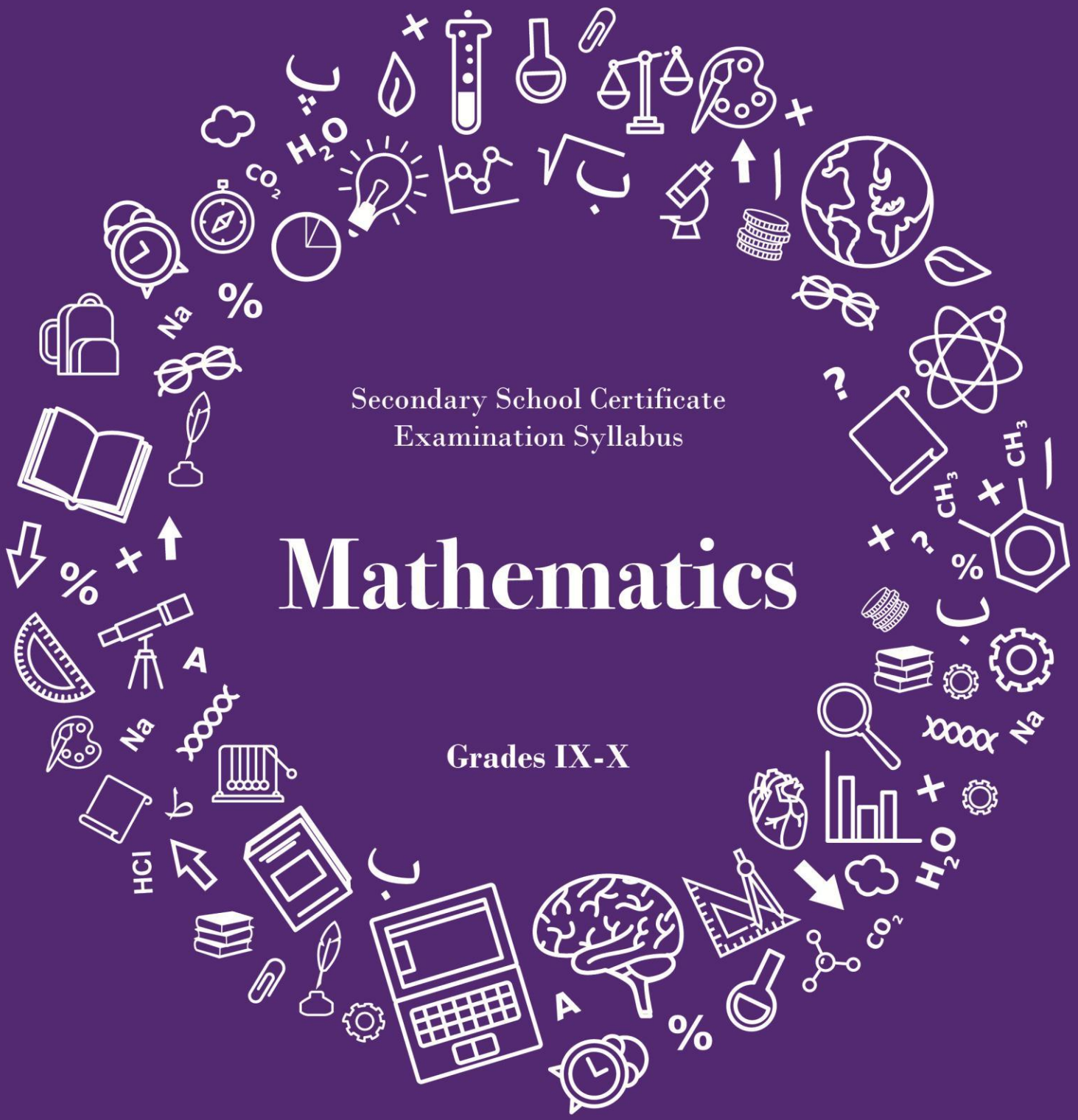

Secondary School Certificate
Examination Syllabus

Mathematics

Grades IX-X

(based on National Curriculum 2006)

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Secondary School Certificate
Examination Syllabus

MATHEMATICS
GRADES IX-X

This syllabus will be examined in both
May and September Examination sessions from
May 2019 for Grade IX and May 2020 for Grade X

For queries and feedback

Address: Aga Khan University Examination Board
Block - C, IED - PDC, 1-5/B-VII
Federal B. Area, Karimabad, Karachi, Pakistan.
Phone: (92-21) 3682-7011
Fax: (92-21) 3682-7019
E-mail: examination.board@aku.edu
Website: http://examinationboard.aku.edu
Facebook: www.facebook.com/akueb

Preface

Established in 2002 through Ordinance CXIV, Aga Khan University Examination Board (AKU-EB) is Pakistan's first private autonomous examination body for secondary (SSC) and higher secondary (HSSC) school certifications. Its vision is to be a model of excellence and innovation in education in Pakistan and the developing world.

One of the ways in which AKU-EB achieves its vision is by developing syllabi which inculcates conceptual thinking and higher order learning based on the National Curriculum. AKU-EB revises its syllabi every 4 years so that they continue to meet the needs of students, teachers and examiners.

The aims of the current syllabus review of SSC and HSSC in 2016 were to:

- Ensure continued compatibility with the goals of the National Curriculum of Pakistan.
- Review the content for inclusion of new knowledge and deletion of obsolete knowledge.
- Review the content for clarity and relevance as per the changing needs of students, teachers and examiners.
- Enhance and strengthen continuation and progression of content both within and across grades IX - XII (SCC and HSSC).
- Ensure the readiness of students for higher education.

During this syllabus review, the needs of all the stakeholders were identified through a needs-assessment survey. Students and teachers of AKU-EB affiliated schools from across Pakistan participated in the survey. Thereafter, a revision panel, which consisted of examiners, schools teachers of affiliated and non-affiliated schools, teacher trainers and university academics, reviewed and revised the syllabus following a planned, meticulous and standardised syllabi review process.

This year, AKU-EB took the initiative of introducing a 'Concept Map' for each syllabus which represents links among the key concepts of the syllabus. These have been designed to improve students' interest in the subject, facilitate conceptual thinking and make the learning and teaching experience more memorable.

The syllabus is organised into topics and subtopics. Each subtopic is further divided into achievable student learning outcomes (SLOs). The SLOs of the cognitive domain are each assigned a cognitive level on which they have to be achieved. These cognitive levels are 'knowledge', 'understanding' and 'application', the latter also including other higher order skills. This is followed by the Exam Specification which gives clear guidance about the weightage of each topic and how the syllabus will be assessed.

The development of the revised syllabus have been made possible by the creativity and relentless hard work of Curriculum and Examination Development unit and the constant support provided by all the other units of AKU-EB. We are particularly thankful to Dr Sohail Qureshi for his very useful feedback on revising the syllabus review process, to Dr Naveed Yousuf for his continued guidance and support throughout the syllabus revision process and to Raabia Hirani for leading the syllabi revision. We are also thankful to all the students and teachers who took part in the needs-assessment survey and to the principals of AKU-EB affiliated schools who made this endeavour possible by facilitating and encouraging their teachers to be a part of the survey and the syllabus revision panel.

With your support and collective hard work, AKU-EB has been able to take the necessary steps to ensure effective implementation of the National Curriculum of Pakistan through this syllabus. We are confident that this syllabus will continue to provide the support that is needed by students to progress to the next level of education and we wish all the best to students and their teachers in implementing this syllabus.

Dr Shehzad Jeeva
Director, Aga Khan University Examination Board
Assistant Professor, Faculty of Arts and Sciences, Aga Khan University

Introduction to AKU-EB Syllabi

1. Aga Khan University Examination Board (AKU-EB) has a mandate by Ordinance CXIV of 2002 'to test the attainment of the objectives of the national curriculum, for the purpose of enhancing student learning, and to do all such things that may be considered appropriate for the improvement of education in respect to teaching and learning, institutional effectiveness and all things ancillary and incidental thereto'.

2. The AKU-EB syllabi are an important tool in the achievement of this mandate. These syllabi are based on the National Curriculum of Pakistan 2006 and the National Scheme of Studies 2006 – 2007. The syllabi bring together all those cognitive outcomes of the National Curriculum statement which can be reliably and validly assessed. Moreover, the syllabi aim to achieve the pedagogically desirable objectives of the National Curriculum which encourage 'observation, creativity and other higher order thinking skills', better meeting the needs of the students of the twenty-first century.

3. The syllabi guide the students, teachers, parents and other stakeholders regarding the topics that will be taught and examined in each grade (IX, X, XI and XII). In each syllabus document, the content progresses from simple to complex, thereby, facilitating a gradual, conceptual learning of the content.

4. The topics of the syllabi are grouped into themes derived from the national curriculum. The connection between various themes and topics is highlighted in the '**concept map**' provided at the beginning of each syllabus. This ensures that students begin to understand the interconnectedness of knowledge, learn conceptually and think critically.

5. The topics of the syllabi are divided into subtopics and **student learning outcomes (SLOs)**. The subtopics and the SLOs define the depth and the breadth at which each topic will be taught, learnt and examined. The syllabi complement the national curriculum by providing enabling SLOs where needed to scaffold student learning.

6. Each SLO starts with an achievable and assessable **command word** such as describe, relate, evaluate, etc. The purpose of the command words is to direct the attention of teachers and students to specific tasks that the students are expected to undertake in the course of their studies. The examination questions are framed using the same command words or their connotations to elicit evidence of these competencies in students' responses.

7. The SLOs are classified under three **cognitive levels**: knowledge (K), understanding (U) and application and other higher order skills (A) for effective planning during teaching and learning and deriving multiple choice questions (MCQs) and constructed response questions (CRQs) and extended response questions (ERQs) on a rational basis from the subject syllabi, ensuring that the intentions of the national curriculum are also met during examinations.

8. By focusing on the achievement of the SLOs, these syllabi aim to counter the culture of rote memorisation as the preferred method of examination preparation. While suggesting relevant, locally available textbooks for achieving these outcomes, AKU-EB recommends that teachers and students use multiple teaching and learning resources for achieving these outcomes.

9. The syllabi follow a uniform layout for all subjects to make them easier for students and teachers to follow. They act as a bridge between students, teachers and assessment specialists by providing a common framework of student learning outcomes and **exam specifications**.

10. On the whole, the AKU-EB syllabi for Secondary School Certificate (SSC) provide a framework that helps students to acquire conceptual understanding of the content of the National Curriculum and learn to critically engage with it. This lays a solid foundation for HSSC and beyond.

Aims/ Objectives of the National Curriculum (2006)[1]

The following themes permeate the National Curriculum for Mathematics.

- The curriculum is designed to help students build the solid conceptual foundation in Mathematics that will enable them to apply their knowledge skilfully and further their learning successfully.
- The curriculum emphasises on the geometrical concepts that enable the students to think logically, reason systematically and conjecture astutely.
- The curriculum stresses graphics that enable the students to visualise and interpret mathematical expressions correctly rather to manipulate them 'blindly'.
- The curriculum recognises 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.

National Curriculum for Mathematics is comprised of five standards. The competencies are intentionally kept broad as to allow flexibility to the teachers in accordance with their students. These five standards are:

i. Number and Operations
ii. Algebra
iii. Measurements and Geometry
iv. Information Handling
v. Reasoning and Logical Thinking

[1] Government of Pakistan (2006), Page 2, *National Curriculum for Mathematics Grades I – XII, Islamabad,* Ministry of Education (Curriculum Wing)

Subject Rationale of AKU-EB Mathematics

What will you learn in AKU-EB Mathematics Compulsory?

Mathematics is not only the language of science, engineering and technology but also of Economics, Psychology and many other fields of study. Mathematics teaches the core skills required to function in today's world.

Most school going students understand the use of basic math in daily life. What they fail to understand is why they should learn advanced mathematics since they cannot see how concepts like algebra, matrices, imaginary numbers, and calculus can help them later on in life.

What you are actually supposed to be learning in mathematics class is the art of problem reduction by systematic and critical thinking, i.e. starting with a problem and reducing it to a simpler problem in a way that it becomes easy to solve. Any real life problem can be accessed and solved through similar mathematical/ logical thinking approach.

The current National Curriculum of Pakistan covers a wide array of topics that provide a deep conceptual understanding of Mathematics. The AKU-EB syllabus of Mathematics has enhanced it further by making conceptual connections between topics and improving the logical flow of concepts.

The AKU-EB Mathematics syllabus focuses on mathematical skills and logical thinking to help students develop their mathematical skills and understanding. It helps improve students' ability to apply their content knowledge in new and unexpected situations, rather than on rote learning. This is significantly evident in application of theorems where students are not required to reproduce theorems, but to apply them.

Where will it take you?

The AKUEB syllabus of Mathematics will provide conceptual basis for higher studies in many subjects. For those who pursue mathematics in higher studies, wide career opportunities are available such as:

- Actuary
- Banker
- Architect
- Musician
- Fashion Designer
- Pharmacologist
- Physical Scientist
- Astronomer, astrologist and navigational scientist
- Graphic designer (Creating 3D and 2D animations)

How to approach the syllabus?

The concept map of the syllabus gives an overview of the entire syllabus. The topics and the student learning outcomes (SLOs) guide regarding the details about what has to be achieved. And finally, the exam specification guides regarding what will be expected in the examination.

What is the concept map telling you?

THE HELM OF MATHEMATICS

Ahoy! Turn the wheel and come on board.
The navigation wheel is a simple, symmetrical geometric shape which illustrates the four core standards/ competencies of mathematics, the concepts that fall under them, and the flow/ linkages between them, smoothly sailing you through the sea of problem solving and critical thinking.

Mathematics

CONCEPT MAP - SSC I & II

Student Learning Outcomes of AKU-EB SSC Mathematics Syllabus

Part I (Grade IX)

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level[2]		
				K	U	A
1. Sets and Functions		Students should be able to:				
1.1	Operations on Sets	1.1.1	identify the sets denoted by *N*, *Z*, *W*, *O*, *P*, *Q* and by other symbols;		*	
		1.1.2	identify operation $(\cup, \cap, -$ or $\setminus, \Delta)$ on sets;		*	
		1.1.3	solve problems using the following operations on sets: a. union b. intersection c. difference d. symmetric difference e. complement;			*
1.2	Properties of Union and Intersection	1.2.1	describe the following fundamental properties of union and intersection of two or three sets: a. commutative property of union b. commutative property of intersection c. associative property of union d. associative property of intersection e. distributive property of union over intersection f. distributive property of intersection over union g. De Morgan's laws;		*	
		1.2.2	verify the fundamental properties mentioned in SLO 1.2.1 for given sets;			*

[2] K = Knowledge, U = Understanding, A = Application and other higher-order cognitive skills
CA = Class Activity

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				K	U	A
		Students should be able to:				
1.3	Venn Diagram	1.3.1	draw Venn diagrams to represent: a. union and intersection of sets b. complement of a set c. symmetric difference of sets;			*
		1.3.2	draw Venn diagrams to verify: a. commutative laws for union and intersection of sets b. associative laws for union and intersection of sets (when three sets are mutually overlapping) c. distributive laws for union and intersection of sets (when three sets are mutually overlapping); d. De Morgan's laws;			*
		1.3.3	solve problems related to Venn Diagrams;			*
1.4	Ordered Pairs and Cartesian Product	1.4.1	describe ordered pairs and Cartesian product;		*	
		1.4.2	solve problems related to SLO 1.4.1;			*
1.5	Binary Relation	1.5.1	describe a binary relation;		*	
		1.5.2	find the domain and range of a binary relation;			*
1.6	Functions	1.6.1	define function;	*		
		1.6.2	determine whether a given relation is a function or not;		*	
		1.6.3	find (and illustrate): a. into function b. one-one function c. into and one-one function (injective function) d. onto function (surjective function) e. one-one and onto function (bijective function);			*
		1.6.4	distinguish between one-one correspondence and one-one function.		*	

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				K	U	A
2. Real and Complex Numbers		Students should be able to:				
2.1	Real Numbers	2.1.1	describe terminating and non-terminating (recurring and non-recurring) decimal fractions, as rational and irrational numbers;		*	
		2.1.2	identify the set of real numbers as a union of sets of rational and irrational numbers;		*	
2.2	Properties of Real Numbers	2.2.1	describe the properties of real numbers (closure, commutative, associative, identities, inverse, distributive properties);		*	
2.3	Radicals and Radicands	2.3.1	identify radicals and radicands;		*	
		2.3.2	convert radical form to exponential form and vice versa;			*
2.4	Laws of Exponents/ Indices	2.4.1	simplify expressions containing exponents;			*
		2.4.2	apply the laws of exponents to simplify expressions with real base and exponents $x^m.x^n = x^{m+n}, (xy)^m = x^m y^m, (x^m)^n = x^{mn}, \left(\frac{x}{y}\right)^m = \frac{x^m}{y^m}, y^0 = 1, \frac{x^m}{x^n} = x^{m-n}; x \neq 0;$			*
2.5	Complex Numbers	2.5.1	describe complex number z represented by an expression of the form $z = a + ib$, where a and b are real numbers and $i = \sqrt{-1}$;		*	
		2.5.2	identify a as real part and b as imaginary part of $z = a + ib$;		*	
		2.5.3	solve problems based on the conjugate of a complex number; where i^n, $n = 2$;			*
		2.5.4	describe the condition for equality of complex numbers;		*	
		2.5.5	apply the condition for equality of complex numbers;			*
2.6	Basic Operations on Complex Numbers	2.6.1	apply basic operations (i.e. addition, subtraction, multiplication, and division) on complex numbers.			*

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				K	U	A
3. Logarithms		Students should be able to:				
3.1	Scientific Notation	3.1.1	convert a number in ordinary form (common form) to scientific notation and vice versa;			*
3.2	Logarithms	3.2.1	explain the meaning of logarithm and exponential form and their relationship with each other ; $\left(\text{i.e.}\, a^x = y \Leftrightarrow \log_a y = x, a > 0, y > 0 \text{ and } a \neq 1\right)$;		*	
		3.2.2	solve problems related to SLO 3.2.1;			*
		3.2.3	find the characteristic and mantissa (by using log table) of common log (logarithm with base 10) of a number;		CA[3]	
		3.2.4	find the antilog of a number by using table;		CA	
3.3	Laws of Logarithms	3.3.1	prove the following laws of logarithms: a. $\log_a (mn) = \log_a m + \log_a n$ b. $\log_a \left(\frac{m}{n}\right) = \log_a m - \log_a n$ c. $\log_a m^n = n \log_a m$ d. $\log_m n = \frac{\log_a n}{\log_a m}$;			*
3.4	Application of Logarithms	3.4.1	solve problems using the laws of logarithm (without using log and antilog tables).			*

[3] CA=Classroom Activity, not to be assessed under examination conditions

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				K	U	A
4. Algebraic Expressions and Algebraic Formulae		Students should be able to:				
4.1	Algebraic Expressions	4.1.1	define polynomial and rational expression ($\frac{p(x)}{q(x)}$ of two polynomials $p(x)$ and $q(x)$ where $q(x)$ is a non-zero polynomial);	*		
		4.1.2	discuss whether a given algebraic expression is a a. polynomial or not b. rational expression or not;		*	
		4.1.3	simplify a given rational expressions to its lowest terms;			*
		4.1.4	solve problems based on the multiplication and division of a rational expression;			*
		4.1.5	find the value of an algebraic expression for a given real number;			*
4.2	Algebraic Formulae	4.2.1	derive the formulae: a. $(a+b)^2+(a-b)^2=2(a^2+b^2)$ b. $(a+b)^2-(a-b)^2=4ab$ c. $a^2-b^2=(a+b)(a-b)$;			*
		4.2.2	find the value of a^2+b^2, a^2-b^2, $a+b$, $a-b$ and ab, using the above formulae;			*
		4.2.3	derive the formula $(a+b+c)^2=a^2+b^2+c^2+2ab+2bc+2ca$;			*

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				K	U	A
		Students should be able to:				
		4.2.4	find the values of $a^2+b^2+c^2$, $a+b+c$ and $ab+bc+ca$, when values of any two of these are given in the above formula;			*
		4.2.5	derive the formulae: a. $(a+b)^3 = a^3+3ab(a+b)+b^3$ b. $(a-b)^3 = a^3-3ab(a-b)-b^3$;			*
		4.2.6	solve problems based on the above formulae;			*
		4.2.7	find the value of $x^3 \pm \frac{1}{x^3}$ when the value of $x \pm \frac{1}{x}$ is given or vice versa;			*
		4.2.8	derive the formulae: a. $a^3+b^3 = (a+b)(a^2-ab+b^2)$ b. $a^3-b^3 = (a-b)(a^2+ab+b^2)$;			*
		4.2.9	find the continued product by using the above formulae (e.g. $(x+y)(x-y)(x^2+xy+y^2)(x^2-xy+y^2)$).			*
4.3	Surds of Second Order and their Applications	4.3.1	describe the surds of second order;		*	
		4.3.2	apply the basic operations (addition, subtraction and multiplication) on surds of second order;			*
4.4	Rationalisation	4.4.1	rationalise the denominator of real numbers using conjugate surds (e.g. $\frac{1}{a+b\sqrt{x}}, \frac{1}{\sqrt{x}+\sqrt{y}}$, where x and y are natural numbers and a and b are integers) and their combinations;			*
		4.4.2	solve problems based on surds.			*

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				K	U	A
5. Factorisation		Students should be able to:				
5.1	Basic Factorisation	5.1.1	factorise the expression of the following types: a. $ka+kb+kc$, b. $ac+ad+bc+bd$, c. $a^2 \pm 2ab + b^2$ d. $a^2 - b^2$ e. $a^2 \pm 2ab + b^2 - c^2$;			*
5.2	Factorisation	5.2.1	factorise the expression of the following types: a. $a^4 + a^2b^2 + b^4$ or $a^4 + 4b^4$, b. $ax^2 + bx + c$, c. $(ax^2 + bx + c)(ax^2 + bx + d) + k$ d. $\{a^3 + 3a^2b + 3ab^2 + b^3,\}$ $\{a^3 - 3a^2b + 3ab^2 - b^3,\}$ e. $a^3 \pm b^3$;			*
5.3	Remainder Theorem and Factor Theorem	5.3.1 5.3.2 5.3.3	find the remainder using remainder theorem, when a polynomial is divided by a linear polynomial; define zeros of a polynomial; solve problems based on the concept of zeros of a polynomial;	 * 	 	* *
5.4	Factorisation of a Cubic Polynomial	5.4.1	apply factor theorem to factorise a cubic polynomial.			*

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				K	U	A
6. Variations		Students should be able to:				
6.1	Ratio and Proportion	6.1.1 6.1.2	define ratio and proportion; calculate 3rd, 4th proportional and mean proportional for continued proportion;	*		*
6.2	Theorems on Proportions	6.2.1	apply theorems of invertendo, alternendo, componendo, dividendo and componendo-dividendo to find proportions;			*
6.3	Direct, Inverse and Joint Variations	6.3.1 6.3.2	describe direct, inverse, and joint variations; solve problems related to variations (up to four quantities);		*	*
6.4	K-Method	6.4.1	prove conditional equalities involving proportions using K-method.			*

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				K	U	A
7. Matrices and Determinants		Students should be able to:				
7.1	Introduction to Matrices	7.1.1	define matrix with real entries;	*		
		7.1.2	define: a. rows and columns of a matrix b. order of a matrix c. equality of matrices;	*		
7.2	Types of Matrices (up to order 3 × 3)	7.2.1	describe row matrix, column matrix, rectangular matrix, square matrix, zero/ null matrix, diagonal matrix, scalar matrix, unit matrix and symmetric matrix;		*	
		7.2.2	find the transpose of a matrix;			*
7.3	Addition and Subtraction of Matrices (up to order 3 ×3)	7.3.1	discuss whether the given matrices are conformable for addition/ subtraction;		*	
		7.3.2	find the addition and subtraction of matrices;			*
		7.3.3	verify commutative and associative laws under addition;			*
		7.3.4	define the additive identity of a matrix;	*		
		7.3.5	find the additive inverse of a matrix;			*
7.4	Multiplication of Matrices (up to order 2 × 2)	7.4.1	find the multiplication of a matrix by a real number;			*
		7.4.2	discuss whether the given matrices are conformable for multiplication;		*	
		7.4.3	find the multiplication of two (or three) matrices;			*
		7.4.4	verify associative law under multiplication;			*
		7.4.5	verify distributive laws of multiplication over addition and subtraction;			*

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level K	U	A
		Students should be able to:				
		7.4.6	verify with the help of examples that commutative law under multiplication does not hold in general $(\text{i.e. } AB \neq BA)$;			*
		7.4.7	verify with the help of examples that $(AB)^t = B^t A^t$;			*
7.5	Multiplicative Inverse of a Matrix (up to order 2 × 2)	7.5.1	describe the determinant of a square matrix;		*	
		7.5.2	calculate the determinant of a matrix;			*
		7.5.3	define singular and non-singular matrix;	*		
		7.5.4	solve problems related to singular and non-singular matrix;			*
		7.5.5	find the adjoint of a matrix and related problems;			*
		7.5.6	define the multiplicative identity of a matrix;	*		
		7.5.7	find the multiplicative inverse of a non-singular matrix A;			*
		7.5.8	verify that $AA^{-1} = I = A^{-1}A$, where I is the multiplicative identity matrix;			*
		7.5.9	find the inverse of a non-singular matrix by using adjoint method;			*
		7.5.10	verify the result $(AB)^{-1} = B^{-1}A^{-1}$ with the help of examples;			*
7.6	Solution of Matrix Equations and Simultaneous Linear Equations	7.6.1	solve matrix equations (e.g. Find A, if $A+\begin{bmatrix}2 & 1\\ 0 & 3\end{bmatrix}\begin{bmatrix}1\\ 0\end{bmatrix}=5\begin{bmatrix}3\\ 2\end{bmatrix}$);			*
		7.6.2	solve a system of two simultaneous linear equations in two unknowns using a. matrix inverse method b. Cramer's rule. (**Note:** Word problems based on simultaneous linear equations are not included.)			*

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				K	U	A
8. Practical Geometry –Triangles		Students should be able to:				
8.1	Construction of Triangles	8.1.1	draw a triangle when: a. two sides and one of the angle is given b. one side and two of the angles are given c. two of its sides and the angle opposite to one of them (with all the three possibilities) are given;			*
		8.1.2	draw for a given triangle: a. angle bisectors b. perpendicular bisectors c. medians d. altitudes;			*
		8.1.3	verify, for a given triangle, the concurrency of: a. angle bisectors, b. altitudes, c. perpendicular bisectors, d. medians.			*

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				K	U	A
9. Congruent Triangles		Students should be able to:				
9.1	Congruent Triangles	9.1.1	apply the following theorems to solve related problems: a. if two angles of a triangle are congruent, then the sides opposite to them are also congruent. b. in any correspondence of two triangles, if two sides and the included angle of one triangle are congruent to corresponding two sides and the included angle of the other, then the two triangles are congruent ($SAS \cong SAS$). c. in any correspondence of two triangles, if one side and any two angles of one triangle are congruent to the corresponding side and angles of the other, then the two triangles are congruent ($AAS \cong AAS$). d. in a correspondence of two triangles, if three sides of one triangle are congruent to the corresponding three sides of the other, then the two triangles are congruent ($SSS \cong SSS$). e. if in the correspondence of two right-angled triangles, the hypotenuse and one side of one are congruent to the hypotenuse and the corresponding side of the other, then the triangles are congruent ($RHS \cong RHS$).			*

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level K	U	A
10. Parallelograms and Triangles		Students should be able to:				
10.1	Parallelograms and Triangles	10.1.1	apply the following theorems to solve related problems: a. in a parallelogram: i. the opposite sides are congruent ii. the opposite angles are congruent iii. the diagonals bisect each other; b. if two opposite sides of a quadrilateral are congruent and parallel, it is a parallelogram. c. the line segment, joining the midpoints of two sides of a triangle, is parallel to the third side and is equal to one half of its length. d. the medians of a triangle are concurrent and their point of concurrency is the point of trisection of each median. e. if three or more parallel lines make congruent intercepts on a transversal they also intercept congruent segments on any other transversal.			*

Topics and Sub-topics		Student Learning Outcomes	Cognitive Level K	U	A
11. Line Bisectors and Angle Bisectors		Students should be able to:			
11.1 Line Bisectors and Angle Bisectors	11.1.1	apply the following theorems to solve related problems: a. any point on the right bisector of a line segment is equidistant from its end points. b. any point equidistant from the end points of a line segment is on the right bisector of it. c. the right bisectors of the sides of a triangle are concurrent. d. any point on the bisector of an angle is equidistant from its arms. e. any point inside an angle, equidistant from its arms, is on the bisector of it. f. the bisector of the angles of a triangle are concurrent.			*

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				K	U	A
12. Sides and Angles of a Triangle		Students should be able to:				
12.1	Sides and Angles of a Triangle	12.1.1	apply the following theorems to solve related problems: a. if two sides of a triangle are unequal in length, the longer side has an angle of greater measure opposite to it. b. if two angles of a triangle are unequal in measure, the side opposite to the greater angle is longer than the side opposite to the smaller angle. c. the sum of the lengths of any two sides of a triangle is greater than the length of the third side. d. perpendicular is the shortest distance from a point to the line.			*

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				K	U	A
13. Application of Ratio and Proportion in Geometrical Theorems		Students should be able to:				
13.1	Application of Ratio and Proportion in Geometrical Theorems	13.1.1	apply the following theorems to solve related problems: a. a line parallel to one side of a triangle, intersecting the other two sides, divides them proportionally. b. if a line segment intersects the two sides of a triangle in the same ratio then it is parallel to the third side. c. the internal bisector of an angle of a triangle divides the side opposite to it in the ratio of the length of the sides containing the angle. d. if two triangles are similar, the measures of their corresponding sides are proportional.			*

Part II (Grade X)

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level K	U	A
14. Basic Statistics		Students should be able to:				
14.1	Frequency Distribution and Graphs	14.1.1	construct a grouped frequency table (using direct and tally marks method);			*
		14.1.2	draw (and interpret) bar charts and histograms with equal and unequal class intervals;			*
		14.1.3	draw (and interpret) a frequency curve and a frequency polygon;			*
		14.1.4	draw (and interpret) a pie-chart;			*
14.2	Cumulative Frequency Distribution	14.2.1	construct a cumulative frequency table;			*
		14.2.2	draw (and interpret) a cumulative frequency curve and cumulative frequency polygon;			*
14.3	Measures of Central Tendency	14.3.1	calculate (and interpret) the arithmetic mean by direct method (only), weighted mean, median and mode for ungrouped data.			*
		14.3.2	calculate (and interpret) the arithmetic mean by direct method (only), median and mode for grouped data;			*
		14.3.3	find the approximate value of median and mode graphically;			*
		14.3.4	describe the following properties of arithmetic mean if: a. $X = a$ (a is constant), then $\bar{X} = a$ b. $Y = X \pm a$, then $\bar{Y} = \bar{X} \pm a$ c. $Y = bX$, then $\bar{Y} = b\ \bar{X}$ d. $Y = \frac{X}{a}$ then $\bar{Y} = \frac{\bar{X}}{a}$ or $\bar{Y} = \frac{1}{a}(\bar{X})$		*	
		14.3.5	apply the properties of arithmetic mean to solve related problems;			*
14.4	Measures of Dispersion	14.4.1	calculate the range, variance and standard deviation for grouped and ungrouped data.			*

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				K	U	A
15. Algebraic Manipulation		Students should be able to:				
15.1	Highest Common Factor and Least Common Multiple	15.1.1	find the highest common factor (H.C.F.) and the least common multiple (L.C.M.) of algebraic expressions using factorisation;			*
		15.1.2	find the highest common factor (H.C.F.) and the least common multiple (L.C.M.) of algebraic expressions using division;			*
		15.1.3	apply H.C.F., L.C.M. and their relationship in solving problems;			*
15.2	Basic Operations on Algebraic Fractions	15.2.1	simplify algebraic fractional expressions or rational expressions involving basic operations of $+, -, \times, \div$;			*
15.3	Square Root of Algebraic Expressions	15.3.1	calculate square root of algebraic expressions by factorisation;			*
		15.3.2	calculate square root of algebraic expressions by division.			*

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				K	U	A
16. Partial Fractions		Students should be able to:				
16.1	Proper and Improper Rational Fractions	16.1.1	distinguish between proper and improper rational fractions;		*	
16.2	Resolution of Fraction into Partial Fractions	16.2.1	convert an algebraic fraction into partial fractions when its denominator consists of a. non-repeated linear factors b. repeated linear factors.			*

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				K	U	A
17. Linear Equations and Inequalities		Students should be able to:				
17.1	Linear Equations	17.1.1	define linear equation in one variable;	*		
		17.1.2	solve linear equation with real coefficients;			*
		17.1.3	convert equations, involving radicals, reducible to linear form and find their solutions with verification;			*
		17.1.4	solve word problems based on linear equations (and verify its solutions);			*
17.2	Equations involving Absolute Value	17.2.1	define absolute value;	*		
		17.2.2	solve equations involving absolute value in one variable;			*
17.3	Linear Inequalities	17.3.1	define inequalities $(>,<)$ and $(\geq,\leq)$;	*		
		17.3.2	describe the properties of inequalities (i.e. trichotomy, transitive, additive and multiplicative);		*	
17.4	Solving Linear Inequalities	17.4.1	solve linear inequalities with real coefficient, in one variable;			*
		17.4.2	represent the solution of linear inequalities on the number line;			*
		17.4.3	solve linear inequalities, involving absolute value, in one variable x, where $x \in R$, of the following cases: a. $\|x\| < 0$ (Null Set) b. $\|x\| > 0$ (Set of Real Numbers) c. $\|x\| < a$, where a is an integer d. $\|x\| > a$, where a is an integer e. $\|x \pm a\| < 0$, where a is an integer f. $\|x \pm a\| > 0$, where a is an integer;			*
		17.4.4	illustrate the solution of the above cases on the number line.			*

Topics and Sub-topics		Student Learning Outcomes	Cognitive Level K	U	A
18. Linear Graphs and their Applications		Students should be able to:			
18.1 Cartesian Plane and Linear Graphs	18.1.1	identify pair of real numbers as an ordered pair;		*	
	18.1.2	describe Cartesian/ rectangular plane consisting of two number lines (x-axis and y-axis) intersecting at right angles at the point O (origin);		*	
	18.1.3	locate an ordered pair (a, b) as point in the rectangular plane: a. a as the x-coordinate (or abscissa) b. b as the y-coordinate (or ordinate);			*
	18.1.4	draw different geometrical shapes (e.g., line segment, triangle and rectangle etc) by joining a set of given points;			*
	18.1.5	construct a table for pairs of values satisfying a linear equation in two variables;			*
	18.1.6	draw the graph of a given linear equation: a. $y = mx$ b. $y = mx + c$ c. $ax + by + c = 0$;			*
	18.1.7	draw the graph of an equation of the form: a. $y = c$ b. $x = a$;			*
	18.1.8	draw the graph from a given table of discrete values and choose an appropriate scale to draw the graph (every first degree equation does not form a linear graph, it may be a point graph);			*
	18.1.9	solve problems related to linear graphs;			*

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				K	U	A
		Students should be able to:				
18.2	Conversion Graphs	18.2.1	interpret conversion graph as a linear graph relating two quantities which are in direct proportion;			*
		18.2.2	convert the given quantities using conversion graphs: a. miles and kilometres b. acres and hectares c. degree Celsius and degree Fahrenheit d. Pakistani currency and other currencies e. other inter-related quantities;			*
18.3	Solution of Equations in two Variables	18.3.1	solve the simultaneous linear equations in two variables using: a. algebraic method b. graphical method;			*
		18.3.2	solve word problems involving two simultaneous linear equations in two variables.			*

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				K	U	A
19. Quadratic Equations		Students should be able to:				
19.1	Quadratic Equations (in one variable)	19.1.1	distinguish between quadratic equations and other equations;		*	
		19.1.2	convert a given quadratic equation in standard form;			*
19.2	Solution of Quadratic Equations	19.2.1	solve quadratic equations involving real roots in one variable by: a. factorisation b. completing the square method;			*
19.3	Quadratic Formula	19.3.1	derive quadratic formula by using completing square method;			*
		19.3.2	find discriminant ($b^2 - 4ac$) of a given quadratic equation;			*
		19.3.3	determine the nature of the roots of a given quadratic equation through discriminant;			*
		19.3.4	solve the quadratic equations involving real and complex roots using quadratic formula;			*
		19.3.5	solve word problems based on the quadratic equation.			*

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				K	U	A
20. Introduction to Coordinate Geometry		Students should be able to:				
20.1	Distance Formula	20.1.1	describe coordinate geometry;		*	
		20.1.2	prove distance formula between two points given in Cartesian plane;			*
		20.1.3	find the distance between two given points using distance formula;			*
20.2	Collinear Points	20.2.1	distinguish between collinear and non-collinear points;		*	
		20.2.2	show whether the given three points are collinear or non-collinear using distance formula;			*
		20.2.3	use distance formula to show that three non-collinear points may form a/ an: a. equilateral triangle b. isosceles triangle c. right-angled triangle d. scalene triangle;			*
		20.2.4	use distance formula to show that four non-collinear points may form a: a. parallelogram b. square c. rectangle;			*
20.3	Mid-Point Formula	20.3.1	find the midpoint of a line segment joining two given points;			*
		20.3.2	solve problems related to midpoint formula.			*

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level K	Cognitive Level U	Cognitive Level A
21. Introduction to Trigonometry		Students should be able to:				
21.1	Measurement of an Angle	21.1.1	describe sexagesimal system (degree, minute and second);		*	
		21.1.2	convert an angle given in $D°M'S''$ form into a decimal form and vice versa;			*
21.2	Length of Circular Arc	21.2.1	define radian;	*		
		21.2.2	convert an angle from degree to radian and vice versa;			*
		21.2.3	derive $l = r\theta$, where r is the radius of the circle, l is the length of circular arc and θ is the central angle measured in radians;			*
		21.2.4	apply $l = r\theta$ to solve problems;			*
		21.2.5	prove area of sector of a circle $A = \frac{1}{2} r^2 \theta$;			*
		21.2.6	apply $A = \frac{1}{2} r^2 \theta$ to solve related problems;			*
21.3	Trigonometric Ratios	21.3.1	identify quadrants and quadrantal angles (0, ± 90º, ± 180º, ± 270º, ± 360º);		*	
		21.3.2	calculate the values of trigonometric ratios and their reciprocals for 45º, 30º, and 60º;			*
		21.3.3	identify the signs of trigonometric ratios in different quadrants;		*	

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				K	U	A
		Students should be able to:				
21.4	Trigonometric Identities	21.4.1	prove the fundamental trigonometric identities i.e. $\sin^2\theta + \cos^2\theta = 1$, $1 + \tan^2\theta = \sec^2\theta$, $1 + \cot^2\theta = \operatorname{cosec}^2\theta$;		*	
		21.4.2	prove different trigonometric relations using the above trigonometric identities;			*
21.5	Angle of Elevation and Depression	21.5.1	illustrate angle of elevation and depression;		*	
		21.5.2	solve word problems involving angle of elevation and depression in a right-angled triangle.			*

Topics and Sub-topics		Student Learning Outcomes	Cognitive Level		
			K	U	A
22. Pythagoras' Theorem		Students should be able to:			
22.1 Pythagoras' Theorem	22.1.1	apply the following theorems to solve related problems: a. in a right-angled triangle, the square of the length to hypotenuse is equal to the sum of the squares of the lengths of the other two sides (Pythagoras' theorem) b. if the square of one side of a triangle is equal to the sum of the squares of the other two sides then the triangle is a right-angled triangle.			*

Topics and Sub-topics		Student Learning Outcomes	Cognitive Level		
			K	U	A
23. Chords of a Circle		Students should be able to:			
23.1 Chords of a Circle	23.1.1	apply the following theorems to solve related problems: a. one and only one circle can pass through three non-collinear points. b. a straight line drawn from the centre of a circle to bisect a chord which is not a diameter is perpendicular to the chord. c. perpendicular from the centre of a circle on a chord bisects it. d. if two chords of a circle are congruent then they will be equidistant from the centre. e. two chords of a circle which are equidistant from the centre are congruent.			*

Topics and Sub-topics		Student Learning Outcomes	Cognitive Level		
			K	U	A
24. Tangent to a Circle		Students should be able to:			
24.1 Tangent to a Circle	24.1.1	apply the following theorems to solve related problems: a. 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. b. the tangent to a circle and the radial segment joining the point of contact and the centre are perpendicular to each other. c. the two tangents drawn to a circle from a point outside it are equal in length. d. if two circles touch externally or internally the distance between their centres is respectively equal to the sum or difference of their radii.			*

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				K	U	A
25. Chords and Arcs		Students should be able to:				
25.1	Chords and Arcs	25.1.1	apply the following theorems to solve related problems: a. if two arcs of a circle (or of congruent circles) are congruent then the corresponding chords are equal. b. if two chords of circle (or of congruent circles) are equal, then their corresponding arcs (minor, major or semi-circular) are congruent. c. equal chords of a circle (or of congruent circles) subtend equal angles at the centre (at the corresponding centres). d. if the angles subtended by two chords of a circle (or congruent circles) at the centre (corresponding centres) are equal, the chords are equal.			*

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				K	U	A
26. Angle in a Segment of a Circle		Students should be able to:				
26.1	Angle in a Segment of a Circle	26.1.1	apply the following theorems to solve related problems: a. the measure of a central angle of a minor arc of a circle, is double that of the angle subtended by the corresponding major arc. b. any two angles in the same segment of a circle are equal. c. the inscribed angle in a semi-circle is a right angle. d. the angle in a segment greater than a semi-circle is less than a right angle. e. the angle in a segment less than a semi-circle is greater than right angle. f. the opposite angles of any quadrilateral inscribed in a circle are supplementary.			*

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				K	U	A
27. Practical Geometry–Circles		Students should be able to:				
27.1	Construction of Circle	27.1.1	find the centre of a given circle;			*
		27.1.2	draw a circle passing through three given non-collinear points;			*
27.2	Circles Attached to Polygons	27.2.1	draw a circumscribed circle about a given triangle;			*
		27.2.2	draw an inscribed circle in a given triangle;			*
		27.2.3	draw described circles to a given triangle;			*
		27.2.4	draw a circumscribed equilateral triangle about a given circle;			*
		27.2.5	draw an inscribed equilateral triangle in a given circle;			*
		27.2.6	draw a circumscribed square about a given circle;			*
		27.2.7	draw an inscribed square in a given circle;			*
		27.2.8	draw a circumscribed regular hexagon about a given circle;			*
		27.2.9	draw an inscribed regular hexagon in a given circle;			*
27.3	Tangents to the Circle	27.3.1	draw a tangent to a given circle from a point *P* when *P* lies: a. on the circumference; b. outside the circle;			*
		27.3.2	draw: a. direct common tangent(s) or external tangent(s) to two equal circles; b. direct common tangent(s) or external tangent(s) to two unequal circles; c. transverse common tangent(s) or internal tangent(s) to two equal circles; d. transverse common tangent(s) or internal tangent(s) to two unequal circles.			*

Scheme of Assessment

Grade IX

Table 1: Number of Student Learning Outcomes by Cognitive Level

Topic No.	Topics	No. of Sub-topics	SLOs			Total
			K	U	A	
1.	Sets and Functions	6	1	7	8	16
2.	Real and Complex Numbers	6	0	7	6	13
3.	Logarithms	4	0	1	4	5
4.	Algebraic Expressions and Algebraic Formulae	4	1	2	15	18
5.	Factorisation	4	1	0	5	6
6.	Variations	4	1	1	4	6
7.	Matrices and Determinants	6	5	4	19	28
8.	Practical Geometry-Triangles	1	0	0	3	3
9.	Congruent Triangles	1	0	0	1	1
10.	Parallelograms and Triangles	1	0	0	1	1
11.	Line Bisectors and Angle Bisectors	1	0	0	1	1
12.	Sides and Angles of a Triangle	1	0	0	1	1
13.	Application of Ratio and Proportion in Geometrical Theorems	1	0	0	1	1
	Total	**40**	**9**	**22**	**69**	**100**
	Percentage		**9**	**22**	**69**	**100**

Table 2: Exam Specifications

Topic No.	Topics	Marks Distribution	Total Marks
1.	Sets and Functions	MCQs 5 @ 1 Mark CRQ 1 @ 4 Marks	9
2.	Real and Complex Numbers	MCQs 4 @1 Mark CRQ 1 @ 4 Marks	8
3.	Logarithms	MCQ 3 @ 1 Mark CRQ 1 @ 4 Marks	7
4.	Algebraic Expressions and Algebraic Formulae	MCQs 4 @ 1 Mark *CRQs 2 @ 5 Marks each Choose any ONE from TWO	9
5.	Factorisation	MCQs 5 @ 1 Mark *CRQs 2 @ 5 Marks Choose any ONE from TWO	10
6.	Variations	MCQs 2 @ 1 Mark CRQ 1 @ 4 Marks	6
7.	Matrices and Determinants	MCQs 5 @ 1 Mark CRQ 1 @ 5 Marks	10
8.	Practical Geometry-Triangles	CRQ 1 @ 3 Marks	3
9.	Congruent Triangles	MCQs 7 @ 1 Mark **CRQs 3 @ 3 Marks each Choose any TWO from THREE	13
10.	Parallelograms and Triangles		
11.	Line Bisectors and Angle Bisectors		
12.	Sides and Angles of a Triangle		
13.	Application of Ratio and Proportion in Geometrical Theorems		
	Total Marks	**MCQs** 35 / **CRQs** 40	**75**

* There will be TWO questions and students will be required to attempt any ONE by making a choice out of the TWO.

** There will be THREE questions and the students will be required to attempt any TWO by making a choice out of the THREE.

Grade X

Table 3: Number of Student Learning Outcomes by Cognitive Level

Topic No.	Topics	No. of Sub-topics	SLOs			Total
			K	U	A	
14.	Basic Statistics	4	0	1	11	12
15.	Algebraic Manipulation	3	0	0	6	6
16.	Partial Fractions	2	0	1	1	2
17.	Linear Equations and Inequalities	4	3	1	8	12
18.	Linear Graphs and Their Applications	3	0	2	11	13
19.	Quadratic Equations	3	0	1	7	8
20.	Introduction to Coordinate Geometry	3	0	2	7	9
21.	Introduction to Trigonometry	5	1	5	9	15
22.	Pythagoras' Theorem	1	0	0	1	1
23.	Chords of a Circle	1	0	0	1	1
24.	Tangent to a Circle	1	0	0	1	1
25.	Chords and Arcs	1	0	0	1	1
26.	Angle in a Segment of a Circle	1	0	0	1	1
27.	Practical Geometry–Circles	3	0	0	13	13
	Total	**35**	**4**	**13**	**78**	**95**
	Percentage		**4**	**14**	**82**	**100**

Table 4:Exam Specifications

Topic No.	Topics	Marks Distribution	Total Marks
14.	Basic Statistics	MCQ 4 @ 1 Mark CRQ 1 @ 4 Marks	8
15.	Algebraic Manipulation	MCQs 6 @1 Mark *CRQs 2 @ 5Marks each Choose any ONE from TWO	11
16.	Partial Fractions		
17.	Linear Equations and Inequalities	MCQs 4 @1 Mark *CRQs 2 @ 4 Marks each Choose any ONE from TWO	8
18.	Linear Graphs and their Applications	MCQs 3 @1 Mark CRQ 1 @ 3 Marks	6
19.	Quadratic Equations	MCQs 3 @ 1 Mark CRQ 1 @ 4 Marks	7
20.	Introduction to Coordinate Geometry	MCQs 2 @ 1 Mark CRQs 1 @ 3 Marks	5
21.	Introduction to Trigonometry	MCQs 8 @ 1 Mark **CRQs 3 @ 3 Marks each Choose any TWO from THREE	14
22.	Pythagoras' Theorem		
23.	Chords of a Circle	MCQs 5 @ 1 Mark **CRQs 3 @ 4 Marks each Choose any TWO from THREE	13
24.	Tangent to a Circle		
25.	Chords and Arcs		
26.	Angle in a Segment of a Circle		
27.	Practical Geometry–Circles	CRQ 1 @ 3 Marks	3
Total Marks		**MCQs** **CRQs** **35** **40**	**75**

* There will be TWO questions and the students will be required to attempt any ONE by making a choice out of the TWO.

** There will be THREE questions and the students will be required to attempt any TWO by making a choice out of the THREE.

- Tables 1 and 3 indicate the number and nature of SLOs in each topic in grades IX and X respectively. This will serve as a guide in the construction of the examination paper. It also indicates that more emphasis has been given to the Understanding (22% in IX and 14% in X), Application and higher order skills (69% in IX and 82% in X) to discourage rote memorization. Tables 1 and 3, however, do not translate directly into marks.

- There will be two examinations, one at the end of grade IX and one at the end of grade X.

- In each grade, the theory paper will be in two parts: paper I and paper II. Both papers will be of duration of 3 hours.

- Paper I theory will consist of 35 compulsory, multiple choice questions. These questions will involve four response options.

- Paper II theory will carry 40 marks and consist of a number of compulsory, constructed response questions. There will be no choice among the topics in constructed response questions but it may be within the topic.

- All constructed response questions will be in a booklet which will also serve as an answer script.

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In-house Team

- **Final Reviewer and Advisor: Dr Shehzad Jeeva**
  Director, AKU-EB

- **Mentor and Guide for Syllabi Review: Dr Naveed Yousuf**
  Associate Director, Assessment

- **Syllabi Review Lead: Raabia Hirani**
  Manager, Curriculum Development

- **Syllabi Review Facilitator: Banazeer Yaqoob**
  Associate, Curriculum Development

- **Learning Resources Reviewers: Aamna Pasha**
  Associate Director, Teacher Development and the Teacher Development Team

- **Administrative Support: Hanif Shariff**
  Associate Director, Operations
  Raheel Sadruddin
  Assistant Manager, Administration

- **Syllabi Feedback Data Analysts: Tooba Farooqui** and **Muhammad Kashif**
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  Specialist, Assessment

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