آغا خان یونیورسٹی ایگزامینیشن بورڈ

AGA KHAN UNIVERSITY EXAMINATION BOARD

Higher Secondary School Certificate
Examination Syllabus

Mathematics

Grades XI - XII

(Based on New National Curriculum 2022-2023)

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Higher Secondary School Certificate Examination Syllabus

MATHEMATICS

GRADES XI-XII

This syllabus will be examined in both Annual and September Examination sessions from Annual Examinations 2026 for Grade XI and Annual Examinations 2027 for Grade XII

For queries and feedback

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Preface

Established in 2002 through the Pakistan government's ordinance, the Aga Khan University Examination Board (AKU-EB) is country's first private autonomous qualification awarding body for Secondary School Certificate (SSC) and Higher Secondary School Certificate (HSSC). Its vision is to be a model of excellence and innovation in education in Pakistan and the developing world.

AKU-EB achieves its vision by developing examination syllabi which inculcate conceptual thinking and higher order learning and is aligned with the National Curriculum and mapped with provincial curricula and international standards. AKU-EB revises its syllabi periodically to support the needs of students, teachers and society.

The aims of the syllabus review of SSC and HSSC are 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 society.
- 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 the 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, teachers of affiliated and non-affiliated schools, teacher trainers and university academicians, reviewed and revised the syllabus following a planned, meticulous and standardised syllabi review process.

The development of the revised syllabus has been made possible by the creativity and relentless hard work of Curriculum and Examination Development unit and the constant support provided our Principal Syllabus Reviewers, Syllabus Revision Panellists and all other reviewers for their contribution. 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 and students 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 the very best to our students and teachers in implementing this syllabus.

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Understanding of AKU-EB Syllabi

1. The AKU-EB 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.

2. The topics of the syllabi are divided into subtopics and **student learning outcomes** (**SLOs**). The SLOs define the depth and the breadth at which each topic or sub-topic will be taught, learnt and examined. The syllabi also provide enabling SLOs where needed to scaffold student learning.

3. 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.

4. The SLOs are classified under the following cognitive levels of Blooms Taxonomy: Remember (R), Understand (U), Apply and beyond [Apply (A), Analyse (An), Evaluate (E), Create (C)]. This is to facilitate effective planning for teaching, learning and assessment. In addition, some SLOs are identified as Formative Assessments (FA), where applicable.

5. The **Examination Specification** is provided which elucidates the weightage of each topic in the examinations determined on the basis of the content as well as the relevance of the topic.

6. To implement this syllabus, students and teachers can take support from additional material provided by the board to its affiliated schools including **Learning Resource Guides**, **Pacing Guides** and **Model Papers**.

7. The AKU-EB syllabi for Secondary School Certificate (SSC) and Higher Secondary School Certificate (HSSC) are designed to foster not only conceptual understanding but also critical thinking and problem-solving skills. These syllabi ensure students develop the cognitive, affective and psychomotor skills essential for success at the university and beyond.

Subject Rationale of AKU-EB Mathematics

Why study Mathematics?

Mathematics offers far more than just formulae and equations. It fosters critical thinking, logical reasoning, and problem-solving skills that are invaluable in every aspect of life. Whether you are embarking on a career in science, technology, finance, or even the arts, mathematics equips you with the tools and mind-set to analyse, interpret, and innovate. This essential discipline opens doors to countless opportunities, empowering you to face life's challenges with confidence and clarity.

What will you learn in AKU-EB Mathematics Compulsory?

Mathematics is an empowering and versatile tool that drives success across a vast array of fields, from science, engineering, and technology to economics, psychology, and beyond. It equips you with invaluable skills; critical thinking, problem-solving, and logical reasoning, that are essential for thriving in today's world. By mastering mathematics, you unlock endless opportunities and develop the core abilities needed to excel in any endeavour. Most of the school going students understand the use of basic math in daily life.

Mathematics is essential for careers in data science, finance, and engineering, and it enhances cognitive abilities, creativity, and decision-making. It also prepares you for complex challenges, both professionally and in everyday life, by teaching persistence and resilience.

In mathematics, you are mastering the art of problem-solving through systematic and critical thinking. The key is to take a complex problem and break it down into simpler, more solvable components. This method of reduction and logical reasoning can be applied to tackle any real-world challenge.

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 the topics.

The AKU-EB Mathematics syllabus focuses on developing understanding, mathematical skills and logical thinking. It helps improve students' ability to apply their content knowledge in new and unexpected situations, rather than focusing on rote learning. This is particularly evident in the application of theorems, where students are not simply memorising and reciting them, but learning how to apply them effectively.

Where will it take you?

The AKU-EB 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 the role of:

- Actuary
- Banker
- Architect
- Musician
- Fashion Designer
- Physical Scientist
- Astronomer, Astrologist and Navigational Scientist
- Graphic Designer (Creating 3D and 2D animations)
- Data Science & Analytics
- Engineering
- Finance
- Artificial Intelligence & Machine Learning

How to approach the syllabus?

The AKU-EB syllabi is carefully designed with a reader-friendly approach to ensure that students and teachers can easily comprehend it, making it functional for teaching, learning and assessment purposes. The syllabus includes following parts:

Subject Rationale	It is an introductory document for students.
Student Learning Outcomes (SLOs)	These guides regarding the details about what has to be achieved.
Exam Specification	It guides regarding what is expected in the examination.
Additional Resources:	
Pacing Guide	It ensures smooth transition and curricular continuity of a school's academic year. It also predicts the time and pace of syllabi implementation.
Resource Guide	It includes teaching and learning resources for students and teachers.
Model Paper	It guides regarding exam pattern, types of questions and marking scheme.
Command Word Guide	It clarifies expectations regarding the cognitive levels and skills that should be acquired by the students and which are assessed in its examinations.

Student Learning Outcomes of AKU-EB HSSC Mathematics Syllabus

Part I (Grade XI)

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level[1]		
				R	U	A and beyond
1. Complex Numbers		Students should be able to:				
1.1	Complex Numbers	1.1.1	describe the complex number z, represented by an expression of the form $z=a+ib$ into the form (a, b) and vice versa, where a and b are real numbers and $i=\sqrt{-1}$;		*	
		1.1.2	describe complex plane and the representation of a complex number on a complex plane;		*	
		1.1.3	identify a as real part and b as imaginary part of $z=a+ib$;		*	
		1.1.4	apply the condition of equality of complex numbers to solve problems;			A
		1.1.5	apply fundamental operations such as addition, subtraction, multiplication and division on complex numbers;			A
		1.1.6	state $z=a-ib$, the complex conjugate of $z=a+ib$;	*		
		1.1.7	calculate $\lvert z\rvert=\sqrt{a^2+b^2}$, the absolute value or modulus of a complex number $z=a+ib$;			A
1.2	Triangular Inequality	1.2.1	define triangular inequality of a complex number;	FA[2]		

[1]R = Remember, U = Understand, A = Apply and beyond [Apply (A), Analyse (An), Evaluate (E), Create (C)]
[2]FA= Formative Assessment, not to be assessed under examination conditions.

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				R	U	A and beyond
1.3	Factorisation and Solution of Equations	1.3.1	factorise quadratic and cubic polynomials of the form: a. $z^2+a^2=(z+ia)(z-ia), [a \in R, \text{and } a \neq 0]$, b. $z^3-3z^2+z+5=(z+1)(z-2-i)(z-2+i)$;			A
		1.3.2	solve simultaneous linear equations with complex coefficients such as, $5x-(3+i)y=7-i$, and $(2-i)x+2iy=-1+i$;			A
		1.3.3	solve quadratic equations of the form $pz^2+qz+r=0$ by completing square, where p, q and r are real numbers with $p \neq 0$ and z is a complex number;			A
1.4	Complex Numbers in Polar Coordinates	1.4.1	define the polar coordinate system;	*		
		1.4.2	describe the polar representation of a complex number;		*	
		1.4.3	convert complex numbers in polar representation and vice versa;			A
		1.4.4	describe De-Moivre's theorem;		*	
		1.4.5	describe the following properties: a. $z_1.z_2=r_1.r_2\{\cos(\theta+\phi)+i\sin(\theta+\phi)\}$, b. $\frac{z_1}{z_2}=\frac{r_1}{r_2}\{\cos(\theta-\phi)+i\sin(\theta-\phi)\}$;		*	
		1.4.6	solve problems of multiplication and division of a complex number in polar form;			A
1.5	Real World Application of Complex Numbers	1.5.1	apply the concepts of complex numbers to the real world problems.			FA

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				R	U	A and beyond
2. Matrices and Determinants		Students should be able to:				
2.1	Matrices	2.1.1	apply matrix operations such as addition, subtraction and multiplication of matrices with real and complex entries;			A
		2.1.2	describe the following terms: a. upper triangular matrix, b. lower triangular matrix, c. transpose of a matrix, d. symmetric and skew-symmetric matrices, e. hermitian and skew-hermitian matrices, f. involutory matrix, g. nilpotent matrix, h. idempotent matrix, i. periodic matrix, j. orthogonal matrix;		*	
2.2	Determinants of Matrices of order 3	2.2.1	explain the properties of determinants;		*	
		2.2.2	find the determinant of a square matrix;			A
		2.2.3	find the minor and cofactor of elements of a square matrix;			A
		2.2.4	find the adjoint of a square matrix;			A
		2.2.5	solve problems related to singular and non-singular matrices;			A
		2.2.6	evaluate the determinant without expansion (using properties of determinants);			E
		2.2.7	define: a. elementary row operations, b. echelon and reduced echelon forms;	*		
		2.2.8	find the inverse of a matrix using row operation;			A
		2.2.9	find the rank of a matrix using row operation;			A

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				R	U	A and beyond
2.3	Solution of Linear Equations using Matrices	2.3.1	explain homogeneous and non-homogeneous linear equations in two and three unknowns;		*	
		2.3.2	explain solution of system of linear equations as: a. consistent and inconsistent, b. trivial and non-trivial;		*	
		2.3.3	solve a system of three non-homogeneous linear equations using: a. matrix inversion method i.e., $X = A^{-1}B$, b. Cramer's rule;			A
		2.3.4	solve a system of three linear equations in three unknowns using Gauss elimination method (echelon form); (**Note**: For consistent unique solution only.)			A
		2.3.5	solve a system of three linear equations in three unknowns using Gauss Jordan method (reduced echelon form); (**Note:** For consistent unique solution only.)			FA
		2.3.6	apply the concepts of matrices to the following real world problems: a. graphic design, b. data encryption, c. seismic analysis, d. cryptography, e. transformation of geometric shapes, f. social network analysis.			FA

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				R	U	A and beyond
3. Sequence and Series		Students should be able to:				
3.1	Sequence (progression)	3.1.1	describe a sequence (progression);		*	
		3.1.2	find the general term when a sequence is given;			A
		3.1.3	find a particular term of a sequence using the general term;			A
3.2	Arithmetic Sequence	3.2.1	describe an arithmetic sequence;		*	
		3.2.2	derive the formula of n^{th} or general term of an arithmetic sequence;			A
		3.2.3	solve problems involving arithmetic sequence;			A
3.3	Arithmetic Mean	3.3.1	find the arithmetic mean between two terms;			A
		3.3.2	find '*n*' arithmetic means between two terms;			A
3.4	Arithmetic Series	3.4.1	describe an arithmetic series;		*	
		3.4.2	derive the formula of sum of an arithmetic series up to *n* terms;			A
		3.4.3	solve problems involving arithmetic series;			A
3.5	Geometric Sequence	3.5.1	describe a geometric sequence;		*	
		3.5.2	derive the formula of n^{th} or general term of a geometric sequence;			A
		3.5.3	solve problems involving geometric sequence;			A
3.6	Geometric Mean	3.6.1	find the geometric mean between two terms;			A
		3.6.2	find '*n*' geometric means between two terms;			A

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				R	U	A and beyond
3.7	Geometric Series	3.7.1	describe a geometric series;		*	
		3.7.2	find the sum to '*n*' terms of a geometric series;			A
		3.7.3	find the sum of an infinite geometric series;			A
		3.7.4	convert the recurring decimal into an equivalent common fraction;			A
		3.7.5	solve problems involving geometric series;			A
3.8	Harmonic Sequence	3.8.1	describe the harmonic sequence;		*	
		3.8.2	find the n^{th} term of harmonic sequence;			A
		3.8.3	solve problems involving harmonic sequence;			A
3.9	Harmonic Mean	3.9.1	find the harmonic mean between two terms;			A
		3.9.2	find '*n*' harmonic means between two terms;			A
		3.9.3	find the relationship among arithmetic, geometric and harmonic means;			A
		3.9.4	solve problems by analysing harmonic sequences up to *n* terms;			FA
3.10	Real World Application of Sequences	3.10.1	explain the leasing of motor vehicles, down payment, motor vehicle insurance, processing charges, repayment in monthly instalments as the applications of sequences;		*	
		3.10.2	apply the concepts from sequence and series to the real world problems involving calculating simple interest on loan, investment, depreciation, investment planning on compound interest and leasing of motor vehicle under different conditions.			FA

Topics and Sub-topics		Student Learning Outcomes	Cognitive Level		
			R	U	A and beyond
4. Miscellaneous Series		Students should be able to:			
4.1 Evaluation of $\sum n, \sum n^2$ and $\sum n^3$	4.1.1	identify the sigma notation ($\sum$) to express the sum of values of a variable concisely;		*	
	4.1.2	find the sum of the: a. first n natural numbers $\sum n$, b. squares of the first n natural numbers $\sum n^2$, c. cubes of the first n natural numbers $\sum n^3$;			A
	4.1.3	solve problems involving $\sum n$, $\sum n^2$ and $\sum n^3$.			A

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				R	U	A and beyond
5. Permutation and Combination		Students should be able to:				
5.1	Factorial of a Natural Number	5.1.1	explain the concept of factorial and the fact that 0! = 1;		*	
5.2	Counting Techniques (Fundamental Principle of Counting, Permutation and Combination)	5.2.1	apply the fundamental principle of counting in different situations;			A
		5.2.2	construct tree diagram using the fundamental principle of counting;			A
		5.2.3	explain the meaning of permutation (${}^{n}P_{r}$) of 'n' different objects taken 'r' at a time;		*	
		5.2.4	solve problems involving permutation;			A
		5.2.5	find the arrangement of different objects around a circle;			A
		5.2.6	explain the meaning of combination (${}^{n}C_{r}$) of 'n' different objects taken r at a time;		*	
		5.2.7	solve problems involving combination;			A
		5.2.8	verify the following for any positive integers 'n' and 'r', where $n > r$: a. $\binom{n}{n} = \binom{n}{0} = 1$, b. $\binom{n}{r} = \binom{n}{n-r}, \binom{n}{1} = \binom{n}{n-1} = n$, c. $\binom{n}{r} + \binom{n}{r-1} = \binom{n+1}{r}$;			E
5.3	Application of Counting Techniques in Real Life Situations	5.3.1	apply the concepts of permutation and combination to the real world problems.			A

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				R	U	A and beyond
6. Mathematical Induction and Binomial Theorem		Students should be able to:				
6.1	Mathematical Induction	6.1.1	describe the principle of mathematical induction as a mathematical argument;		*	
		6.1.2	identify the base case (induction hypothesis and precise conclusion);		*	
		6.1.3	prove statements, identities, divisibility of numbers and summation formulae by the principle of mathematical induction;			E
		6.1.4	draw conclusions based on the SLO 6.1.2;			E
6.2	Binomial Theorem	6.2.1	expand $(x + y)^n$ using Pascal's triangle for positive integral values where $n \leq 5$;			A
		6.2.2	derive binomial theorem for positive integral index;			A
		6.2.3	find the general term while expanding $(x + y)^n$ using binomial theorem, where $(x + y)$ is a binomial expression;			A
		6.2.4	find the remainder when a number raised to a large exponent is divided by another number using binomial theorem;			FA
		6.2.5	find the specified term in the expansion of $(x + y)^n$;			A
		6.2.6	determine the last digit of a number using binomial theorem, to test its divisibility by another number;			FA
		6.2.7	apply the concepts of binomial theorem to the real world problems;			A

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				R	U	A and beyond
6.3	Binomial Series	6.3.1	expand $(1 + x)^n$ in ascending powers of x, where n is a rational number (except a natural number) and $\|x\| < 1$;			A
		6.3.2	explain the convergence of $(1 + x)^n$ for $\|x\| < 1$, where n is a rational number (except a natural number);		*	
		6.3.3	determine the approximate values of binomial expansions with fraction indices;			A
		6.3.4	simplify the product and ratio of binomial expressions.			A

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				R	U	A and beyond
7. Factor and Remainder Theorems		Students should be able to:				
7.1	Remainder Theorem	7.1.1	explain the remainder theorem;		FA	
		7.1.2	solve by dividing a polynomial (up to degree 4) by linear and quadratic polynomials and identify the quotient and remainder;			FA
		7.1.3	solve problems involving remainder theorem;			FA
7.2	Factor Theorem	7.2.1	explain the factor theorem;		FA	
		7.2.2	identify the quotient and factor;		FA	
		7.2.3	solve problems related to factor theorem;			FA
		7.2.4	solve by dividing a cubic polynomial by linear and quadratic polynomials;			FA
7.3	Real World Application of Remainder and Factor Theorems	7.3.1	apply the concepts of remainder and factor theorem to the real world problems such as polynomial regression, signal processing, and coding theory.			FA

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				R	U	A and beyond
8. Trigonometric Identities		Students should be able to:				
8.1	Fundamental Law of Trigonometry	8.1.1	define the following fundamental trigonometric identities: a. $\sin^2\theta + \cos^2\theta = 1$, b. $1 + \tan^2\theta = \sec^2\theta$, c. $1 + \cot^2\theta = \operatorname{cosec}^2\theta$;	*		
		8.1.2	explain the fundamental law of trigonometry using distance formula, $[\cos(\alpha - \beta) = \cos\alpha\cos\beta + \sin\alpha\sin\beta]$;		*	
		8.1.3	explain the following laws using the fundamental law of trigonometry: a. $\cos(\alpha + \beta) = \cos\alpha\cos\beta - \sin\alpha\sin\beta$, b. $\sin(\alpha \pm \beta) = \sin\alpha\cos\beta \pm \cos\alpha\sin\beta$, c. $\tan(\alpha \pm \beta) = \frac{\tan\alpha \pm \tan\beta}{1 \pm \tan\alpha\tan\beta}$;		*	
		8.1.4	solve problems related to a fundamental law of trigonometry and its deductions;			A
8.2	Trigonometric Ratios of Allied Angles	8.2.1	define allied angles;	*		
		8.2.2	derive trigonometric ratios of allied angles using a fundamental law and its deductions;			A
		8.2.3	convert $a\sin\theta \pm b\cos\theta$ in the form $r\sin(\theta \pm \phi)$, where $a = r\cos\theta$ and $b = r\sin\phi$;			A
8.3	Double, Half and Triple Angle Identities	8.3.1	derive double angle, half angle and triple angle identities from a fundamental law of trigonometry and its deductions;			A
		8.3.2	prove different trigonometric relations using the identities mentioned in SLO 8.3.1;			E

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				R	U	A and beyond
8.4	Sum, Difference and Product of Sine and Cosine	8.4.1	convert the product of sine and cosine into sum or difference and vice versa;			A
		8.4.2	apply the sum or difference of sine and cosine as products of sine and cosine, and vice versa.			A

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				R	U	A and beyond
9. Trigonometric Functions and their Graphs		Students should be able to:				
9.1	Trigonometric Functions	9.1.1	describe trigonometric functions;		*	
		9.1.2	find the domain and range of trigonometric functions;			A
		9.1.3	distinguish between even and odd trigonometric functions;		*	
		9.1.4	describe the periodicity of trigonometric functions numerically;		*	
		9.1.5	find the maximum value, minimum value and amplitude of a given function of the following types: a. $a + b\sin\theta$, b. $a + b\cos\theta$, c. $a + b\sin(c\theta + d)$, d. $a + b\cos(c\theta + d)$, where a, b, c and d are real numbers;			A
9.2	Graphs of Trigonometric Functions	9.2.1	describe the following properties for $\sin\theta$, $\cos\theta$ and $\tan\theta$: a. periodic property, e.g., $\sin(\theta \pm 2\pi) = \sin\theta$, b. odd property, e.g., $\sin(-\theta) = -\sin\theta$, c. translation property, e.g., $\sin(\theta - \pi) = -\sin\theta$ and $\sin(\pi - \theta) = \sin\theta$;		*	
		9.2.2	draw the graph of trigonometric functions of sine, cosine, tangent, secant and cosecant, cotangent within the domain -2π to 2π;			A
		9.2.3	sketch the trigonometric functions of the form $a\sin(b\theta)$, $a\cos(b\theta)$, and $a\tan(b\theta)$, where a and b are integers;			A
		9.2.4	interpret the graphs of trigonometric functions and their reciprocals focusing on periodicity, even/ odd nature and extreme values;			An
		9.2.5	apply the concepts of trigonometric functions, identities, graphs, periodicity, even/ odd functions, and extreme values to the real world problems.			FA

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				R	U	A and beyond
10. Inverse Trigonometric Functions and Trigonometric Equations		Students should be able to:				
10.1	Inverse Trigonometric Functions	10.1.1	describe principal trigonometric functions and inverse trigonometric functions;		*	
		10.1.2	find the domain and range of principal trigonometric functions and inverse trigonometric functions;			A
		10.1.3	draw the graph of inverse trigonometric functions of cosine, sine, tangent, secant, cosecant and cotangent;			FA
10.2	Inverse Trigonometric Identities	10.2.1	prove addition and subtraction formulae of inverse trigonometric functions;			E
		10.2.2	prove inverse trigonometric identities using the addition and subtraction formulae of inverse trigonometric functions;			E
10.3	Trigonometric Equations	10.3.1	solve trigonometric equations of the type $\sin\theta = k$, $\cos\theta = k$ and $\tan\theta = k$ where k is constant;			A
		10.3.2	find the general solution or principal solution of a trigonometric equation, and discard extraneous roots by considering the period of the trigonometric function;			E
		10.3.3	solve the following types of trigonometric equations graphically: a. $\sin\theta = \frac{\theta}{2}$, b. $\cos\theta = \theta$, c. $\tan\theta = 2\theta$, where $-\frac{\pi}{2} < \theta < \frac{\pi}{2}$;			A
		10.3.4	apply the concepts of inverse trigonometric functions and equations to the real world problems.			FA

Topics and Sub-topics		Student Learning Outcomes	Cognitive Level		
			R	U	A and beyond
11. Vectors		Students should be able to:			
11.1 Vectors in a Plane	11.1.1	explain scalar and vector quantities;		*	
	11.1.2	describe magnitude of the following vectors: a. equal vectors, b. negative of a vector, c. unit vector, d. zero / null vector, e. position vector, f. parallel vectors;		*	
	11.1.3	represent a vector graphically;			A
	11.1.4	apply the concepts of multiplying a vector by a scalar, and addition and subtraction of two vectors, graphically;			A
	11.1.5	represent a vector in a Cartesian plane by describing the fundamental unit vectors $\hat{i}$ and $\hat{j}$;			A
	11.1.6	find the unit vector in the direction of a given vector;			A
	11.1.7	find the position vector of a point which divides the line segment joining two points in a given ratio;			A
11.2 Vectors in Space	11.2.1	describe rectangular coordinates in space;		*	
	11.2.2	represent a vector in space by using the fundamental unit vectors $\hat{i}, \hat{j}$ and $\hat{k}$;			A
	11.2.3	find the distance between two points in space;			A
	11.2.4	apply the concepts of multiplying a vector by a scalar, and addition and subtraction of two vectors in three dimensions;			A
	11.2.5	find the magnitude of a vector;			A
	11.2.6	find the unit vector in the direction of a given vector;			A

Topics and Sub-topics	Student Learning Outcomes		Cognitive Level		
			R	U	A and beyond
	11.2.7	prove the following laws: a. commutative law for vector addition, b. associative law for vector addition, c. 0 as additive identity, d. $-z$ as additive inverse of z;			E
	11.2.8	apply concepts of vectors in space to the real world problems;			FA
11.3 Dot or Scalar Product	11.3.1	explain the dot or scalar product of two vectors;		*	
	11.3.2	interpret the dot or scalar product graphically;			An
	11.3.3	prove that: a. $\hat{\imath}.\hat{\imath} = \hat{\jmath}.\hat{\jmath} = \hat{k}.\hat{k} = 1$, b. $\hat{\imath}.\hat{\jmath} = \hat{\jmath}.\hat{k} = \hat{k}.\hat{\imath} = 0$;			E
	11.3.4	find the dot product of two vectors;			A
	11.3.5	solve problems based on the condition of orthogonality of two vectors;			A
	11.3.6	find the angle between two vectors using dot product;			A
	11.3.7	describe the direction cosines of a vector;		*	
	11.3.8	find the direction cosines of a vector;			A
	11.3.9	prove that the sum of the squares of direction cosines is unity;			E
	11.3.10	find the projection of a vector along another vector;			A
	11.3.11	solve problems related to SLO 11.3.4, 11.3.7 and 11.3.9;			A
	11.3.12	apply the concepts of dot product of vectors to the real world problems;			FA
11.4 Cross or Vector Product	11.4.1	describe cross or vector product of two vectors with its geometrical illustration;		*	
	11.4.2	describe the properties of cross or vector product;		*	
	11.4.3	prove that: a. $\hat{\imath} \times \hat{\imath} = \hat{\jmath} \times \hat{\jmath} = \hat{k} \times \hat{k} = 0$, b. $\hat{\imath} \times \hat{\jmath} = -\hat{\jmath} \times \hat{\imath} = \hat{k}$, c. $\hat{\jmath} \times \hat{k} = -\hat{k} \times \hat{\jmath} = \hat{\imath}$, d. $\hat{k} \times \hat{\imath} = -\hat{\imath} \times \hat{k}\hat{\jmath}$;			E

Topics and Sub-topics	Student Learning Outcomes		Cognitive Level		
			R	U	A and beyond
	11.4.4	find the cross product of two vectors;			A
	11.4.5	prove that the magnitude of $A \times B$ represents the area of a parallelogram with adjacent sides A and B;			E
	11.4.6	determine the condition of parallel vectors of two non-zero vectors;			A
	11.4.7	solve problems using condition of parallel vectors of two non-zero vectors;			A
	11.4.8	prove $A \times B = -(B \times A)$ with the help of given vectors;			E
	11.4.9	solve problems related to SLO 11.4.4 and 11.4.8;			A
	11.4.10	apply the concepts of cross product of vectors to the real world problems;			FA
11.5 Scalar Triple Product	11.5.1	describe the scalar triple product of vectors in terms of components or determinant form;		*	
	11.5.2	find the scalar triple product of vectors;			A
	11.5.3	prove that: a. $\hat{i} \cdot \hat{j} \times \hat{k} = \hat{j} \cdot \hat{k} \times \hat{i} = \hat{k} \cdot \hat{i} \times \hat{j} = 1$, b. $\hat{i} \cdot \hat{k} \times \hat{j} = \hat{j} \cdot \hat{i} \times \hat{k} = \hat{k} \cdot \hat{j} \times \hat{i} = -1$;			E
	11.5.4	state that the dot and cross are interchangeable in the scalar triple product;	*		
	11.5.5	solve problems related to SLO 11.5.2 and 11.5.4;			A
	11.5.6	find the volume of the following solids determined by three given vectors: a. parallelepiped, b. tetrahedron;			A
	11.5.7	describe coplanar vectors;		*	
	11.5.8	determine the condition for co-planarity of three vectors;			A
	11.5.9	solve problems using the condition of co-planarity of three vectors.			A

Part II (Grade XII)

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level[3]		
				R	U	A and beyond
12. Straight Line		Students should be able to:				
12.1 Equation of Straight Line	12.1.1	describe the equation of straight line parallel to coordinate axes;			*	
	12.1.2	describe the following forms of equation of a straight line: a. point – slope form, b. slope – intercept form, c. two points form, d. two intercepts form, e. normal form, f. symmetric form;			*	
	12.1.3	convert the general form of the equation of a straight line into the forms mentioned in SLO 12.1.2;				A
	12.1.4	find the distance between: a. a point and a line, b. two parallel lines;				FA[4]
	12.1.5	describe concurrent lines and the point of concurrency;			*	
	12.1.6	find the equations of the medians, altitudes and perpendicular bisectors of a triangle for the given vertices of a triangle;				A
	12.1.7	determine the condition of concurrency of three straight lines; (**Note**: When equations or vertices are given.)				A
	12.1.8	prove that in a triangle, the three: a. perpendicular bisectors are concurrent (circum-centre), b. medians are concurrent (centroid), c. altitudes are concurrent (orthocentre);				E

[3]R = Remember, U = Understand, A = Application and beyond [Apply (A), Analyse (An), Evaluate (E), Create (C)]
[4]FA= Formative Assessment, not to be assessed under examination conditions.

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				R	U	A and beyond
12.2	Angle Between Lines	12.2.1	find the angle between two intersecting lines;			A
		12.2.2	find the equation of the family of lines passing through the point of intersection of two given lines;			A
		12.2.3	calculate the angles of a triangle when the slopes of the sides are given;			A
12.3	Area of Polygon	12.3.1	find the area of a triangular region whose vertices are given;			A
		12.3.2	find the area of a quadrilateral region whose vertices are given;			A
12.4	Homogeneous Linear and Quadratic Equations in Two Variables	12.4.1	define the second degree homogeneous equations in two variables;	*		
		12.4.2	find the equation of the pair of lines represented jointly by the second degree homogeneous equation $ax^2 + 2hxy + by^2 = 0$;			A
		12.4.3	determine the nature of the lines of $ax^2 + 2hxy + by^2 = 0$, using the discriminant $D = \sqrt{h^2 - ab}$;			A
		12.4.4	find the acute angle between a pair of straight lines passing through the origin;			A
		12.4.5	solve the real world problems using the concepts of analytical geometry.			A

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				R	U	A and beyond
13. Functions and Limits		Students should be able to:				
13.1	Functions and Types of Functions	13.1.1	describe the following types of intervals: a. open interval, b. closed interval, c. semi-open and semi-closed intervals;		*	
		13.1.2	represent the intervals mentioned in SLO 13.1.1 on a number line;			A
		13.1.3	describe a function as a rule of correspondence and notation of a function, its domain, codomain and range, including one-one and onto functions;		*	
		13.1.4	find the value of a function for given values of dependent and independent variables;			A
		13.1.5	identify functions as: a. algebraic functions, b. transcendental functions;		*	
		13.1.6	describe various transcendental functions such as trigonometric functions, inverse trigonometric functions, logarithmic functions, exponential functions and modulus functions;		*	
		13.1.7	describe quadratic and square root functions;		*	
		13.1.8	describe: a. explicit and implicit functions, b. even and odd functions, c. parametric equations of functions such as $x = at^2$ $y = 2at$, $x = a\sec\theta$, $y = b\tan\theta$, d. piecewise functions, such as $y = \begin{cases} x & \text{when} \quad 0 \le x < 1 \\ x-1 & \text{when} \quad 1 \le x \le 2 \end{cases}$;		*	

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				R	U	A and beyond
		13.1.9	find the domain and range of algebraic functions;			A
		13.1.10	find the domain and range of transcendental functions;			A
		13.1.11	solve problems related to exponential and logarithmic functions;			A
		13.1.12	solve compound interest problems using exponential function;			A
13.2	Inverse Functions	13.2.1	describe inverse of a function and its notation;		*	
		13.2.2	find the inverse of a function and its domain and range;			A
13.3	Graph of Functions	13.3.1	plot the graph of the function $y = x^n$ ($n \neq 0$), where n is a rational number;			A
		13.3.2	find the equation of a quadratic function $f(x) = ax^2 + bx + c$ based on the given graph $y = a(x - p)(x - q)$, where the curve intersects the x-axis at $(p, 0)$ and $(q, 0)$, and passing through the point (x_1, y_1);			An
		13.3.3	sketch the graph of a quadratic function using its factors;			A
		13.3.4	distinguish among linear, quadratic and square root functions graphically;		*	
		13.3.5	interpret the graph of exponential and logarithmic function;			An
		13.3.6	draw the graph of the modulus function of the form $y = \|x\|$ and $y = c \times \|x \pm a\| \pm b$, where a and b are rational numbers;			A
		13.3.7	find the domain and range of a function using its graph;			An
		13.3.8	interpret the relation between a one-one function and its inverse through a graph;			An
		13.3.9	illustrate the transformations of a graph through: a. horizontal shift, b. vertical shift, c. scaling (using scale factor) (FA);			A

Topics and Sub-topics	Student Learning Outcomes		Cognitive Level		
			R	U	A and beyond
	13.3.10	interpret the graph/ sketch of piecewise functions, such as $y = \begin{cases} x & \text{when} \quad 0 \le x < 1 \\ x-1 & \text{when} \quad 1 \le x \le 2 \end{cases}$;			An

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				R	U	A and beyond
13.4	Limit of a Function	13.4.1	describe the following phrases: a. $x \to 0$, b. $x \to a$, c. $x \to \infty$;		*	
		13.4.2	describe the limit of a sequence;		*	
		13.4.3	find the limit of a sequence;			A
		13.4.4	describe the limit of a function;		*	
		13.4.5	state theorems of limits for the sum, difference, power, product, and quotient of functions;	*		
		13.4.6	find the limit of a function using the theorems of limits;			A
		13.4.7	evaluate the limits of functions of the following forms: a. $\frac{x^n - a^n}{x-a}, \frac{x-a}{\sqrt{x}-\sqrt{a}}$ when $x \to a$, b. $\left(1+\frac{1}{x}\right)^x$ when $x \to \infty$, c. $(1+x)^{\frac{1}{x}}, \frac{\sqrt{x+a}-\sqrt{a}}{x}, \frac{a^x-1}{x}, \frac{(1+x)^n-1}{x}$, and $\frac{\sin x}{x}$, when x is in radian and $x \to 0$;			E
		13.4.8	evaluate the limits of different algebraic, exponential, logarithmic and trigonometric functions;			E
13.5	Continuous and Discontinuous Functions	13.5.1	determine the existence and non-existence of limit of a function by illustrating the left hand and right hand limits;			A
		13.5.2	describe the continuity of a function at a point and in an interval;		*	
		13.5.3	determine the continuity and discontinuity of a function at a point and in an interval;			A

Topics and Sub-topics	Student Learning Outcomes		Cognitive Level		
			R	U	A and beyond
	13.5.4	apply the concepts of logarithm and exponential functions, limit of a function and its continuity to the following real world problems: a. growth and decay, b. finance, c. economics, d. surveying, e. navigation, f. astronomy, g. growth rate of sales, h. rate of change in sales, i. predicting long-term stock prices.			FA

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				R	U	A and beyond
14. Differentiation		Students should be able to:				
14.1	Derivative of a Function	14.1.1	distinguish between independent and dependent variables;		*	
		14.1.2	determine the approximate value of the corresponding change in the dependent variable when the independent variable is increased or decreased;			A
		14.1.3	explain the concept of rate of change;		*	
		14.1.4	distinguish between the average rate of change and the instantaneous rate of change;		*	
		14.1.5	solve problems based on the average rate of change and the instantaneous rate of change;			A
		14.1.6	describe the derivative or differential coefficient of a function as the instantaneous rate of change of the dependent variable with respect to the independent variable and its notation for derivatives;		*	
		14.1.7	find the derivative of the function using the definition of the derivative, or by first principles or by ab-initio: a. $y = x^n$ where $n \in \mathrm{Q}$, represents the set of rational numbers, b. $y = (ax+b)^n$, where $n = \frac{p}{q}$ and p, q are integers such that $q \neq 0$;			A
		14.1.8	find the derivative of algebraic functions using the direct method (power rule);			A
14.2	Theorems on Differentiation and their Applications	14.2.1	find the derivative of: a. any constant multiple of a function, b. sum (or difference) of two functions, c. product of two functions, d. quotient of two functions;			A

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				R	U	A and beyond
		14.2.2	determine the derivative of a polynomial or rational functions with reference to the combination of differentiation rules mentioned in SLO 14.2.1;			A
14.3	Chain Rule	14.3.1	describe the chain rule e.g., $\frac{dy}{dx} = \frac{dy}{du} \times \frac{du}{dx}$, when $y = f(u), u = g(x)$ and $\frac{dy}{dx} = \frac{1}{\frac{dx}{dy}}$;		*	
		14.3.2	solve problems related to the chain rule;			A
		14.3.3	find the derivative of implicit functions;			A
14.4	Differentiation of Trigonometric and Inverse Trigonometric Functions	14.4.1	find the derivative of trigonometric functions by first principles;			A
		14.4.2	find the derivative of trigonometric functions using the direct method;			A
		14.4.3	find the derivative of inverse trigonometric functions using formulae;			A
14.5	Differentiation of Exponential and Logarithmic Functions	14.5.1	find the derivative of e^x and a^x by first principles;			A
		14.5.2	find the derivative of lnx and $\log_a x$ by first principles;			A
		14.5.3	find the derivative of exponential and logarithmic functions using the direct method;			A
		14.5.4	determine the derivative of algebraic expressions involving product, quotient and power using the laws of logarithms;			A
14.6	Differentiation of Hyperbolic and Inverse Hyperbolic Functions	14.6.1	find the derivative of an: a. hyperbolic functions ($\sinh x$, $\cosh x$, $\tanh x$, $\operatorname{cosech} x$, $\operatorname{sech} x$ and $\coth x$), b. inverse hyperbolic functions ($\sinh^{-1} x$, $\cosh^{-1} x$, $\tanh^{-1} x$, $\operatorname{cosech}^{-1} x$, $\operatorname{sech}^{-1} x$, and $\coth^{-1} x$);			A

Topics and Sub-topics	Student Learning Outcomes		Cognitive Level		
			R	U	A and beyond
14.7 Application of Derivatives	14.7.1	find the velocity and acceleration of an object moving along a straight line using differentiation when displacement is given;			A
	14.7.2	apply the concepts of differentiation to the following real world problems: a. profits on diminishing returns, b. financial investments, c. population growth, d. spread of diseases, e. movement of particles, f. time-speed in transportation;			FA
14.8 Partial Derivations	14.8.1	define a function of two independent variables e.g., $z = f(x, y)$;	*		
	14.8.2	explain partial derivatives of the first order;		*	
	14.8.3	solve problems related to partial derivatives of the first order.			A

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				R	U	A and beyond
15. Higher Order Derivatives and their Applications		Students should be able to:				
15.1	Higher Order Derivatives	15.1.1	find the higher order derivatives of algebraic, trigonometric, exponential and logarithmic functions;			A
		15.1.2	find the second derivative of implicit, inverse trigonometric and parametric functions;			A
15.2	Application of Derivatives	15.2.1	explain differentials to approximate the change in a quantity;		*	
		15.2.2	interpret derivatives geometrically;			An
		15.2.3	calculate the relative error and percentage error in using a differential approximation (volume of a cube and sphere);			A
		15.2.4	find the gradient of a curve at a point;			A
		15.2.5	find the angle of intersection of two curves;			A
		15.2.6	find the equation of the tangent and normal to the curve at a point;			A
		15.2.7	state Maclaurin's and Taylor's theorems;	*		
		15.2.8	expand $\sin x$, $\cos x$, $\tan x$, a^x , e^x, $\log_a(1+x)$ and $\ln(1+x)$ using Maclaurin's and Taylor's theorems to;			FA
15.3	Extreme Values of a Function	15.3.1	find the point on a curve where the tangent is parallel to the given line;			A
		15.3.2	apply the first derivative rule to identify increasing and decreasing functions;			A
		15.3.3	define critical and stationary points;	*		
		15.3.4	illustrate Global extrema (absolute extrema) and local extrema (relative extrema);			A
		15.3.5	apply the second derivative rule to examine a given function for extreme values;			A
		15.3.6	apply the concepts of higher order derivatives to the real world problems.			A

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				R	U	A and beyond
16. Vector Differentiation		Students should be able to:				
	16.1 Vector Valued Functions	16.1.1	describe vector valued functions;		*	
		16.1.2	identify domain and range of vector valued functions;		*	
		16.1.3	describe scaler valued functions;		*	
		16.1.4	differentiate between scalar and vector valued functions;		*	
		16.1.5	construct vector valued functions;			A
	16.2 Derivative of Vector Valued Functions	16.2.1	explain the derivative of vector function $f(t) = f_1(t)i + f_2(t)j + f_3(t)k$, where $f_1(t)$, $f_2(t)$ and $f_3(t)$ are differentiable functions of a scalar variable t, and the derivative is given by $\frac{df}{dt} = \frac{df_1}{dt}i + \frac{df_2}{dt}j + \frac{df_3}{dt}k$;		*	
		16.2.2	calculate the velocity and acceleration of a position vector $f(t) = x(t)i + y(t)j + z(t)k$, using vector differentiation;			A
		16.2.3	apply the concepts of vector valued functions to the real world problems in engineering and transportation.			A

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				R	U	A and beyond
17. Integration		Students should be able to:				
17.1	Introduction	17.1.1	describe the general antiderivative of a function;		*	
		17.1.2	identify the terms and notations for antiderivatives;		*	
		17.1.3	find the indefinite integrals to establish a relationship between basic standard integral formulae and their corresponding differentiation formulae;			A
17.2	Rules of Integration	17.2.1	describe the following rules of integration: a. $\int \frac{d}{dx}[f(x)]dx = \frac{d}{dx}\left[\int f(x)dx\right] = f(x)+c,$ where 'c' is the constant of integration, b. the integral of the product of a constant and a function is the product of the constant and the integral of the function, c. the integral of the sum of a finite number of functions is equal to the sum of their integrals;		*	
		17.2.2	prove the results for the following integrals using the standard differentiation formulae: a. $\int [f(x)]^n f'(x)dx = f(x)+c,$ where $f'(x) = f(x),$ b. $\int \frac{f'(x)}{f(x)}dx = \ln \lvert f(x) \rvert + c,$ c. $\int e^{ax}[af(x) + f'(x)]dx = f(x)e^{ax},$ where 'a' is a constant;			E
		17.2.3	evaluate indefinite integrals;			E
17.3	Integration by Substitution	17.3.1	explain the following methods of integration: a. basic substitution, b. trigonometric substitutions;		*	

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				R	U	A and beyond
		17.3.2	evaluate the integrals using the appropriate method of substitution;			A
17.4	Integration by Parts	17.4.1	explain the formula of integration by parts;		*	
		17.4.2	evaluate the integrals using the integration by parts;			A
17.5	Integration using Partial Fractions	17.5.1	find $\int \frac{f(x)}{g(x)}dx$ using partial fractions where $f(x)$ and $g(x)$ are algebraic functions and $g(x) \neq 0$;			A
17.6	Definite Integrals	17.6.1	define definite integral;	*		
		17.6.2	explain the terms integrand, limits of integration and variable of integration;		*	
		17.6.3	describe the trapezium rule to estimate the value of a definite integral;		FA	
		17.6.4	describe the fundamental theorem of integral calculus to recognise the following basic properties: a. $\int_a^a f(x)dx = 0,$ b. $\int_a^b f(x)dx = -\int_b^a f(x)dx,$ c. $\int_a^b f(x)dx = \int_a^c f(x)dx + \int_c^b f(x)dx,$ where $a < c < b,$ d. $\int_{-a}^{a} f(x)dx = \begin{cases} 2\int_0^a f(x)\,dx, & \text{when } f(-x) = f(x) \\ 0, & \text{when } f(-x) = -f(x) \end{cases}$;		*	
		17.6.5	evaluate definite integrals;			E

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				R	U	A and beyond
		17.6.6	describe the definite integral as the area under the curve with respect to the *x*-axis;		*	
		17.6.7	calculate the area under the curve using definite integrals;			A
17.7	Application of Definite Integrals	17.7.1	identify distance and speed as scalar quantities, and displacement, velocity, and acceleration as vector quantities;		*	
		17.7.2	determine the volume of revolution about one of the axes;			A
		17.7.3	interpret displacement–time graphs and velocity– time graphs;			An
		17.7.4	apply the concepts of integration to the real world problems involving the volume of a container and the growth rate of a population;			FA
17.8	Differential Equations	17.8.1	explain the concept of ordinary differential equation (ODE), order and degree of a differential equation;		*	
		17.8.2	construct first order differential equations from practical situations;			An
		17.8.3	solve differential equations of the first order and first degree by separating the variables;			A
		17.8.4	explain homogeneous function and homogeneous differential equations;		*	
		17.8.5	solve homogeneous differential equations of first order and first degree using suitable substitution;			FA
		17.8.6	solve word problems related to differentiation and integration, e.g., finding displacement from velocity and velocity from acceleration, population growth and decay;			A
		17.8.7	apply the concepts of mechanics to the real world problems involving motion of vehicles on roads and projectile motion.			A

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				R	U	A and beyond
18. Numerical Solution of Nonlinear Equations		Students should be able to:				
	18.1 Introduction	18.1.1	describe non-linear equations;		*	
		18.1.2	differentiate between linear and non-linear equations;		*	
	18.2 Solution of Nonlinear Equations	18.2.1	explain the basic principles of selection of initial roots for solving a non-linear equation in one variable;		*	
		18.2.2	explain the following three iterative methods of solving non-linear equations: a. bisection method, b. regular-falsi method, c. Newton Raphson method;		*	
		18.2.3	solve non-linear equations up to three iterations using the methods in SLO 18.2.3;			A
		18.2.4	apply the concepts of non-linear equations to the real world problems in chemical reactions and cryptography;			A
		18.2.5	estimate a root of an equation either graphically or by identifying a sign change;			E
		18.2.6	describe the order of accuracy;		*	
		18.2.7	analyse the order of accuracy of the methods mentioned in SLO 18.2.3.			An

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				R	U	A and beyond
19. Circles		Students should be able to:				
19.1	Introduction to Conics	19.1.1	describe conics and members of its family, i.e., circle, parabola, ellipse and hyperbola;		*	
19.2	Circle and its Equation	19.2.1	explain the circle and its elements;		*	
		19.2.2	derive the equation of a circle in standard form $(x-h)^2+(y-k)^2=r^2$;			A
		19.2.3	describe the general equation of a circle $x^2+y^2+2gx+2fy+c=0$;		*	
		19.2.4	find the centre and radius of a circle using the general and standard forms of the equation;			A
		19.2.5	sketch a circle when its elements are given;			A
		19.2.6	find the equation of a circle passing through: a. three non-collinear points, b. two points and having its centre on a given line, c. two points and equation of tangent at one of these points is known, d. two points and touching a given line, etc.;			A
		19.2.7	solve word problems related to circles;			A
19.3	Tangents and Normals to a Circle	19.3.1	determine the condition when a line intersects a circle;			A
		19.3.2	determine the condition when a line touches a circle;			A
		19.3.3	find the equation of a tangent to a circle in the slope-intercept form;			A
		19.3.4	find the equations of a tangent and a normal to a circle: a. at a given point on the circle, b. parallel to a given line, c. perpendicular to a given line;			A

Topics and Sub-topics	Student Learning Outcomes		Cognitive Level		
			R	U	A and beyond
	19.3.5	determine whether a point lies inside, on or outside a circle;			A
	19.3.6	determine the nature of tangents through the points: a. inside the circle (no real tangent), b. on the circle (one real tangent), c. outside the circle (two real tangents);			A
	19.3.7	calculate the length of the tangent to a circle from an external point to a circle.			A

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				R	U	A and beyond
20. Parabola		Students should be able to:				
20.1	Introduction to a Parabola	20.1.1	describe parabola and its elements;		*	
20.2	Equation of a Parabola	20.2.1	derive the general form and standard form of the equation of a parabola;			A
		20.2.2	find the elements of a parabola when its equation is given;			A
		20.2.3	sketch a parabola using its given elements;			A
		20.2.4	find the equation of a parabola using its given elements;			A
		20.2.5	solve problems related to parabolas;			A
20.3	Tangents and Normals to a Parabola	20.3.1	determine the condition for a line to be tangent to a parabola at a point;			A
		20.3.2	find the equations of a tangent and a normal to a parabola: a. at a given point on the parabola, b. parallel to a given line, c. perpendicular to a given line;			A
		20.3.3	solve problems related to the tangents and normals to a parabola;			A
20.4	Application of Parabola	20.4.1	apply the concepts of parabola to the real world problems involving: a. suspension (such as the shape of suspension bridge), b. reflection problems (such as the focus of parabolic reflectors).			A

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				R	U	A and beyond
21. Ellipse		Students should be able to:				
21.1	Introduction to an Ellipse	21.1.1	describe ellipse and its elements;		*	
		21.1.2	explain the concept that a circle is a special case of an ellipse, when the two foci coincide at the centre, and the major and minor axes are equal in length;		*	
21.2	Equation of an Ellipse	21.2.1	derive the standard form of the equation of an ellipse;			A
		21.2.2	find the equation of an ellipse using its given elements;			A
		21.2.3	find the elements of an ellipse by converting a given equation to its standard form;			A
		21.2.4	sketch an ellipse using the given elements;			A
		21.2.5	solve problems related to ellipse;			A
21.3	Tangents and Normals to an Ellipse	21.3.1	determine the points of intersection of an ellipse with a line and the condition of tangency;			A
		21.3.2	find the equation of the tangent and normal to an ellipse: a. at a given point on the ellipse, b. which is parallel to a given line, c. which is perpendicular to a given line;			A
21.4	Application of an Ellipse	21.4.1	apply the concepts of an ellipse to the real world problems: a. satellite orbit in space, b. elliptic motion of electrons in an atom around the nucleus.			A

Topics and Sub-topics		Student Learning Outcomes		Cognitive Level		
				R	U	A and beyond
22. Hyperbola		Students should be able to:				
22.1	Introduction to a Hyperbola	22.1.1	describe hyperbola and its elements;		*	
22.2	Equation of Hyperbola	22.2.1	derive the standard form of equation of a hyperbola;			A
		22.2.2	find the equation of a hyperbola using its given elements;			A
		22.2.3	find the elements of hyperbola given in SLO 22.2.1 by converting a given equation to its standard form;			A
		22.2.4	sketch a hyperbola using the given elements;			A
		22.2.5	solve problems related to hyperbola;			A
22.3	Tangents and Normals to a Hyperbola	22.3.1	determine the points of intersection of a hyperbola with a line, including the condition of tangency;			A
		22.3.2	find the equation of the tangent and normal to a hyperbola: a. at a given point on the hyperbola, b. parallel to a given line, c. perpendicular to a given line;			A
		22.3.3	solve problems related to tangents and normal to hyperbolas;			A
22.4	Application of Hyperbola	22.4.1	apply the concepts of hyperbola to the real world problems such as radio system used for hyperbolic functions.			A

Topics and Subtopics	Student Learning Outcomes		Cognitive Level		
			R	U	A and beyond
23. MAPLE	Students should be able to:				
23.1 Introduction	23.1.1	explain MAPLE integrated development environment;		FA	
	23.1.2	identify basic MAPLE commands;		FA	
	23.1.3	apply MAPLE as a calculator;			FA
	23.1.4	use online MAPLE help;			FA
23.2 Polynomials	23.2.1	apply MAPLE commands to: a. find the factors of a polynomial, b. expand an expression, c. simplify an expression, d. simplify a rational expression, e. find the value of an expression by substituting value;			FA
23.3 Graphics	23.3.1	apply MAPLE commands to: a. plot a two-dimensional graph, b. demonstrate domain and range of a plot, c. sketch parametric equations, d. use plotting options;			FA
23.4 Matrices	23.4.1	identify matrix and vector entry arrangement through MAPLE;		FA	
	23.4.2	apply matrix operations;			FA
	23.4.3	find the inverse and transpose of a matrix;			FA
23.5 Straight Lines	23.5.1	apply MAPLE graphic commands for two-dimensional plot of an expression (or a function);			FA
	23.5.2	apply MAPLE package plots for plotting different types of functions;			FA
23.6 Limits and Functions	23.6.1	evaluate the limit of a function using MAPLE command *limit*;			FA
	23.6.2	apply MAPLE command *iscont* to test continuity of a function at a point and in a given interval;			FA
23.7 Differentiation	23.7.1	differentiate a function using MAPLE command *diff*;			FA

Topics and Subtopics		Student Learning Outcomes		Cognitive Level		
				R	U	A and beyond
23.8	Higher Order Derivatives and their Applications	23.8.1	determine higher order derivative of a function using MAPLE command *diff* repeatedly;			FA
		23.8.2	apply MAPLE command *maximize* and *minimize* to compute; the maximum and minimum value of a function;			FA
23.9	Integrations	23.9.1	evaluate definite and indefinite integrals using MAPLE command *int*.			FA

NOTE:
MAPPLE exercises can be used as **Formative Assessment (FA)**.
MAPPLE is given zero weightage in examinations as per the National Curriculum Wing (Ministry of Education) of Pakistan.

Scheme of Assessment

Grade XI

Table 1: Exam Specifications

Topic No.	Topics	Marks Distribution		Total Marks
		MCQs	CRQs	
1.	Complex Numbers	5	Total 4 Marks (1 CRQ @ 4 Marks)	9
2.	Matrices and Determinants	6	Total 8 Marks Choose any TWO from THREE (3 CRQs @ 4 Marks each)	14
3.	Sequence and Series	6	Total 6 Marks Choose any TWO from THREE (3 CRQs @ 3 Marks each)	12
4.	Miscellaneous Series	3	-	03
5.	Permutation and Combination	5	Total 5 Marks (1 CRQ @ 5 Marks)	10
6.	Mathematical Induction and Binomial Theorem	5	Total 5 Marks Choose any ONE from TWO (2 CRQs @ 5 Marks each)	10
7.	Factor and Remainder Theorem	-	-	-
8.	Trigonometric Identities	5	Total 8 Marks (2 CRQs @ 4 Marks each)	13
9.	Trigonometric Functions and their graphs	6	Total 6 Marks Choose any TWO from THREE (3 CRQs @ 3 Marks each)	12
10.	Inverse Trigonometric Functions and Trigonometric Equations	4	Total 4 Marks (1 CRQ @ 4 Marks)	8
11.	Vectors	5	Total 4 Marks (1 CRQ @ 4 Marks)	9
	Total	**50**	**50**	**100**

Grade XII

Table 2: Exam Specifications

Topic No.	Topics	Marks Distribution		Total Marks
		MCQs	CRQs	
12.	Straight Line	8	Total 4 Marks (1 CRQ @ 4 Marks)	12
13.	Functions and Limits	8	Total 6 Marks (2 CRQs @ 3 Marks each)	14
14.	Differentiation	7	Total 8 Marks Choose any TWO from THREE (3 CRQs @ 4 Marks each)	15
15.	Higher Order Derivatives and their Applications	4	Total 4 Marks (1 CRQ @ 4 Marks)	8
16.	Vector Differentiation	3	-	3
17.	Integration	5	Total 10 Marks Choose any TWO from THREE (3 CRQs @ 5 Marks each)	15
18.	Numerical Solution of Nonlinear Equations	2	Total 4 Marks (1 CRQ @ 4 Marks)	6
19.	Circles	6	Total 6 Marks (2 CRQ @ 3 Marks)	12
20.	Parabola	7	Total 8 Marks Choose any TWO from THREE (3 CRQs @ 4 Marks each)	15
21.	Ellipse			
22.	Hyperbola			
23.	MAPLE	-	-	-
	Total	**50**	**50**	**100**

Examination Structure for Grades XI and XII

Theory:

- Multiple Choice Question (MCQ) requires candidates to choose one best/ correct answer from four options for each question. Each MCQ carries ONE mark.
- Constructed Response Question (CRQ) requires students to respond with a short text (few phrases/ sentences), calculations or diagrams.
- Table 1 and 2 contains the mark distribution for each topic.
- There will be two examinations, one at the end of grade XI and one at the end of grade XII.
- In each grade, the theory paper will be of 3 hours and will consist of two papers: paper I and paper II.
- Paper I theory will consist of 50 compulsories, multiple choice questions. These questions will involve four responses options. The answer sheet for paper I will be provided separately.
- Paper II theory will carry 50 marks and consist of Constructed Response Questions (CRQs).
- The booklet for paper II will serve as an answer script.

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