ASSESSMENT FRAMEWORK AND MODEL QUESTION PAPER

MATHEMATICS

Grade XII

NATIONAL CURRICULUM OF PAKISTAN
2022-23

FEDERAL BOARD
OF INTERMEDIATE AND SECONDARY
EDUCATION, ISLAMABAD

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FEDERAL BOARD OF INTERMEDIATE AND SECONDARY EDUCATION

H-8/4, ISLAMABAD

ASSESSMENT FRAMEWORK

FOR

MATHEMATICS GRADE-XII

CURRICULUM 2022-23

ACKNOWLEDGEMENT

It is a great honour that we, at the Federal Board of Intermediate and Secondary Education, have developed the Assessment Framework (AF) for the subject of Mathematics for Grade-XII. The primary objective of the AF is to optimize the current curriculum 2022-23. This comprehensive framework has been crafted meticulously by subject matter and assessment experts who conducted an in-depth review of all learning outcomes for Grade-XII Mathematics curriculum. They evaluated these outcomes in terms of their scope, cognitive level, and progression across the grade.

This significant undertaking was the result of a series of extensive meetings and collaborative efforts of the subject and assessment experts. Their dedication and expertise have been instrumental in bringing this framework to fruition.

The Assessment Framework will serve as a guiding document for students, teachers and paper setters. Students will receive clear directions for preparing themselves for the annual examination. Similarly, teachers will use it as a guide to understand what to teach in class and to prepare students for the final examinations accordingly. Similarly paper setters will also seek guidance from this document.

Following subject as well as assessment experts/committee members remained constantly engaged in the development of the AF:

1. Dr. Javed Iqbal, Principal, OPF Boys College, H-8, Islamabad
2. Dr. Muhammad Anwar Assistant Professor, Islamabad Model College for Boys, G-10/4, Islamabad
3. Mr. Anwar ul Haq, Assistant Professor, Bahria College, Naval Complex, E-8, Islamabad
4. Mr. Ali Raza, Assistant Professor, Islamabad Model College for Boys, F-8/4, Islamabad
5. Ms. Zohra Yousaf, HOD Math, Army Public School & College, Hamza Camp Rawalpindi

The whole work was successfully accomplished under the able supervision and guidance of Dr. Ikram Ali Malik, Chairman, FBISE and due to the hard work and dedication of the staff of Research Section of FBISE, in particular, Syed Zulfiqar Shah, Deputy Secretary, Research and Academics who played a pivotal and leading role in finalizing the Assessment Framework.

MIRZA ALI
Director (Test Development)
FBISE, Islamabad

ASSESSMENT FRAMEWORK FOR MATHEMATICS GRADE-XII, CURRICULUM 2022-23

To ensure clarity and precision in assessment, the learning outcomes have been categorized into two distinct groups: formative and summative. This classification helps in effectively measuring student progress and understanding. Each Student learning outcome (SLO) has been carefully marked as either formative or summative within the newly developed Assessment Framework. SLOs of Summative Assessment Format will be part of the Final Examination while SLOs of Formative Assessment will although be part of the teaching-learning activity but they will **NOT** be part of Final Examinations. Estimated cognitive levels i.e Knowledge (K), Understanding (U) and Application (A) of all the SLOs have also been indicated. It may be noted that all the higher cognitive levels have been collectively accumulated in the cognitive level of 'Application'. In subjects involving Practicals (Lab work), it has been mentioned categorically whether an SLO is summative for theory or summative for Practical Based Assessment (PBA). If an SLO is summative for PBA, it means that Laboratory work is required in the teaching-learning activity and it will be part of the Practical Examination/ Practical Based Assessment.

The Assessment Framework will act as a comprehensive guide for students, teachers and paper setters. Students will have clear instructions on how to prepare for the annual examinations. Teachers will use the framework to understand the curriculum and effectively prepare their students for the final examination. Additionally, paper setters will refer to this document for guidance in setting examination papers.

A model question paper has also been developed to provide a clear structure and format for upcoming examinations. The model question paper ensures consistency and fairness, offering students a comprehensive understanding of what to expect in their examinations. By aligning the paper with the Student Learning Outcomes (SLOs) of the curriculum, we ensured that the questions accurately reflect the skills and knowledge that students are expected to acquire.

A detailed Table of Specifications (ToS) has been created to ensure equitable coverage of cognitive levels and content domains in order to generate a balanced question paper. The ToS serves as drawing scale and action plan for the question paper, ensuring that all important areas of the curriculum are adequately and proportionately assessed.

FORMATIVE ASSESSMENT: AN ESSENTIAL COMPONENT OF EFFECTIVE LEARNING

Formative assessment is a pivotal element in the educational process, distinguished by its role in providing ongoing feedback to both students and educators. Unlike summative assessments, which evaluate student learning at the end of an instructional period, formative assessments are integrated into the learning process to monitor student understanding and guide instructional decisions.

The primary objective of formative assessment is to identify learning gaps and misunderstandings as they occur, enabling timely interventions. This dynamic approach allows teachers to adjust their teaching strategies to better meet the needs of their students. For instance, if a teacher notices through a quick quiz or class discussion that a significant portion of the class struggles with a particular concept, they can revisit that topic, providing additional explanations or alternative methods of instruction. This adaptability is crucial for fostering a deeper understanding of the material.

Formative assessments come in various forms, ranging from informal methods like classroom discussions, observations, and questioning, to more structured approaches such as quizzes, peer assessments, and self-reflections. These methods are not limited to paper-and-pencil tasks but can include digital tools that provide instant feedback. The versatility of formative assessments allows educators to cater to diverse learning styles and preferences, ensuring that all students are engaged and supported in their learning journey.

Formative assessment plays a significant role in creating a supportive classroom environment. It shifts the focus from merely achieving grades to understanding the learning process. This approach reduces the pressure on students, as they perceive assessments not as a final judgment of their abilities but as a part of their learning journey. Consequently, formative assessment can lead to increased student motivation and engagement.

In conclusion, formative assessment is a powerful tool that, when effectively implemented, can significantly enhance the learning experience. It provides invaluable insights for both teachers and students, promotes a growth-oriented learning environment, and supports the continuous development of essential skills. As education evolves, the role of formative assessment will undoubtedly continue to be central in fostering successful and meaningful learning experiences.

SUMMATIVE ASSESSMENT: EVALUATING LEARNING OUTCOMES IN THE FORM OF TERMINAL/FINAL EXAMINATION

Summative assessment is a fundamental component of the educational process, designed to evaluate student learning at the conclusion of an instructional period. Unlike formative assessment, which provides ongoing feedback during the learning process, summative assessment serves as a final measure of what students have learned. Typically administered at the end of a unit, course, or academic year. Summative assessment aims to determine the extent to which educational objectives have been achieved.

The primary purpose of summative assessment is to assess the overall effectiveness of instruction and learning. It provides a conclusive evaluation of student performance, often in the form of tests, final projects, or standardized exams. These assessments generate grades or scores that reflect a student's achievement in a given subject area over a specific period or time duration.

Summative assessment is often used to make critical decisions regarding student progression, certification, or placement in subsequent educational levels. Additionally, summative assessments provide valuable data that inform curriculum development and instructional strategies. By analyzing summative assessment results, educators can identify trends, strengths, and weaknesses within their instructional approaches, allowing for improvements in future teaching.

In conclusion, summative assessment plays a critical role in the educational process by providing a final evaluation of student learning. While it differs from formative assessment in its focus and application, it is an essential tool for measuring academic achievement. When balanced with formative assessments, summative assessments contribute to a well-rounded and effective approach to evaluating and supporting student learning.

National Curriculum of Pakistan 2022- 23

Assessment Framework

MATHEMATICS Grade-XII (HSSC-II)

Content Domain/ Area	Topics	SLO Number/ Description	Form of Assessment	Cognitive Level (Knowledge, Understanding, Application)	Remarks	Number of Periods required (1 period = 40 minutes)
A: Numbers and Algebra	**Functions and Graphs**	**[SLO: M-12-A-01]:** Recall • function as a rule of correspondence, • domain, co-domain and range of a function, • one to one and onto functions.	**Formative**	**Knowledge**	**Question(s) will not be asked in the annual examination; however, it will be part of regular teaching practice.**	2
		[SLO: M-12-A -02]: Know linear, quadratic and square root functions.	**Formative**	**Knowledge**	**Question(s) will not be asked in the annual examination; however, it will be part of regular teaching practice.**	
	Inverse Function	**[SLO: M-12-A-03]:** Define inverse functions and demonstrate their domain and range with examples.	Summative	Understanding	Question(s) will be asked in the annual examination	**2**
	Graphical Representation of Functions	**[SLO: M-12-A-04]:** Sketch graphs of linear functions (e.g., $y = ax + b$), non-linear functions (e.g., $y^2 = x$).	**Formative**	**Knowledge**	**Question(s) will not be asked in the annual examination; however, it will be part of regular teaching practice.**	6

Content Domain/ Area	Topics	SLO Number/ Description	Form of Assessment	Cognitive Level (Knowledge, Understanding, Application)	Remarks	Number of Periods required (1 period = 40 minutes)
		[SLO: M-12-A-05]: Plot the graph of the function $y = x^n$ where n is a • $+ve$ integer, • $-ve$ integer $(x \neq 0)$, • rational number for $x > 0$	**Formative**	**Knowledge**	**Question(s) will not be asked in the annual examination; however, it will be part of regular teaching practice.**	
		SLO: M-12-A-06]: Plot graph of quadratic function of the form $y = ax^2 + bx + c$, where a, b, c are integers and $a \neq 0$	**Formative**	**Knowledge**	**Question(s) will not be asked in the annual examination; however, it will be part of regular teaching practice.**	
		[SLO: M-12-A-07]: Draw graph using factors.	**Formative**	**Knowledge**	**Question(s) will not be asked in the annual examination; however, it will be part of regular teaching practice.**	
		[SLO: M-12-A-08]: Predict functions from their graphs (use the factor form to predict the equation of a function of the type $f(x) = ax^2 + bx + c$ (if two points where the graph crosses $x-axis$ and a third point on the curve are given).	Summative	Understanding	Question(s) will be asked in the annual examination	
	Intersecting Graphs	**[SLO: M-12-A-09]:** Find the intersecting point graphically when intersection occurs between	**Formative**	**Knowledge**	**Question(s) will not be asked in the annual**	7

Content Domain/ Area	Topics	SLO Number/ Description	Form of Assessment	Cognitive Level (Knowledge, Understanding, Application)	Remarks	Number of Periods required (1 period = 40 minutes)
		• a linear function and coordinate axes, • two linear functions, • a linear and a quadratic function.			**examination; however, it will be part of regular teaching practice.**	
		[SLO: M-12-A-10]: Solve graphically, appropriate problems from daily life.	**Formative**	**Application**	**Question(s) will not be asked in the annual examination; however, it will be part of regular teaching practice.**	
		[SLO: M-12-A-11]: Classify the functions as algebraic and transcendental functions.	**Formative**	**Knowledge**	**Question(s) will not be asked in the annual examination; however, it will be part of regular teaching practice.**	
		[SLO: M-12-A-12]: Describe various transcendental functions, such as: • Trigonometric functions, • Inverse trigonometric functions, • Logarithmic function, • Exponential function	Summative	Knowledge	Question(s) will be asked in the annual examination	
	Logarithmic Function	**[SLO: M-12-A-13]:** Demonstrate an understanding of logarithms.	Summative	Knowledge	Question(s) will be asked in the annual examination	2
		[SLO: M-12-A-14]: Derive and apply product, quotient, and power laws of logarithms.	Summative	Knowledge	Question(s) will be asked in the annual examination	

Content Domain/ Area	Topics	SLO Number/ Description	Form of Assessment	Cognitive Level (Knowledge, Understanding, Application)	Remarks	Number of Periods required (1 period = 40 minutes)
	Exponential Function	**[SLO: M-12-A-15]:** Graph and analyze exponential and logarithmic function. Apply the concept of exponential function to find compound interest.	Summative	Application	Question(s) will be asked in the annual examination	5
		[SLO: M-12-A-16]: Solve problems that involve exponential and logarithmic Equations.	Summative	Understanding	Question(s) will be asked in the annual examination	
		[SLO: M-12-A-17]: Identify the domain and range of fundamental transcendental functions.	Summative	Understanding	Question(s) will be asked in the annual examination	
	Graphical Representation	**[SLO: M-12-A-18]:** Draw the graph of modulus function.	**Formative**	**Knowledge**	**Question(s) will not be asked in the annual examination; however, it will be part of regular teaching practice.**	5
		[SLO: M-12-A-19]: Interpret the relation between a one-one function and its inverse through graph.	Summative	Understanding	Question(s) will be asked in the annual examination	
		[SLO: M-12-A-20]: Demonstrate the transformations of a graph through horizontal shift, vertical shift, and scaling.	Summative	Understanding	Question(s) will be asked in the annual examination	
	Limit of a Function	**[SLO: M-12-A-21]:** Demonstrate and find the limit of a sequence and a function.	Summative	Understanding	Question(s) will be asked in the annual examination	4
		[SLO: M-12-A-22]: State and apply theorems on limit of sum, difference, product and quotient of functions to algebraic, exponential and trigonometric functions.	Summative	Knowledge	Question(s) will be asked in the annual examination	
	Continuous and	**[SLO: M-12-A-23]:** Demonstrate and test Continuity, discontinuity of a function at a point and in an interval.	Summative	Understanding	Question(s) will be asked in the annual examination	8

Content Domain/ Area	Topics	SLO Number/ Description	Form of Assessment	Cognitive Level (Knowledge, Understanding, Application)	Remarks	Number of Periods required (1 period = 40 minutes)
	Discontinuous Functions	**[SLO: M-12-A-24]:** Apply concepts of transcendental functions, limit of a function and its continuity to real world problems such as (growth and decay, finance, economics, surveying, navigation, astronomy, growth rate of sales, rate of change in sales, predicting long-term stock prices).	Summative	Application	Question(s) will be asked in the annual examination	
		[SLO: M-12-A-25]: Calculate inflation over a period of time.	Summative	Understanding	Question(s) will be asked in the annual examination	
		[SLO: M-12-A-26]: Calculate depreciation with the help of straight-line method, sum of years digit method and production unit method.	Summative	Application	Question(s) will be asked in the annual examination	
	Gradient of a Curve	**[SLO: M-12-A-27]:** Recognize the meaning of the tangent to a curve at a point.	**Formative**	**Knowledge**	**Question(s) will not be asked in the annual examination; however, it will be part of regular teaching practice.**	6
		[SLO: M-12-A-28]: Calculate the gradient of a curve at a point.	Summative	Understanding	Question(s) will be asked in the annual examination	
		[SLO: M-12-A-29]: Identify the derivative as the limit of a difference quotient.	Summative	Knowledge	Question(s) will be asked in the annual examination	
		SLO: M-12-A-30]: Calculate the derivative of a given function at a point.	Summative	Understanding	Question(s) will be asked in the annual examination	
		[SLO: M-12-A-31]: Estimate the derivative as rate of change of velocity, temperature and profit.	Summative	Understanding	Question(s) will be asked in the annual examination	

Content Domain/ Area	Topics	SLO Number/ Description	Form of Assessment	Cognitive Level (Knowledge, Understanding, Application)	Remarks	Number of Periods required (1 period = 40 minutes)
	Derivative of a Function	**[SLO: M-12-A-32]:** Recognize the derivative function.	**Formative**	**Knowledge**	**Question(s) will not be asked in the annual examination; however, it will be part of regular teaching practice.**	3
		[SLO: M-12-A-33]: Find the derivative of a square root function.	Summative	Knowledge	Question(s) will be asked in the annual examination	
		[SLO: M-12-A-34]: Find the derivative of a quadratic function.	Summative	Knowledge	Question(s) will be asked in the annual examination	
	Differentiation Rules	**[SLO: M-12-A-35]:** State the connection between derivatives and continuity.	**Formative**	**Knowledge**	**Question(s) will not be asked in the annual examination; however, it will be part of regular teaching practice.**	8
		[SLO: M-12-A-36]: State, prove and apply the constant rule, the coefficient rule, the power rule, the sum and difference rule, the product rule, the quotient rule for differentiation.	Summative	Understanding	Question(s) will be asked in the annual examination	
		[SLO: M-12-A-37]: Extend the power rule to functions with negative exponents.	Summative	Knowledge	Question(s) will be asked in the annual examination	
		SLO: M-12-A-38]: Combine the differentiation rules to find the derivative of a polynomial or rational function.	Summative	Understanding	Question(s) will be asked in the annual examination	

Content Domain/ Area	Topics	SLO Number/ Description	Form of Assessment	Cognitive Level (Knowledge, Understanding, Application)	Remarks	Number of Periods required (1 period = 40 minutes)
		[SLO: M-12-A-39]: Apply rates of change to displacement, velocity and acceleration of an object moving along a straight line.	Summative	Application	Question(s) will be asked in the annual examination	
	Further on Differentiation	**[SLO: M-12-A-40]:** Find the derivative of trigonometric and inverse trigonometric functions.	Summative	Understanding	Question(s) will be asked in the annual examination	10
		[SLO: M-12-A-41]: Find the derivative of exponential functions.	Summative	Understanding	Question(s) will be asked in the annual examination	
		SLO: M-12-A-42]: Find the derivative of logarithmic functions.	Summative	Understanding	Question(s) will be asked in the annual examination	
		[SLO: M-12-A-43]: Apply differentiation to state the increasing and decreasing functions.	Summative	Application	Question(s) will be asked in the annual examination	
		[SLO: M-12-A-44]: Apply differentiation to find equations of tangent and normal to a curve at a point.	Summative	Application	Question(s) will be asked in the annual examination	
		[SLO: M-12-A-45]: Apply concepts of Differentiation to real world problems such as (profits on diminishing returns, environmental factors, financial investments, population growth, spread of diseases, movement of particles, time-speed in transportation, structural stress, material required viz a viz changes in construction).	Summative	Application	Question(s) will be asked in the annual examination	
	Higher Order Derivatives	**SLO: M-12-A-46]:** Find higher order derivatives of algebraic, implicit, parametric, trigonometric, inverse-trigonometric, exponential and logarithmic functions.	Summative	Understanding	Question(s) will be asked in the annual examination	2
	Applications of Derivatives	**[SLO: M-12-A-47]:** Describe the ability to approximate functions locally by linear functions.	Summative	Knowledge	Question(s) will be asked in the annual examination	4

Content Domain/ Area	Topics	SLO Number/ Description	Form of Assessment	Cognitive Level (Knowledge, Understanding, Application)	Remarks	Number of Periods required (1 period = 40 minutes)
		(Linear approximations of square root functions, trigonometric functions)				
		[SLO: M-12-A-48]: Explain differentials and draw a graph that illustrates the use of differentials to approximate the change in a quantity.	**Formative**	**Knowledge**	**Question(s) will not be asked in the annual examination; however, it will be part of regular teaching practice.**	
		[SLO: M-12-A-49]: Calculate the relative error and percentage error in using a differential approximation. (Volume of a cube and sphere)	Summative	Understanding	Question(s) will be asked in the annual examination	
	Extreme Values	**[SLO: M-12-A-50]:** Illustrate Global extrema (absolute extrema) and local extrema (relative extrema)	Summative	Understanding	Question(s) will be asked in the annual examination	6
		[SLO: M-12-A-51]: Find the extreme values by applying the second derivative test.	Summative	Application	Question(s) will be asked in the annual examination	
		[SLO: M-12-A-52]: Explain how to find the critical points of a function over a closed interval.	Summative	Understanding	Question(s) will be asked in the annual examination	
		[SLO: M-12-A-53]: Describe how to use critical points to locate absolute extrema over a closed interval.	Summative	Understanding	Question(s) will be asked in the annual examination	
		[SLO: M-12-A-54]: Apply derivatives to real-world problems to find the maximum and the minimum values of a function under certain conditions.	Summative	Application	Question(s) will be asked in the annual examination	
		[SLO: M-12-A-55]: Apply the concept of higher order derivatives to real life problems (such as transportation devices, cars, planes, roller coasters, rate of spread of a	Summative	Application	Question(s) will be asked in the annual examination	

Content Domain/ Area	Topics	SLO Number/ Description	Form of Assessment	Cognitive Level (Knowledge, Understanding, Application)	Remarks	Number of Periods required (1 period = 40 minutes)
		disease, rate of improvement of performance in psychology, automobiles, radar guns, economics).				
	Integration-I	**[SLO: M-12-A-56]:** Find the general antiderivative of a given function.	Summative	Understanding	Question(s) will be asked in the annual examination	16
		[SLO: M-12-A-57]: Recognize and use the terms and notations for antiderivatives.	**Formative**	**Knowledge**	**Question(s) will not be asked in the annual examination; however, it will be part of regular teaching practice.**	
		[SLO: M-12-A-58]: State the power rule for integrals.	**Formative**	**Knowledge**	**Question(s) will not be asked in the annual examination; however, it will be part of regular teaching practice.**	
		[SLO: M-12-A-59]: State and apply the properties of indefinite integrals.	Summative	Understanding	Question(s) will be asked in the annual examination	
		[SLO: M-12-A-60]: State the definition of the definite integral.	**Formative**	**Knowledge**	**Question(s) will not be asked in the annual examination; however, it will be part of regular teaching practice.**	
		[SLO: M-12-A-61]: Explain the terms integrand, limits of integration, and variable of integration.	**Formative**	**Knowledge**	**Question(s) will not be asked in the annual**	

Content Domain/ Area	Topics	SLO Number/ Description	Form of Assessment	Cognitive Level (Knowledge, Understanding, Application)	Remarks	Number of Periods required (1 period = 40 minutes)
					examination; however, it will be part of regular teaching practice.	
		[SLO: M-12-A-62]: State and apply the properties of definite integrals.	Summative	Understanding	Question(s) will be asked in the annual examination	
		[SLO: M-12-A-63]: State and apply Fundamental Theorem of Calculus to evaluate the definite integrals.	Summative	Application	Question(s) will be asked in the annual examination	
		[SLO: M-12-A-64]: Describe the relationship between the definite integral and net area.	**Formative**	**Knowledge**	**Question(s) will not be asked in the annual examination; however, it will be part of regular teaching practice.**	
		[SLO: M-12-A-65]: Find the area of a region bounded by a curve and lines parallel to axes, or between a curve and a line, or between two curves.	Summative	Application	Question(s) will be asked in the annual examination	
		[SLO: M-12-A-66]: Find Volume of revolution about one of the axes.	Summative	Understanding	Question(s) will be asked in the annual examination	
		[SLO: M-12-A-67]: Demonstrate trapezium rule to estimate the value of a definite integral.	Summative	Knowledge	Question(s) will be asked in the annual examination	
		[SLO: M-12-A-68]: Apply concepts of Integration to real world problems such as (volume of a container, consumer surplus and producer surplus, growth rate of a population, investment return time period, drug dosage required by integrating the concentration).	Summative	Application	Question(s) will be asked in the annual examination	

Content Domain/ Area	Topics	SLO Number/ Description	Form of Assessment	Cognitive Level (Knowledge, Understanding, Application)	Remarks	Number of Periods required (1 period = 40 minutes)
	Mechanics (Kinematics of motion in a straight line)	**[SLO: M-12-A-69]:** Recognize distance and speed as scalar quantities, and displacement, velocity and acceleration as vector quantities.	**Formative**	**Knowledge**	**Question(s) will not be asked in the annual examination; however, it will be part of regular teaching practice.**	8
		[SLO: M-12-A-70]: Sketch and interpret displacement-time graphs and velocity-time graphs.	Summative	Application	Question(s) will be asked in the annual examination	
		[SLO: M-12-A-71]: Use differentiation and integration with respect to time to solve simple problems concerning displacement, velocity and acceleration.	Summative	Application	Question(s) will be asked in the annual examination	
		[SLO: M-12-A-72]: Use appropriate formulae for motion with constant acceleration in a straight line.	Summative	Knowledge	Question(s) will be asked in the annual examination	
		[SLO: M-12-A-73]: Apply the concept of mechanics to real life problems (such as motion of vehicles on roads, Projectile motion, free fall motion, relative motion animation).	Summative	Application	Question(s) will be asked in the annual examination	
	Integration-II (Techniques of Integration)	**[SLO: M-12-B-74]:** Utilize trigonometric relationships to evaluate integrals.	Summative	Application	Question(s) will be asked in the annual examination	12
		[SLO: M-12-A-75]: Integrate functions involving the exponential and logarithmic functions.	Summative	Understanding	Question(s) will be asked in the annual examination	
		[SLO: M-12-A-76]: Identify when to use integration by parts to solve integration problems.	**Formative**	**Knowledge**	**Question(s) will not be asked in the annual examination; however, it will be**	

Content Domain/ Area	Topics	SLO Number/ Description	Form of Assessment	Cognitive Level (Knowledge, Understanding, Application)	Remarks	Number of Periods required (1 period = 40 minutes)
					part of regular teaching practice.	
		[SLO: M-12-A-77]: Apply the integration-by-parts formula for definite integrals.	Summative	Understanding	Question(s) will be asked in the annual examination	
		[SLO: M-12-A-78]: Solve integration problems involving trigonometric substitution.	Summative	Understanding	Question(s) will be asked in the annual examination	
		[SLO: M-12-A-79]: Integrate a rational function using the method of partial fractions.	Summative	Understanding	Question(s) will be asked in the annual examination	
		[SLO: M-12-A-80]: Apply concepts of integration to real life word problems (such as area between curves, average value of a function, distance velocity, acceleration, growth rate of population, moment of inertia, vector calculus to measure sensor network).	Summative	Application	Question(s) will be asked in the annual examination	
	Differential Equations	**[SLO: M-12-A-81]:** Identify and construct first order differential equations from practical situations. Solution of Differential Equation.	Summative	Application	Question(s) will be asked in the annual examination	6
		[SLO: M-12-A-82]: Solve separable differential equations of first order and first degree of the form • Separable variable equations • Homogeneous equations.	Summative	Understanding	Question(s) will be asked in the annual examination	
		[SLO: M-12-A-83]: Apply concepts of first order differential equations to real life word problems (such as population growth and decay, Cooling/Warming law, flow of electricity, series circuits, economics and finance, radioactive decay).	Summative	Application	Question(s) will be asked in the annual examination	

Content Domain/ Area	Topics	SLO Number/ Description	Form of Assessment	Cognitive Level (Knowledge, Understanding, Application)	Remarks	Number of Periods required (1 period = 40 minutes)
	Numerical Solution of Non-linear Equations	**[SLO: M-12-A-84]:** Analyze the searching of roots of an equation by graphical means and/or searching for the sign change.	Summative	Application	Question(s) will be asked in the annual examination	7
		[SLO: M-12-A-85]: Explain the basic principles of solving a in nonlinear equation one variable.	**Formative**	**Knowledge**	**Question(s) will not be asked in the annual examination; however, it will be part of regular teaching practice.**	
		[SLO: M-12-A-86]: Calculate real roots of a nonlinear equation in one variable by Bisection Method, Regula-Falsi Method, Newton Raphson Method.	Summative	Understanding	Question(s) will be asked in the annual examination	
		[SLO: M-12-A-87]: Apply concepts of nonlinear equations to real life word problems (such as chemical reactions, regulation of heart beats, electronic circuits, and cryptography).	Summative	Application	Question(s) will be asked in the annual examination	
B: Geometry	**Analytical Geometry (Concurrency of straight lines)**	**[SLO: M-12-B-01]:** Find the condition of concurrency of three straight lines.	Summative	Understanding	Question(s) will be asked in the annual examination	5
		[SLO: M-12-B-02]: Find the equation of median, altitude and right bisector of a triangle.	Summative	Understanding	Question(s) will be asked in the annual examination	
		[SLO: M-12-B-03]: Show that the • three right bisectors, • three medians, • three altitudes of a triangle are concurrent.	Summative	Understanding	Question(s) will be asked in the annual examination	

Content Domain/ Area	Topics	SLO Number/ Description	Form of Assessment	Cognitive Level (Knowledge, Understanding, Application)	Remarks	Number of Periods required (1 period = 40 minutes)
	Area of a Triangular Region	**[SLO: M-12-B-04]:** Find the area of a triangular region whose vertices are given.	Summative	Understanding	Question(s) will be asked in the annual examination	1
	Homogeneous Equations	**[SLO: M-12-B-05]:** Recognize homogeneous linear and quadratic equations in two variables.	**Formative**	**Knowledge**	**Question(s) will not be asked in the annual examination; however, it will be part of regular teaching practice.**	5
		[SLO: M-12-B-06]: Investigate that the 2nd degree homogeneous equation in two variables x and y represents a pair of straight lines through the origin and find an acute angle between them.	Summative	Understanding	Question(s) will be asked in the annual examination	
		[SLO: M-12-B-07]: Apply concepts of analytical geometry to real life world problems (such as aviation, to track stars, distance between planets and satellites, space science and engineering).	Summative	Application	Question(s) will be asked in the annual examination	
	Vector Valued Function	**[SLO: M-12-B-08]:** Explain the need for a vector valued function.	**Formative**	**Knowledge**	**Question(s) will not be asked in the annual examination; however, it will be part of regular teaching practice.**	4
		[SLO: M-12-B-09]: Construct vector valued function.	**Formative**	**Knowledge**	**Question(s) will not be asked in the annual examination; however, it will be**	

Content Domain/ Area	Topics	SLO Number/ Description	Form of Assessment	Cognitive Level (Knowledge, Understanding, Application)	Remarks	Number of Periods required (1 period = 40 minutes)
					part of regular teaching practice.	
		[SLO: M-12-B-10]: Identify domain and range of vector valued functions.	Summative	Knowledge	Question(s) will be asked in the annual examination	
		[SLO: M-12-B-11]: Identify difference between scalar and vector valued functions Derivative of Vector Function.	**Formative**	**Knowledge**	**Question(s) will not be asked in the annual examination; however, it will be part of regular teaching practice.**	
	Derivative of a Vector Function	**[SLO: M-12-B-12]:** Explain derivative of a vector function of a single variable and elaborate the result: If $f(t) = f_1(t)\hat{i} + f_2(t)\hat{j} + f_3(t)\hat{k}$ where $f_1(t)$, $f_2(t)$, $f_3(t)$ are differentiable functions of a scalar variable t, then $\frac{df}{dt} = \frac{df_1}{dt}\hat{i} + \frac{df_2}{dt}\hat{j} + \frac{df_3}{dt}\hat{k}$	Summative	Knowledge	Question(s) will be asked in the annual examination	5
		[SLO: M-12-B-13]: Apply vector differentiation to calculate velocity and acceleration of a position vector $f(t) = x(t)\hat{i} + y(t)\hat{j}$	Summative	Application	Question(s) will be asked in the annual examination	
		[SLO: M-12-B-14]: Apply concepts of vector valued functions to real life word problems (such as engineering and transportation).	Summative	Application	Question(s) will be asked in the annual examination	
	Inverse Trigonometric Functions	**[SLO: M-12-B-15]:** Find domains and ranges of principal trigonometric functions, inverse trigonometric functions.	Summative	Understanding	Question(s) will be asked in the annual examination	6

Content Domain/ Area	Topics	SLO Number/ Description	Form of Assessment	Cognitive Level (Knowledge, Understanding, Application)	Remarks	Number of Periods required (1 period = 40 minutes)
	Graphs of Inverse Trigonometric Functions	**[SLO: M-12-B-16]:** Draw the graphs of the inverse trigonometric functions of cosine, sine, tangent, secant, cosecant and cotangent within the domain from -2π to 2π .	Summative	Understanding	Question(s) will be asked in the annual examination	6
	Inverse Trigonometric Identities and Solution of Trigonometric Equations	**[SLO: M-12-B-17]:** State, prove and apply the addition and subtraction formulae of inverse trigonometric functions**.**	Summative	Understanding	Question(s) will be asked in the annual examination	12
		[SLO: M-12-B-18]: Solve trigonometric equations of the type Solve trigonometric equations of the type $sin\theta = k$, $cos\theta = k$ and, $tan\theta = k$ using periodic, even/odd and k, translation properties.	Summative	Understanding	Question(s) will be asked in the annual examination	
		[SLO: M-12-B-19]: Solve graphically the trigonometric equations of the type: $sin\theta = \frac{\theta}{2}, cos\theta = \theta, tan\theta = 2\theta$ where $-\frac{\pi}{2} < \theta < \frac{\pi}{2}$	Summative	Understanding	Question(s) will be asked in the annual examination	
		[SLO: M-12-B-20]: Use the periods of trigonometric functions to find the general solution of the trigonometric equations.	Summative	Understanding	Question(s) will be asked in the annual examination	
		[SLO: M-12-B-21]: Apply concepts of inverse trigonometric functions to real lifeworld problems (such as mechanical engineering, architecture to find the height of the building, angle of elevation and depression, identifying the angle of bridges to build scale models).	Summative	Application	Question(s) will be asked in the annual examination	
	Conics	**[SLO: M-12-B-22]:** Demonstrate conics and members of its family i.e., circle, parabola, ellipse and hyperbola	**Formative**	**Knowledge**	**Question(s) will not be asked in the annual examination;**	2

Content Domain/ Area	Topics	SLO Number/ Description	Form of Assessment	Cognitive Level (Knowledge, Understanding, Application)	Remarks	Number of Periods required (1 period = 40 minutes)
					however, it will be part of regular teaching practice.	
	Circle (Equation of a circle)	**[SLO: M-12-B-23]:** Derive and apply equation of a circle in standard form i.e., $(x-h)^2+(y-k)^2=r^2$	Summative	Understanding	Question(s) will be asked in the annual examination	5
		[SLO: M-12-B-24]: Find the equation of a circle passing through: three non collinear points, two points and having its centre on a given line, two points and equation of tangent at one of these points is known, two points and touching a given line.	Summative	Understanding	Question(s) will be asked in the annual examination	
	Tangent and Normal	**[SLO: M-12-B-25]:** Find the condition when: • a line intersects the circle. • a line touches the circle.	Summative	Understanding	Question(s) will be asked in the annual examination	5
		[SLO: M-12-B-26]: Find the equation of tangent: to a circle in slope form and a normal to circle at a point.	Summative	Understanding	Question(s) will be asked in the annual examination	
		[SLO: M-12-B-27]: Find the length of tangent to a circle from a given external point.	Summative	Understanding	Question(s) will be asked in the annual examination	
	Parabola	**[SLO: M-12-B-28]:** Derive and apply the standard equation of a parabola.	Summative	Understanding	Question(s) will be asked in the annual examination	6
		[SLO: M-12-B-29]: Sketch their graphs and find their elements.	Summative	Understanding	Question(s) will be asked in the annual examination	
		[SLO: M-12-B-30]: Find the equation of a parabola with the following given elements: focus and vertex, focus and directrix, vertex and directrix.	Summative	Understanding	Question(s) will be asked in the annual examination	

Content Domain/ Area	Topics	SLO Number/ Description	Form of Assessment	Cognitive Level (Knowledge, Understanding, Application)	Remarks	Number of Periods required (1 period = 40 minutes)
	Equations of Tangent and Normal	**[SLO: M-12-B-31]:** Find the condition when a line is tangent to parabola at a point and hence write the equation of a tangent line in slope form.	Summative	Understanding	Question(s) will be asked in the annual examination	4
		[SLO: M-12-B-32]: Find the equation of a tangent and a normal to a parabola at a point.	Summative	Understanding	Question(s) will be asked in the annual examination	
	Ellipse	**[SLO: M-12-B-33]:** Derive and apply the standard form of equation of an ellipse and identify its elements.	Summative	Understanding	Question(s) will be asked in the annual examination	5
		[SLO: M-12-B-34]: Convert a given equation to the standard form of equation of an ellipse, find its elements and draw the graph.	Summative	Understanding	Question(s) will be asked in the annual examination	
	Equations of Tangent and Normal	**[SLO: M-12-B-35]:** Find points of intersection of an ellipse with a line including the condition of tangency.	Summative	Understanding	Question(s) will be asked in the annual examination	5
		[SLO: M-12-B-36]: Find the equation of a tangent to an ellipse in point slope form.	Summative	Understanding	Question(s) will be asked in the annual examination	
		[SLO: M-12-B-37]: Find the equation of a tangent and a normal to an ellipse at a point.	Summative	Understanding	Question(s) will be asked in the annual examination	
	Standard Form of Equation of Hyperbola	**[SLO: M-12-B-38]:** Derive and apply the standard form of equation of a hyperbola and identify its elements.	Summative	Understanding	Question(s) will be asked in the annual examination	5
		[SLO: M-12-B-39]: Find the equation of a hyperbola with the following given elements: transverse and conjugate axes with centre at origin, two points, eccentricity, latera recta and transverse axes, focus, eccentricity and centre, focus, centre and directrix.	Summative	Understanding	Question(s) will be asked in the annual examination	

Content Domain/ Area	Topics	SLO Number/ Description	Form of Assessment	Cognitive Level (Knowledge, Understanding, Application)	Remarks	Number of Periods required (1 period = 40 minutes)
	Equations of Tangent and Normal	**[SLO: M-12-B-40]:** Find points of intersection of hyperbola with a line including the condition of tangency.	Summative	Understanding	Question(s) will be asked in the annual examination	5
		[SLO: M-12-B-41]: Find the equation of a tangent to a hyperbola in point slope form.	Summative	Understanding	Question(s) will be asked in the annual examination	
		[SLO: M-12-B-42]: Find the equation of a tangent and a normal to a hyperbola at a point.	Summative	Understanding	Question(s) will be asked in the annual examination	
		[SLO: M-12-B-43]: Apply concepts of conics to real life world problems (such as suspension and reflection problems related to parabola, Satellite system, elliptic movement of electrons in the atom around the nucleus, radio system uses as hyperbolic functions, flashlights, conics in architecture).	Summative	Application	Question(s) will be asked in the annual examination	
					Total	**215**

Federal Board HSSC-II Examination
Model Question Paper Mathematics
(Curriculum 2022-2023)

ROLL NUMBER					
0	0	0	0	0	0
1	1	1	1	1	1
2	2	2	2	2	2
3	3	3	3	3	3
4	4	4	4	4	4
5	5	5	5	5	5
6	6	6	6	6	6
7	7	7	7	7	7
8	8	8	8	8	8
9	9	9	9	9	9

Version No.			
0	0	0	0
1	1	1	1
2	2	2	2
3	3	3	3
4	4	4	4
5	5	5	5
6	6	6	6
7	7	7	7
8	8	8	8
9	9	9	9

Section - A (Marks 20)

Time Allowed: 25 minutes

Section – A is compulsory.
All parts of this section are to be answered on this page and handed over to the Centre Superintendent.
Deleting/overwriting is not allowed.
Do not use lead pencil.

Invigilator Sign. _____ **Candidate Sign.** _____

Q1. Fill the relevant bubble against each question. Each part carries ONE mark.

Sr No.	Question	A	B	C	D	A	B	C	D
i.	The inverse of $f(x)=\frac{x-1}{2}$ is:	$2x-1$	$2x+1$	$x-2$	$x+2$	O	O	O	O
ii.	For what value of x, $f(x)=\frac{x-2}{x^2-4}$ is discontinuous?	-2	-1	1	0	O	O	O	O
iii.	What is the derivative of $\left(\frac{\sin\alpha}{\sec x}\right)$ w. r. t. x?	$\sin\alpha \ \sin x$	$-\cos\alpha \ \cos x$	$-\sin\alpha \ \sin x$	$-\cos x \ \sin\alpha$	O	O	O	O
iv.	If $y=\sin x$, then what is the value of y_4?	$\sin x$	$\cos x$	$-\sin x$	$-\cos x$	O	O	O	O
v.	The absolute maximum value of $f(x)=-x^2+3x-2$ over $[1,3]$ is:	$\frac{3}{2}$	$\frac{1}{4}$	3	-2	O	O	O	O
vi.	What is the integrated value of $(3x+1)^5$ w.r.t. x?	$\frac{(3x+1)^6}{18}+C$	$\frac{(3x+1)^6}{6}+C$	$\frac{3(3x+1)^6}{6}+C$	$\frac{\left(\frac{3x^2}{2}+x\right)^6}{2}+C$	O	O	O	O
vii.	What evaluates $\int_{-a}^{a}(x^3+x)dx$?	$2\int_0^a(x^3+x)dx$	0	$\int_{-a}^{0}(x^3+x)dx$ $-\int_0^a(x^3+x)dx$	$\int_0^a(x^3+x)dx$	O	O	O	O
viii.	If $\int_2^4 f(x)\,dx=6$, then what results $\int_2^4[f(x)+3]dx$?	12	3	6	9	O	O	O	O

ix.	A car accelerates uniformly from rest and travels a distance of 100 m in 10 s. What is the acceleration of the car?	$1m/s^2$	$2m/s^2$	$4m/s^2$	$0.5m/s^2$	O O O O
x.	In which real-life scenario would the concept of first order differential equations be most applicable?	Predicting the speed of a moving car	Modeling the cooling of a hot beverage	Designing an electric circuit	Calculating the area of a triangle	O O O O
xi.	What is the next approximation, correct to two decimal places, for $f(x)=x^3-x^2+4x-4=0$ with an initial guess $x=2$ using the Newton-Raphson Method?	0.67	1.00	1.33	1.50	O O O O
xii.	If $a^2+b^2-c^2+2ab=0$, then family of straight lines $ax+by+c=0$ is concurrent at the points:	$(1,-1)$	$(-1,1)$	$(1,-2)$	$(1,1)$	O O O O
xiii.	The slope of a line perpendicular to a vertical line is:	0	1	-1	undefined	O O O O
xiv.	If $\vec{r}(t)=\ln(t-2)\hat{i}+\sqrt{4-t}\,\hat{j}+e^t\hat{k}$, then domain of $\vec{r}(t)$ is:	$t>2$	$2<t\leq 4$	$t\geq 2$	$t\in\mathcal{R}$	O O O O
xv.	If $\vec{V}(t)=\cos(t)\hat{i}+2\sin(2t)\hat{j}+3t\hat{k}$, then acceleration $\vec{a}$ in the same direction is:	$-\sin(t)\hat{i}+2\cos(2t)\hat{j}+3$	$-\sin(t)\hat{i}+4\cos(2t)\hat{j}+3t\hat{k}$	$-\sin(t)\hat{i}+2\cos(2t)\hat{j}+3\hat{k}$	$-\sin(t)\hat{i}+4\cos(2t)\hat{j}+3\hat{k}$	O O O O
xvi.	What is the principal value of $Cot^{-1}\left(-\sqrt{3}\right)$?	$-\frac{\pi}{6}$	$\frac{5\pi}{6}$	$-\frac{\pi}{3}$	$\frac{2\pi}{3}$	O O O O
xvii.	What is the general solution of the trigonometric equation $sin(x)=\frac{\sqrt{3}}{2}$?	$-\frac{\pi}{6}$	$\frac{\pi}{6}$	$\frac{\pi}{3}$	$-\frac{\pi}{3}$	O O O O
xviii.	If center of the circle $x^2+y^2+mx+ny+2=0$ lies at $(4,-8)$, then what is the value of $m+n$?	-8	-4	8	4	O O O O
xix.	For what value of a, line $2x-3y+6=0$ is tangent to the parabola $y^2=4ax$?	$-\frac{4}{3}$	$-\frac{3}{4}$	$\frac{4}{3}$	$\frac{3}{4}$	O O O O
xx.	If $x-y+\lambda=0$ is tangent to ellipse $\frac{x^2}{9}+\frac{y^2}{4}=1$, then value of λ is:	$\pm\sqrt{13}$	± 2	$\pm\sqrt{5}$	± 3	O O O O

Federal Board HSSC-II Examination
Model Question Paper Mathematics

(Curriculum 2022-2023)

Time allowed: 2.35 hours Total Marks: 80

Note: Answer all parts from Section 'B' and all questions from Section 'C' on the E-sheet. Write your answers on the allotted/given spaces.

SECTION – B (Marks 48)

$(12 \times 4 = 48)$

Q.2	Question	Marks		Question	Marks
i.	Draw the graph of the function $log_3 y = x$	4	***OR***	Solve the separable differential equation: $\frac{dy}{dx} = \frac{y^2 - 1}{x}$ Determine the general solution and express y in terms of x.	4
ii.	Evaluate: $\lim_{x \to 0} \left(\frac{\frac{1}{x-1} + \frac{1}{x+1}}{4x} \right)$	4	***OR***	Use the bisection method to approximate a root of the nonlinear equation: $f(x) = x^3 - x - 2$ in the interval $[1,2]$. Perform three iterations and find the following: a. The midpoint at each iteration. b. The value of $f(x)$ at the midpoint. c. The approximate root after three iterations.	4
iii.	Test the continuity of the function $f(x) = \begin{cases} 1-3x, & x < -3 \\ 5, & x = -3 \\ x^2, & x > -3 \end{cases}$ at $x = -3$	4	***OR***	A surveillance drone is flying along a straight path defined by the equation $3x + 4y - 12 = 0$, while a stationary communication tower is located at (2,3). a. Find the shortest distance between the drone's path and the communication tower. b. Interpret the result in the context of the real-world scenario.	4
iv.	If $y = x^3 \ln\left(\sqrt{x^2+1}\right)$, then find $\frac{dy}{dx}$.	4	***OR***	The second-degree homogeneous equation $4x^2 + 6xy + y^2 = 0$ represents a pair of straight lines passing through origin. Find an acute angle θ between the two lines.	4
v.	Use the second derivative test to determine whether each critical point corresponds to relative maxima, minima or neither, if $f(x) = 3x^5 - 5x^3 + 2$.	4	***OR***	If $\vec{r}(t) = e^{2t}\,\hat{i} + e^{-t}\,\hat{j} + e^{t}\,\hat{k}$ at $t = ln2$ is the position vector of a particle, then find its velocity and acceleration at the given value of t in the direction of motion.	4
vi.	Find the derivative of the function w.r.t.*x:* $f(x) = \text{Sin}^{-1}\left(\frac{x}{2}\right) + \text{Tan}^{-1}\left(\frac{\sqrt{4-x^2}}{x}\right)$.	4	***OR***	A drone is programmed to follow the path given by the position vector-valued function: $\vec{r}(t) = 5t\,\hat{i} + 3\sin(t)\,\hat{j} + 2\cos(t)\,\hat{k}$, $0 \le t \le 2\pi$ a. Determine the maximum distance the drone travels in the *y*-direction. b. At what time does the drone return to the $z = 0$ plane?	4
vii.	A stone is thrown in the air. Its height at any time t is given by $h = -5t^2 + 10t + 4$. Apply derivatives to find the maximum height of	4	***OR***	A hyperbola of eccentricity $\frac{5}{2}$ has one focus at $(1,-4)$. The corresponding	4

	the stone.			directrix is the line $y=2$. Find equation of the hyperbola.	
viii.	Find the area of the region enclosed between the curves $y=4-x^2$ and $y=x^2$.	4	***OR***	Draw the graph of $y=Cos^{-1}\left(\frac{1-x}{3}\right)$ where $x\in[0,2]$.	4
ix.	The region bounded by $y=x^2$ and $y=x+2$ is revolved around *x*-axis. Calculate the volume of a solid formed by the revolution of this region.	4	***OR***	Solve the trigonometric equation $2cos^2(x)-3cos(x)+1=0$ in the interval $[0,2\pi]$.	4
x.	A car starts from rest and accelerates along a straight road. The acceleration of the car is given by $a(t)=3t\,m/s^2, t\geq 0$ where t is time in seconds. a. Find the velocity $v(t)$ of the car at any time t, given that the initial velocity $v(0)=0$. b. Determine the displacement $s(t)$ of the car at any time t, given that the initial displacement $s(0)=0$.	4	***OR***	Find the equations of tangent and normal to the parabola $x^2=8y$ at a point $(4,2)$.	4
xi.	Estimate the value of the integral $I=\int_0^{\pi} sin(x)dx$, using the trapezium rule with 4 subintervals. Round your answer to 4 decimal places.	4	***OR***	Find the equation of a circle passing through two points $(2,6),(6,4)$ with its centre on the line $3x+2y-1=0$.	4
xii.	Evaluate: $\int \frac{dx}{x^2\sqrt{4-x^2}}$.	4	***OR***	Without using calculator, prove that $Csc^{-1}\left(\frac{2\sqrt{3}}{3}\right)-Csc^{-1}\left(\frac{2}{\sqrt{2}}\right)=\frac{\pi}{12}$	4

SECTION – C (Marks 32)

$(4\times 8=32)$

Note: Attempt all questions. Marks of each question are given.

Q. No.	Question	Marks		Question	Marks
Q3	$y=3e^{2x}+2e^{3x}$, then prove that $\frac{d^2y}{dx^2}-5\frac{dy}{dx}+6y=0$	8	***OR***	Evaluate: $\int \frac{x^2+x-2}{3x^3-x^2+3x-1}dx$	8
Q4	Given the vertices of a triangle A (2,3), B (8,7), and C (4,11): a. Find the equation of the altitude from vertex A. b. Find the equation of the right bisector of side BC. c. Verify that the altitude and the right bisector intersect on the circumcircle of the triangle.	8	***OR***	An engineer is designing a bridge over a river. The bridge will have an inclined ramp that forms an angle of elevation with the ground. The total height of the bridge at its peak is 20 meters, and the base of the ramp is 50 meters long. a. Determine the angle of elevation of the ramp using an appropriate inverse trigonometric function. b. If the engineer wants to increase the height of the bridge to 30 meters while keeping the base length constant, calculate the new angle of elevation.	8
Q5	Solve the first-order homogeneous differential equation: $(x^2+y^2)dx=2xydy$	8	***OR***	A satellite orbits Earth in an elliptic trajectory. The semi major axis of the ellipse is10000 km, and the semi minor axis is 8000 km. Find a. The eccentricity of the orbit	8

	Also, determine the particular solution that passes through the point (1,2).			b. The distance of the satellite from earth's centre at the closest point if earth is at one focus. c. The distance of the satellite from earth's centre at the farthest point.	
Q6	A runner accelerates uniformly from rest to a velocity of 8 m/s in 4 seconds, maintains this velocity for 6 seconds, and then decelerates uniformly to rest in 5 seconds. a. Sketch the velocity-time graph for this motion. b. Interpret the graph to determine: (i) The total time of motion. (ii) The total distance covered by the runner.	8	***OR***	A company's stock price $S(t)$ (in dollars) is modeled by the function: $S(t) = 50 + 20e^{-0.1t}$, where t is the time in years; a. Find the initial stock price. b. Determine the stock price after 5 years. c. Find the limit of $S(t)$ as $t \to \infty$. d. Determine the time at which the stock price reaches 60 dollars.	8

Federal Board HSSC-II Examination

Mathematics Model Question Paper

(Curriculum 2022-23)

Alignment of Questions with Student Learning Outcomes

OBJECTIVE PART
SECTION A

Q. No. (Part no.)	Content Area/ Domain	Student Learning Outcomes	Cognitive Level *	Allocated Marks
Q1(i)	Domain: Algebra	[SLO: M-12-A-03]: Define inverse functions and demonstrate their domain and range with examples.	**K**	**1**
Q1(ii)	Domain: Algebra	[SLO: M-12-A-23]: Demonstrate and test Continuity, discontinuity of a function at a point and in an interval. U	**U**	**1**
Q1(iii)	Domain: Algebra	[SLO: M-12-A-38]: Combine the differentiation rules to find the derivative of a polynomial or rational function.	**K**	**1**
Q1(iv)	Domain: Algebra	SLO: M-12-A-46]: Find higher order derivatives of algebraic, implicit, parametric, trigonometric, inverse-trigonometric, exponential and logarithmic functions.	**K**	**1**
Q1(v)	Domain: Algebra	[SLO: M-12-A-56]: Find the general antiderivative of a given function.	**U**	**1**
Q1(vi)	Domain: Algebra	[SLO: M-12-A-56]: Find the general antiderivative of a given function.	**K**	**1**
Q1(vii)	Domain: Algebra	[SLO: M-12-A-62]: State and apply the properties of definite integrals.	**A**	**1**
Q1(viii)	Domain: Algebra	[SLO: M-12-A-63]: State and apply Fundamental Theorem of Calculus to evaluate the definite integrals.	**A**	**1**
Q1(ix)	Domain: Algebra	[SLO: M-12-A-72]: Use appropriate formulae for motion with constant acceleration in a straight line.	**U**	**1**
Q1(x)	Domain: Algebra	[SLO: M-12-A-83]: Apply concepts of first order differential equations to real life word problems (such as population growth and decay, cooling / warming law, flow of electricity, series circuits, economics and finance, radioactive decay).	**A**	**1**
Q1(xi)	Domain: Algebra	[SLO: M-12-A-86]: Calculate real roots of a nonlinear equation in one variable by Bisection Method, Regula-Falsi Method, Newton Raphson Method.	**U**	**1**
Q1(xii)	Domain: Geometry	[SLO: M-12-B-01]: Find the condition of concurrency of three straight lines.	**U**	**1**
Q1(xiii)	Domain: Geometry	[SLO: M-12-B-02]: Find the equation of median, altitude and right bisector of a triangle.	**K**	**1**
Q1(xiv)	Domain: Geometry	[SLO: M-12-B-10]: Identify domain and range of vector valued functions.	**K**	**1**
Q1(xv)	Domain: Geometry	[SLO: M-12-B-13]: Apply vector differentiation to calculate velocity and acceleration of a position vector $f(t) = x(t)\hat{i} + y(t)\hat{j}$.	**A**	**1**
Q1(xvi)	Domain: Geometry	[SLO: M-12-B-15]: Find domains and ranges of principal trigonometric functions, inverse trigonometric functions.	**U**	**1**

Q1(xvii)	Domain: Geometry	[SLO: M-12-B-20]: Use the periods of trigonometric functions to find the general solution of the trigonometric equations.	**U**	**1**
Q1(xviii)	Domain: Geometry	[SLO: M-12-B-23]: Derive and apply equation of a circle in standard form i.e., $(x-h)^2+(y-k)^2=r^2$	**U**	**1**
Q1(xix)	Domain: Geometry	[SLO: M-12-B-32]: Find the equation of a tangent and a normal to a parabola at a point.	**U**	**1**
Q1(xx)	Domain: Geometry	[SLO: M-12-B-35]: Find the points of intersection of an ellipse with a line including the condition of tangency.	**U**	**1**

SUBJECTIVE PART
SECTION B & C

Q. No. (Part no.)	Content Area/ Domain	Description of Student Learning Outcomes	Cognitive Level *	OR	Content Area/ Domain	Description of Student Learning Outcomes	Cognitive Level *	Allocated Marks
Q2(i)	Domain: Algebra	[SLO: M-12-A-15]: Graph and analyze exponential and logarithmic function. Apply the concept of exponential function to find compound interest.	**K**	***OR***	Domain: Algebra	[SLO: M-12-A-82]: Solve separable differential equations of first order and first degree of - separable variable equations - Homogeneous equations.	**K**	**4**
Q2(ii)	Domain: Algebra	[SLO: M-12-A-22]: State and apply theorems on limit of sum, difference, product and quotient of functions to algebraic, exponential and trigonometric functions.	**A**	***OR***	Domain: Algebra	[SLO: M-12-A-86]: Calculate real roots of a nonlinear equation in one variable by bisection method, Regula-Falsi method, Newton-Raphson method.	**U**	**4**
Q2(iii)	Domain: Algebra	[SLO: M-12-A-23]: Demonstrate and test continuity, discontinuity of a function at a point and in an interval.	**U**	***OR***	Domain: Geometry	[SLO: M-12-B-07]: Apply concepts of analytical geometry to real life world problems (such as aviation, to track stars, distance between planets and satellites, space science and engineering).	**A**	**4**
Q2(iv)	Domain: Algebra	[SLO: M-12-A-42]: Find the derivative of logarithmic functions.	**K**	***OR***	Domain: Geometry	[SLO: M-12-B -06]: Investigate that the 2nd degree homogeneous equation in two variables x and y represents a pair of straight line through the origin and finds an acute angle between them.	**K**	**4**

Q2(v)	Domain: Algebra	[SLO: M-12-A-51]: Find the extreme values by applying the second derivative test.	**U**	***OR***	Domain: Geometry	[SLO: M-12-B-13]: Apply vector differentiation to calculate velocity and acceleration of a position vector $f(t) = x(t)\hat{i} + y(t)\hat{j}$	**A**	**4**
Q2(vi)	Domain: Algebra	[SLO: M-12-A-40]: Find the derivative of trigonometric and inverse trigonometric functions.	**K**	***OR***	Domain: Geometry	[SLO: M-12-B-14]: Apply concepts of vector valued functions to real life word problems (such as engineering and transportation).	**A**	**4**
Q2(vii)	Domain: Algebra	[SLO: M-12-A-54]: Apply derivatives to real-world problems to find the maximum and the minimum values of a function under certain conditions.	**A**	***OR***	Domain: Geometry	[SLO: M-12-B -39]: Find the equation of a hyperbola with the following given elements: transverse and conjugate axes with centre at origin, two points, eccentricity, latera recta and transverse axes, focus, eccentricity and centre, focus, centre and directrix.	**U**	**4**
Q2(viii)	Domain: Algebra	SLO: M-12-A-65]: Find the area of a region bounded by a curve and lines parallel to axes, or between a curve and a line, or between two curves.	**U**	***OR***	Domain: Geometry	[SLO: M-12-B-16]: Draw the graphs of the inverse trigonometric functions of cosine, sine, tangent, secant, cosecant and cotangent within the domain from -2π to 2π.	**U**	**4**
Q2(ix)	Domain: Algebra	[SLO: M-12-A-66]: Find Volume of revolution about one of the axes.	**K**	***OR***	Domain: Geometry	[SLO: M-12-B - 20]: Use the periods of trigonometric functions to find the general solution of the trigonometric equations.	**U**	**4**
Q2(x)	Domain: Algebra	[SLO: M-12-A-71]: Use differentiation and integration with respect to time to solve simple problems concerning displacement, velocity and acceleration.	**K**	***OR***	Domain: Geometry	[SLO: M-12-B-32]: Find the equation of a tangent and a normal to a parabola at a point.	**U**	**4**

Q2(xi)	Domain: Algebra	[SLO: M-12-A-67]: Demonstrate trapezium rule to estimate the value of a definite integral.	**U**	***OR***	Domain: Geometry	[SLO: M-12-B - 24]: Find the equation of a circle passing through: three non collinear points, two points and having its centre on a given line, two points and equation of tangent at one of these points is known, two points and touching a given line.	**U**	**4**
Q2(xii)	Domain: Algebra	[SLO: M-12-A-78]: Solve integration problems involving trigonometric substitution.	**U**	***OR***	Domain: Geometry	[SLO: M-12-B-17]: State, prove and apply the addition and subtraction formulae of inverse trigonometric functions.	**U**	**4**
Q3	Domain: Algebra	[SLO: M-12-A-46]: Find higher order derivatives of algebraic, implicit, parametric, trigonometric, inverse-trigonometric, exponential and logarithmic functions.	**U**	***OR***	Domain: Algebra	[SLO: M-12-A-79]: Integrate a rational function using the method of partial fractions.	**U**	**8**
Q4	Domain: Geometry	[SLO: M-12-B-02]: Find the equation of median, altitude and right bisector of a triangle.	**K**	***OR***	Domain: Geometry	[SLO: M-11-B-21]: Apply concepts of vectors in space to real world problems such as (design and execute optimal navigation paths in transportation and logistics, graphing complex 3D motion), vector operations in engineering and computer graphics, practical proficiency for work, flux, and circulation).	**A**	**8**
Q5	Domain: Algebra	[SLO: M-12-A-82]: Solve separable differential equations of first order and first degree of - separable variable equations - Homogeneous equations.	**K**	***OR***	Domain: Geometry	[SLO: M-12-B-43]: Apply concepts of conics to real life world problems (such as suspension and reflection problems related to parabola, Satellite system, elliptic movement of electrons in the atom around the nucleus, radio system uses as hyperbolic functions,	**A**	**8**

						flashlights, conics in architecture).		
Q6	Domain: Algebra	[SLO: M-12-A-70]: Sketch and interpret displacement-time graphs and velocity-time graphs.	**U**	***OR***	Domain: Algebra	[SLO: M-12-A-24]: Apply concepts of transcendental functions, limit of a function and its continuity to real world problems such as (growth and decay, finance, economics, surveying, navigation, astronomy, growth rate of sales, rate of change in sales, predicting long-term stock prices).	**A**	**8**

*Cognitive Level

K: Knowledge
U: Understanding
A: Application

Table of Specification

Model Paper Mathematics – Grade XII (HSSC-II)

Domain Title/ Content Area Cognitive Domain	Domain A: Numbers and Algebra	Domain B: Geometry	Total Marks	Percentage of Cognitive Domains
Knowledge	Q1(i)1, Q1(iii)1, Q1(iv)1, Q1(vi)1, Q2(i/f)4, Q2(iv/f)4, Q2(vi/f)4, Q2(ix/f)4, Q2(x/f)4, Q2(i/s)4, Q4(f)8, Q5(f)8 (44 marks)	Q1(xiii)1, Q1(xiv)1, Q2(iv/s)4, (06 marks)	50	28%
Understanding	Q1(ii)1, Q1(v)1, Q1(ix)1, Q1(xi)1, Q2(ii/f)4, Q2(iii/f)4, Q2(v/f)4, Q2(viii/f)4, Q2(xi/f)4, Q2(xii/f)4, Q2(ii/s)4, Q3(f)8, Q3(s)8, Q6(f)8 (56 marks)	Q1(xii)1, Q1(xvi)1, Q1(xvii) 1, Q1(xviii)1, Q1(xix)1, Q1(xx)1, Q2(vii/s)4, Q2(viii/s)4, Q2(ix/s)4, Q2(x/s)4, Q2(xi/s)4, Q2(xii/s)4, (30 marks)	86	48%
Application	Q1(vii)1, Q1(viii)1, Q1(x)1 Q2(vii/f)4, Q6(s)8 (15 marks)	Q1(xv)1, Q2(iii/s)4, Q2(v/s)4, Q2(vi/s)4, Q4(s)8, Q5(s)8, (29 marks)	44	24%
Total Marks	115	65	180	-
Total Percentages	64%	36%	-	100%

Note:

1 This ToS does not reflect policy, but it is particular to this model question paper.
2 Proportionate / equitable representation of the content areas may be ensured.
3 The percentage of cognitive domain is 20%, 50%, and 30% for knowledge, understanding, and application, respectively with ± **5%** variation.
4 While selecting alternative questions for SRQs and ERQs, it must be kept in mind that:

- Difficulty levels of both questions should also be same
- SLOs of both the alternative questions must be different

Key: Question Number (part/ first choice) marks example: **Q2 (i / f) 4**
Question Number (part/ second choice) marks example: **Q2 (i / s) 4**

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