MINISTRY OF PRIMARY AND SECONDARY EDUCATION

PURE MATHEMATICS SYLLABUS

FORMS 5 – 6

2024 – 2030

Curriculum Development Unit

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HARARE

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1.0 PREAMBLE

1.1 INTRODUCTION

In developing the Heritage-based Pure Mathematics syllabus form 5 to 6, attention was made to the need to provide continuity of Pure Mathematical concepts and lay foundations for further studies. It is meant for learners who have the ability and interest in studying Pure Mathematics. The two-year learning phase will provide learners with opportunities to apply pure mathematical concepts, principles and skills in other learning areas.

The intention is to provide wider opportunities for learners who wish to acquire competences in scientifically and technologically based areas required for the national human capital development needs and enterprising activities in the 21st century. In learning Pure Mathematics, learners should be helped to acquire a variety of skills, knowledge and processes, and develop positive attitude towards the learning area. These will enhance the ability to investigate and interpret numerical and spatial relationships as well as patterns that exist in mathematics and in the world in general. The syllabus also caters for learners with diverse needs to experience Pure Mathematics as relevant and worthwhile. It also desires to produce a learner with the ability to communicate mathematical ideas and information effectively.

1.2 RATIONALE

Pure Mathematics is the science of abstract concepts in the context of number, time, and space. It uses logic and reasoning to construct new mathematical structures by building on existing ones, and to discover new patterns within, and relationships among mathematical structures. Pure Mathematics is underpinned in abstraction and proof. Typically, the Pure Mathematician finds joy and fulfillment in the intrinsic value of her/his constructions and discoveries, with little or no regard to their applications in life. However, examples abound of instances where Pure Mathematics discoveries initially born and existing only in the abstract, have eventually been found to have important applications in life. These life examples are in the areas of Science, Technology and Engineering, as well as finance, banking and commerce, among others. Given the Pure Mathematician's interest and ability in abstraction and pattern discovery, such a professional is increasingly in demand in such activities as meteorology, investment forecasting, and risk analysis. The teaching and learning Pure Mathematics should not be construed as a luxury, but a 21st Century necessity.

The teaching and learning process in Pure Mathematics at the Form 5 and 6 levels is also expected to help learners to develop their confidence and sense of self fulfillment, collegiality and intellectual honesty, hence contributing to their growth in the acquisition of values.

1.3 SUMMARY OF CONTENT

The syllabus will cover the theoretical and practical aspects of Pure Mathematics. The learning area will cover: algebra, geometry and calculus.

1.4 ASSUMPTIONS

The syllabus assumes that the learner has:

1.4.1 passed at least one of the following at form 4: Mathematics, Pure Mathematics and Additional Mathematics
1.4.2 interest in studying pure mathematics form 5 and 6
1.4.3 ability to operate some ICT tools

1.5 CROSS CUTTING THEMES

The following are some of the cross-cutting themes in the teaching and learning of Pure Mathematics:

1.5.1 Disaster Risk Management
1.5.2 Climate Change
1.5.3 Environmental Management
1.5.4 Business Enterprise skills
1.5.5 Health and life skills

2.0 PRESENTATION OF SYLLABUS

The Pure Mathematics syllabus is a single document covering Forms 5 and 6. It contains the preamble, aims, syllabus objectives, syllabus topics, scope and sequence, competency matrix and assessment.

3.0 AIMS

This syllabus aims to enable learners to:

3.1 develop the abilities to reason logically, to communicate mathematically, and to learn co-operatively and independently
3.2 acquire enterprising skills through modelling, research and project-based learning
3.3 develop an appreciation of the applicability, creativity and power of pure mathematics in solving a broad range of problems
3.4 understand the nature of Pure Mathematics and its relationship to other branches of mathematics and STEM in general.
3.5 appreciate the use of I.C.T tools in solving pure mathematical problems
3.6 engage, persevere, collaborate and show intellectual honesty in performing tasks in pure mathematics, in the spirit of values

4.0 SYLLABUS OBJECTIVES

Learners should be able to:

4.1 make effective use of a variety of mathematical skills (including graphing, proving, modelling, finding pattern and problem solving) in the learning and application of pure mathematics.
4.2 communicate pure mathematical ideas and information, clearly and effectively
4.3 produce imaginative and creative work arising from pure mathematical ideas
4.4 choose appropriate strategies to construct arguments and proofs in both concrete and abstract settings
4.5 construct and use appropriate mathematical models in solving problems in life
4.6 demonstrate perseverance, diligence, cooperation and intellectual honesty.
4.7 use I.C.T tools to solve pure mathematical problems
4.8 conduct research projects including those related to enterprise

5.0 METHODOLOGY AND TIME ALLOCATION

5.1 METHODOLOGY

A constructivist-based teaching and learning approach is recommended for the Form 5 and 6 Pure Mathematics Syllabus. The theoretical basis for this approach is that: in a **conducive environment** with **appropriate stimuli**, learners' capacity to build on their **pre-requisite knowledge** and create new mathematical knowledge is enhanced. A **conducive environment** in this context is one that encourages: creativity and originality; a free exchange of ideas and information; inclusivity and respect for each other's' views, regardless of personal circumstances (in terms of, for example: gender, appearance, disability and religious beliefs); collaboration and cooperation; intellectual honesty; diligence and persistence; and Unhu/ Ubuntu /Vumunhu. This is particularly important in a learning area like mathematics, given the negative attitudes associated with its teaching and learning.

Providing **appropriate stimuli** has to do with posing relevant challenges that excite learners, and help to make learning Pure Mathematics an enjoyable, fulfilling experience. Such challenges could be posed in the form of problems that encourage learners to create new (to them) mathematical knowledge/ideas in line with the teacher expectations and even beyond. New knowledge acquired in such a manner tends to be deep rooted and meaningful to learners, hence enhancing their ability to apply it within the learning area and in life. Definitely spoon feeding is not and cannot be an appropriate stimulus, as it does not help learners to develop critical thinking, creativity, and the ability to think outside the box, which are critical for self-reliance, national sustainable development and global competitiveness. Learners need to be active participants and decision makers in the pure mathematics teaching and learning process, with the teacher playing an enabling/facilitator role.

Pre-requisite knowledge and skills refers to what the learners should already know and can do, which can form a strong basis on which to construct the expected new

knowledge. The Pure Mathematics teacher needs to carefully analyse the new concepts/principles she/he intends to introduce, identify the relevant pre-requisite knowledge, assess to identify any gaps, and take appropriate steps to fill such gaps.

The following, is a list of teaching and learning approaches that are consistent with, and supportive of the above approach:

5.1.1 Guided discovery
5.1.2 Group work
5.1.3 Interactive e-learning
5.1.4 Problem solving
5.1.5 Discussion
5.1.6 Modelling

5.2 TIME ALLOCATION

6 periods of 60 minutes each per week should be allocated.

6.0 TOPICS

The following topics will be covered from Form 5 to 6

6.1 Algebra
6.2 Geometry and vectors
6.3 Series and Sequences
6.4 Trigonometry
6.5 Calculus
6.6 Numerical methods
6.7 Complex numbers

7.0 SCOPE AND SEQUENCE

TOPIC 1: ALGEBRA

TOPIC	FORM 5	FORM 6
Indices and proportionality	• Rational indices • General laws of indices • Direct, inverse, joint and partial variations	
Polynomials	• Polynomial operations • Quadratic operations • Factor and remainder theorems	
Identities, Equations and Inequalities	• Identities • Equations • Partial fractions • Inequalities	
Functions	• Logarithmic functions • Exponential functions • Rational functions • Modulus functions	
Relations	• Relation • Domain, co-domain, and range • Functions • Types of function (injective, bijective, surjective) • Inverse • Composite function	
Matrices		• Basic operation (up to 3 x 3)

		• Determinant and inverse • Systems of linear equations • Transformations
Mathematical Induction		• Proof by Induction
Groups		• Binary operations • Basic properties of a group

TOPIC 2: GEOMETRY AND VECTORS

TOPIC	FORM 5	FORM 6
• Graphs and Coordinate geometry	• Curve sketching • Coordinate geometry • Parametric equations	
• Vectors (up to three dimensions)	• Vector notation • Vector operations • Types of vectors • Magnitude of a vector • Dot (scalar)product • Area of plane shapes	• Vector equation of a straight line • Equation of a plane • Cross product

TOPIC 3: SERIES AND SEQUENCES

TOPIC	FORM 5	FORM 6
Sequence	• Sequences • Arithmetic and Geometric progressions	
Series	• Σ, n! and $\binom{n}{r}$ notation • Arithmetic and Geometric progressions • Binomial expansion	• Standard results • Method of differences • Maclaurin's series • Taylor's series

TOPIC 4: TRIGONOMETRY

TOPIC	FORM 5	FORM 6
Plane Trigonometry	• Radians and degrees • Arc length • Sector area • Segments	
Trigonometrical Functions	• Graphs of Trigonometrical functions • Trigonometrical equations • Trigonometrical identities (excluding half angle identities)	

TOPIC 5: CALCULUS

TOPIC	FORM 5	FORM 6
Differentiation	• First principles differentiation • Polynomials, rational functions, natural logarithms, exponentials, trigonometrical functions • Sums, differences, products, quotients and composites • Implicit and parametric • Gradient, tangents, normals, rates of change and stationary points	
Integration	• Indefinite Integral of Polynomials, Rational functions, exponentials (e^{ax+b}), Trigonometrical functions with standard integrals and those that can be reduced to standard integral • Integration by recognition, by parts and by substitution • Definite Integral • Application of integration to areas and volumes	
1^{st} Order Differential equations		• Rates of change • Separation of Variables • Solution by Integration

TOPIC 6: NUMERICAL METHODS

TOPIC	FORM 5	FORM 6
Numerical Methods		• Errors • Iterative methods • Newton – Raphson method • Trapezium rule

TOPIC 7: COMPLEX NUMBERS

TOPIC	FORM 5	FORM 6
Complex Numbers	• Parts of a complex number • Conjugate, modulus and argument • Operations • Argand diagram	• Equations (up to order 5) • Polar form $(r(\cos\theta + i\sin\theta) = re^{i\theta})$ • Loci • deMoivre's Theorem • n^{th} roots of unit

FORM FIVE (5)

8.0 COMPETENCY MATRIX: FORM 5 SYLLABUS

TOPIC 1: ALGEBRA

SUB TOPIC	OBJECTIVES **Learners should be able to:**	CONTENT (knowledge, skills, values and attitudes)	SUGGESTED NOTES AND ACTIVITIES	SUGGESTED RESOURCES
Indices and proportionality	• state the laws of indices • use laws of indices to solve problems • solve problems involving direct, inverse, partial and joint variation	• Rational indices • General laws of indices • Direct, inverse, partial and joint variation	• Applying laws of indices to solve problems (including life problems) • Modelling situations involving variation and solving related problems	• ICT Tools • Relevant texts
Polynomials	• carry out polynomial operations of addition, subtraction, multiplication and division • complete the square of a quadratic polynomial • use the remainder and factor theorems	• Polynomial operations • Quadratic operations • Factor and remainder theorems	• Performing operations with polynomials including division • Completing the square and solving the related problems • Deriving factor and remainder theorems • Applying the factor and remainder theorems in solving problems	• ICT Tools • Relevant texts

Identities, Equations and Inequalities	• distinguish between equation and identities • solve simultaneous equations • decompose rational polynomials into partial fractions • use the discriminant to determine the number real roots of a quadratic equation • solve polynomial equations using the factor theorem • solve problems using factor and remainder theorem • solve inequalities	• Identities • Equations • Partial fractions • Inequalities	• Discussing the difference between identities and equations • Finding unknown coefficients in polynomials using identities • Solving simultaneous equations (at least one is linear and at most one quadratic) • Expressing rational polynomials in partial fractions (including improper fractions) • Determining the number of real roots of a quadratic equation using the discriminant • Solving problems using the discriminant • Stating and using factor and remainder theorem to solve equation • Solving problems involving inequalities (including rational inequalities) • Modelling situations involving equations and inequalities and solving related problems	• ICT Tools • Relevant texts
Functions	• define the function as a mapping • sketch simple graphs of functions for a given domain	• Logarithmic functions • Exponential functions • Rational functions • Modulus functions	• Discussing the function as a mapping • Sketching graphs of functions	• ICT Tools • Relevant texts

	• explain exponential growth and decay • solve equation of the form $a^x = b$, using logarithms • solve inequalities of the form $a^x \leq b$, or $a^x \geq b$, using logarithms • use logarithms to transform a given relationship to a linear form • describe the meaning of absolute value notation • solve equation and inequalities involving the absolute value		• Discussing examples of exponential growth and decay in life • Modelling situations to solve problems involving exponential growth and decay • Solving equations and inequalities using logarithms • Transforming given relationships to linear form to find unknown constants (including sketching linear graphs) • Modelling situations to solve problems involving the use of logarithms • Solving equations and inequalities involving the modulus function	
Relations	• define a relation • define domain, co-domain and range • describe types of relations • define a function • distinguish among the following types of functions: one to one, bijective and surjective	• Relation • Domain, co-domain, and range • Functions • Types of function (injective, bijective, surjective) • Inverse • Composite function	• Discussing relations, domain, co-domain and range • Describing types of relations • Defining a function • Discussing differences among the following types of functions: injective, bijective and surjective • Finding the inverse of a given function	• ICT Tools • Relevant Texts

	• find the inverse of a given function • illustrate in graphical terms the relation between a one-to-one function and its inverse • illustrate relationship amongst the graphs of y = f(x) and y = $\|f(x)\|, y = af(x), y = f(x) + a, y = f(x + a), y = f(ax)\ and\ y = af(x + b)$ • find composite functions		• Illustrating in graphical terms the relation between a one-to-one function and its inverse • Illustrating relationship amongst the graphs of y = f(x) and y = $\|f(x)\|, y = af(x), y = f(x) + a, y = f(x + a), y = f(ax)\ and\ y = af(x + b)$ • Finding composite functions	

TOPIC 2: GEOMETRY AND VECTORS

SUB TOPIC	OBJECTIVES **Learners should be able to:**	CONTENT (knowledge, skills, values and attitudes)	SUGGESTED NOTES AND ACTIVITIES	SUGGESTED RESOURCES
Graphs and Coordinate geometry	• sketch graphs of the form $y = f(x)$, where $f(x) = kx^n$ and $n = \frac{1}{2}$ or n is an integer, and where f(x) is a quadratic or cubic polynomial • locate solutions of equations and inequalities using sketches of graphs • find equations of parallel and perpendicular lines and distance between two points • reduce an equation to appropriate linear form in solving problems (such as $y = ax^2 + b$ when y is plotted against x^2) • find the equation of a circle • define a curve using parametric equations	• Curve sketching • Coordinate geometry • Parametric equations	• Sketching graphs of the form $y = f(x)$, where $f(x) = kx^n$ and $n = \frac{1}{2}$ or n is an integer, and where f(x) is a quadratic or cubic polynomial • Finding solutions of equations by sketching graphs • Exploring solutions of equations and inequalities by sketching graphs • Finding equations of parallel and perpendicular lines and distance between two points • Reducing equations to appropriate linear form in solving problems (such as $y = ax^2 + b$ when y is plotted against $x^{2)}$ • Finding equations of circles • Defining a curve using parametric equations	• ICT Tools • Relevant texts
Vectors (up to three dimensions)	• define position and free vector	• Vector notation • Vector operations • Types of vectors	• Discussing the use of position and free vectors in life • Carrying out vector operations	• ICT Tools • Relevant texts

SUB TOPIC	OBJECTIVES **Learners should be able to:**	CONTENT (knowledge, skills, values and attitudes)	SUGGESTED NOTES AND ACTIVITIES	SUGGESTED RESOURCES
	• carry out addition, subtraction and scalar multiplication of vectors • use unit, displacement and position vector to solve problems • calculate the magnitude of a vector and the scalar product of two vectors • use scalar product to find angle between two vectors • calculate the area of plane shapes using the dot product • solve problems involving vectors	• Magnitude of a vector • Dot (scalar) product • Area of plane shapes	• Using unit, displacement and position vectors to solve problems • Computing the magnitude of a vector and the scalar product of two vectors • Finding the angle between two vectors and perpendicularity of vectors using scalar product • Computing the area of plane shapes using the dot product • Solving problems involving vectors • Representing life phenomena using mathematical models involving vectors and exploring their applications in life	

TOPIC 3: SERIES AND SEQUENCES

SUB TOPIC	OBJECTIVES **Learners should be able to:**	CONTENT (knowledge, skills, values and attitudes)	SUGGESTED NOTES AND ACTIVITIES	SUGGESTED RESOURCES
Sequence	• define a sequence • use sequence definitions such as $U_n = n^2$ and $U_{n+1} = 2U_n$ to calculate successive terms • distinguish among periodic, oscillating, converging, and diverging sequences • define arithmetic and geometric progressions • find the general terms and other terms of arithmetic and geometric progressions	• Sequences • Arithmetic and geometric progressions	• Discussing the meaning and value of sequences in life • Calculating successive terms using sequence definition such as $U_n = n^2$ and $U_{n+1} = 2U_n$ • Discussing the behaviour of periodic, oscillating, converging, and diverging sequences • Discussing examples of arithmetic and geometric progressions • Finding the general terms and other terms of arithmetic and geometric progressions • Representing life phenomena using mathematical models involving sequences and exploring their applications in life	• ICT Tools • Relevant texts
Series	• use Σ, n! and $\binom{n}{r}$ notation • find the sum of given arithmetic and geometric terms	• Σ, n! and $\binom{n}{r}$ notation • Arithmetic and geometric progressions	• Using the Σ, n! and $\binom{n}{r}$ notation to solve problems • Computing the sum of given arithmetic and geometric terms	• ICT Tools • Relevant texts

SUB TOPIC	OBJECTIVES **Learners should be able to:**	CONTENT (knowledge, skills, values and attitudes)	SUGGESTED NOTES AND ACTIVITIES	SUGGESTED RESOURCES
	• find sum to infinity of given converging geometric series • expand expressions of $(a + b)^n$ where n is a positive integer, and of $(1 + x)^n$, where n is a rational number and $\|x\| < 1$	• Binomial expansion	• Finding sum to infinity of given converging geometric series • Expanding expressions of $(a + b)^n$ where n is a positive integer, and of $(1 + x)^n$, where n is a rational number and $\|x\| < 1$ • Representing life phenomena using mathematical models involving series and exploring their applications in life	

TOPIC 4: TRIGONOMETRY

SUB TOPIC	OBJECTIVES **Learners should be able to:**	CONTENT (knowledge, skills, values and attitudes)	SUGGESTED NOTES AND ACTIVITIES	SUGGESTED RESOURCES
Plane Trigonometry	• distinguish between radians and degrees • convert degrees to radians and vice versa • calculate arc length and sector area • solve problems involving lengths of arcs, areas of sectors and segments	• Radians and degrees • Arc length • Sector area • Segments	• Discussing the concept of radians and degrees, their relationships and the significance of using radians • Deriving and using the formulae for length of an arc and the area of a sector	• ICT Tools • Relevant texts

SUB TOPIC	OBJECTIVES **Learners should be able to:**	CONTENT (knowledge, skills, values and attitudes)	SUGGESTED NOTES AND ACTIVITIES	SUGGESTED RESOURCES
	• use small angle approximation for sin x , cos x and tan x		• Solving problems involving lengths of arcs, areas of sectors and segments • Recalling and using small angle approximation for sin x, cos x and tan x	
Trigonometrical Functions	• sketch the graphs of trigonometrical functions • transform the graphs of trigonometrical functions • sketch graphs of inverse trigonometrical relations • solve trigonometrical equations • prove trigonometrical identities • solve problems using trigonometrical identities	• Graphs of Trigonometrical functions • Trigonometrical equations • Trigonometrical identities (excluding half angle identities)	• Sketching and transforming the graphs of trigonometrical functions • Sketching and transforming graphs of inverse trigonometrical relations • Finding solutions of trigonometrical equations • Proving trigonometrical identities • Solving problems involving trigonometrical identities • Representing life phenomena using mathematical models involving trigonometrical functions and exploring their applications in life	• ICT Tools • Relevant texts

TOPIC 5: CALCULUS

SUB TOPIC	OBJECTIVES **Learners should be able to:**	CONTENT (knowledge, skills, values and attitudes)	SUGGESTED NOTES AND ACTIVITIES	SUGGESTED RESOURCES
Differentiation	• differentiate from first principles excluding logarithmic and exponential functions • differentiate polynomials, rational functions, natural logarithms, exponentials and trigonometrical functions • differentiate sums, differences, products, quotients and composite functions • carry out implicit and parametric differentiation • locate stationary points and distinguish between maxima, minima and point of inflexion • solve problems involving differentiation	• First principles differentiation • Polynomials, rational functions, natural logarithms, exponentials, trigonometrical functions • Sums, differences, products, quotients and composites • Implicit and parametric • Gradient, tangents, normals, rates of change and stationary points	• Differentiating from first principles: polynomials, rational functions, trigonometrical functions excluding logarithmic and exponential functions • Differentiating polynomials, rational functions, natural logarithms, exponentials and trigonometrical functions • Differentiating sums, differences, products, quotients and composite functions • Carrying out implicit and parametric differentiation • Locating stationary points and distinguishing between maxima, minima and point of inflexion • Solving problems involving differentiation • Representing life phenomena using mathematical models involving differentiation and	• ICT Tools • Relevant Texts

			exploring their applications in life	
Integration	• integrate polynomials, rational functions, exponentials, trigonometrical functions • integrate by recognition, by substitution and by parts • evaluate definite integrals • find areas and volumes	• Indefinite Integral of Polynomials, Rational functions, exponentials (e^{ax+b}), trigonometrical functions with standard integrals and those that can be reduced to standard integral • Integration by recognition, parts and substitution • Definite Integral • Application of integration to areas and volumes	• Finding Integrals of polynomials, rational functions, exponentials and trigonometrical functions • Integrating by recognition, by substitution and by parts • Evaluating definite integrals • Applying integration to find areas and volumes • Representing life phenomena using mathematical models involving integration and exploring their applications in life	• ICT Tools • Relevant texts

TOPIC 7: COMPLEX NUMBERS

SUB TOPIC	OBJECTIVES **Learners should be able to:**	CONTENT (knowledge, skills, values and attitudes)	SUGGESTED NOTES AND ACTIVITIES	SUGGESTED RESOURCES
Complex Numbers	• find the conjugates, moduli and arguments of complex numbers • carry out operations with complex numbers • represent complex numbers on an Argand diagram	• Parts of a complex number • Conjugate, modulus and argument • Operations • Argand diagram	• Finding conjugates, modulus and argument of complex numbers • Adding, subtracting, multiplying and dividing complex numbers • Representing complex numbers on an Argand diagram • Interpreting geometric effects of: - conjugating a complex number - adding, subtracting, multiplying and dividing complex numbers	• ICT Tools • Relevant Texts

FORM SIX (6)

8.0 COMPETENCY MATRIX: FORM 6 SYLLABUS

TOPIC 1: ALGEBRA

SUB TOPIC	OBJECTIVES **Learners should be able to:**	CONTENT (knowledge, skills, values and attitudes)	SUGGESTED NOTES AND ACTIVITIES	SUGGESTED RESOURCES
Matrices	• carry out basic operations of matrices • calculate determinant of a square matrix (up to 3 x 3) • identify null matrix, identity matrix, singular and non-singular matrix • find inverse of a 3 x 3 non-singular matrix • apply the result $(AB)^{-1}= B^{-1}A^{-1}$ for non-singular matrices to solve problems • construct 2 x 2 matrices to represent enlargement, rotation, reflection, stretch and shear transformations • use a 2 x 2 matrix to represent certain geometrical transformation in the x – y plane • use the composite transformation AB and A^n in problem solving	• Basic operation (up to 3 x 3) • Determinant and inverse • Systems of linear equations • Transformations	• Adding, subtracting and multiplying matrices • Calculating determinant of a square matrix (up to 3 x 3) • Discussing null matrix, identity matrix, singular and non-singular matrix • Finding inverse of 3 x 3 non-singular matrices • Using the result $(AB)^{-1}= B^{-1}A^{-1}$ for non-singular matrices to solve problems • Constructing 2 x 2 matrices to represent enlargement, rotation, reflection, stretch and shear transformations • Using a 2 x 2 matrix to represent certain geometrical transformations in the x – y plane • Using the composite transformation AB and A^n in problem solving	• ICT Tools • Relevant Text

	• derive the relationship between the area scale-factor of a transformation and the determinant of the corresponding matrix • solve simultaneous equations in 2 or 3 unknowns by reducing them to the matrix equation form (A**X** =**b**)		• Deriving and discussing the relationship between the area scale-factor of a transformation and the determinant of the corresponding matrix • Solving simultaneous equations in 2 or 3 unknowns by reducing them to the matrix equation form (A**x** =**b**) • Representing life phenomena using mathematical models involving matrices and exploring their applications in life	
Mathematical Induction	• describe the process of mathematical induction • prove by mathematical induction to establish a given result • use the strategy of conducting limited trials to formulate a conjecture and proving it by the method of induction	• Proof by Induction • Conjecture	• Discussing the processes of mathematical induction • Proving by mathematical induction to establish given results • Using the strategy of conducting limited trials to formulate conjecture and proving it by the method of induction	• ICT Tools • Relevant Texts
Groups	• define a binary operation • define closure, commutation, association, distribution, identity and inverse element • define a group • use the basic properties to show that a given structure is, or is not, a group	• Binary operations • Basic properties of a group	• Defining a binary operation • Discussing closure, commutation, association, distribution, identity and inverse element • Discussing a group	• ICT Tools • Relevant Texts • Relevant Texts

	• solve problems involving binary operations and properties of a group		• Using the basic properties to show that a given structure is, or is not, a group • Solving problems involving binary operations and properties of a group	

TOPIC 2: GEOMETRY AND VECTORS

SUB TOPIC	OBJECTIVES Learners should be able to:	CONTENT (knowledge, skills, values and attitudes)	SUGGESTED NOTES AND ACTIVITIES	SUGGESTED RESOURCES
Vectors (up to three dimensions)	• find vector and cartesian equations of a straight line in 3D • find cross product of given vectors • use cross product to find area of plane shapes • find vector, parametric and cartesian equations of a plane • find the angle between two lines, two planes and a line and a plane • determine whether two lines are parallel, intersecting or skewed	• Vector equation of a straight line • Equation of a plane • Cross product	• Finding vector and cartesian equations of a straight line in 3D • Finding cross product of given vectors • Using cross product to find area of plane shapes • Finding vector, parametric and cartesian equations of a plane • Finding the angle between two lines, two planes and a line and a plane • Determining whether two lines are parallel, intersecting or skewed	• ICT Tools • Relevant texts

SUB TOPIC	OBJECTIVES **Learners should be able to:**	CONTENT (knowledge, skills, values and attitudes)	SUGGESTED NOTES AND ACTIVITIES	SUGGESTED RESOURCES
	• find point of intersection of two lines if they intersect • find the perpendicular distance from a point to a straight line and the coordinates of the foot of the perpendicular • determine whether a line lies in a plane, is parallel to the plane, or intersects a plane • find the point of intersection of a line and a plane • find the line of intersection of two planes • find the perpendicular distance from a point to a plane • solve problems involving lines and planes		• Finding the point of intersection of two lines if they intersect • Finding the perpendicular distance from a point to a straight line and the coordinates of the foot of the perpendicular • Determining whether a line lies in a plane, is parallel to the plane, or intersects a plane • Finding the point of intersection of a line and a plane • Finding the line of intersection of two planes • Finding the perpendicular distance from a point to a plane • Solving problems involving lines and planes • Representing life phenomena using mathematical models involving vectors and exploring their applications in life	

TOPIC 3 SERIES AND SEQUENCES

SUB TOPIC	OBJECTIVES **Learners should be able to:**	CONTENT (knowledge, skills, values and attitudes)	SUGGESTED NOTES AND ACTIVITIES	SUGGESTED RESOURCES
Series	• use standard results for Σr, Σr^2 and Σr^3 to find related sums • use the method of differences to obtain the sum of finite series • use Taylor's and Maclaurin's series • solve problems involving method of differences as well as Taylor's and Maclaurin's series	• Standard results • Method of differences • Maclaurin's series • Taylor's series	• Finding related sums using standard results for Σr, Σr^2 and Σr^3 • Obtaining the sum of finite series using the method of differences • Using Taylor's and Maclaurin's series • Solving problems involving method of differences as well as Taylor's and Maclaurin's series • Representing life phenomena using mathematical models involving series and exploring their applications in life	• ICT Tools • Relevant Texts

TOPIC 5: CALCULUS

SUB TOPIC	OBJECTIVES **Learners should be able to:**	CONTENT	SUGGESTED NOTES AND ACTIVITIES	SUGGESTED RESOURCES

		(knowledge, skills, values and attitudes)		
1st Order Differential equations	• formulate a statement involving a rate of change as a differential equation • solve differential equations by integration in the case where variables are separable • sketch typical examples of a family of curves representing a general solution of a differential equation • find a particular solution of a differential equation given initial conditions • solve problems involving 1st order differential equation	• Rates of change • Separation of Variables • Solution by Integration	• Formulating statements involving rates of change as differential equations • Solving differential equations by integration in the case where variables are separable • Sketching typical examples of a family of curves representing a general solution of a differential equation • Finding particular solutions of differential equations given initial conditions • Solving problems involving 1st order differential equations • Representing life phenomena using mathematical models involving 1st order differential equations and exploring their applications in life	• ICT Tools • Relevant Texts

TOPIC 6: NUMERICAL METHODS

SUB TOPIC	OBJECTIVES **Learners should be able to:**	CONTENT (knowledge, skills, values and attitudes)	SUGGESTED NOTES AND ACTIVITIES	SUGGESTED RESOURCES
Numerical Methods	• define error • distinguish between absolute error and relative error • estimate errors in calculation including the use of $\partial y \approx \frac{dy}{dx}\partial x$ • locate approximately the root of an equation by graphical means or sign change • derive a converging iterative formula for solving a given equation • solve the equation using iterative procedure • derive the Newton – Raphson formula • solve equations using the Newton – Raphson method • recognise cases where the iterative method may fail to converge to the required root • solve problems involving the use of iterative procedures in root finding • derive the trapezium rule	• Errors • Iterative methods • Newton – Raphson method • Trapezium rule	• Defining error • Distinguishing between absolute error and relative error • Estimating errors in calculations including the use of $\partial y \approx \frac{dy}{dx}\partial x$ • Locating approximately the root of an equation by graphical means or sign change • Deriving a converging iterative formula for solving a given equation • Solving equations using iterative procedure • Deriving the Newton – Raphson formula • Solving equations using the Newton – Raphson method • Recognising cases where the iterative method may fail to converge to the required root	• ICT Tools • Relevant Texts • Environment

SUB TOPIC	OBJECTIVES **Learners should be able to:**	CONTENT (knowledge, skills, values and attitudes)	SUGGESTED NOTES AND ACTIVITIES	SUGGESTED RESOURCES
	• estimate the area under a curve using the trapezium rule • explain how to set bounds for the area under the curve using rectangle or trapezia • solve problems involving the trapezium rule		• Solving problems involving the use of iterative procedures in root finding • Deriving the trapezium rule • Estimating the area under a curve using the trapezium rule • Explaining how to set bounds for the area under the curve using rectangle or trapezia • Solving problems involving the trapezium rule • Representing life phenomena using mathematical models involving numerical methods and exploring their applications in life	

TOPIC 7: COMPLEX NUMBERS

SUB TOPIC	OBJECTIVES **Learners should be able to:**	CONTENT (knowledge, skills, values and attitudes)	SUGGESTED NOTES AND ACTIVITIES	SUGGESTED RESOURCES

Complex Numbers	• solve polynomial equations with at least one pair of non- real roots • express complex numbers in polar form • carry out division and multiplication of complex numbers expressed in polar form • illustrate equations and inequalities involving complex numbers by means of loci in an Argand diagram • derive the deMoivre's Theorem • prove the deMoivre's Theorem • prove trigonometrical identities using deMoivre's Theorem • solve equations using the deMoivre's Theorem • solve problems involving complex numbers	• Equations (up to order 5) • Polar form ($r(\cos\theta + i\sin\theta) = re^{i\theta}$) • Loci • deMoivre's Theorem • n^{th} roots of unit	• Solving polynomial equations with at least one pair of non- real roots • Expressing complex numbers in polar form • Dividing and multiplying complex numbers expressed in polar form • Illustrating equations and inequalities involving complex numbers by means of loci in an Argand diagram • Deriving and discussing the deMoivre's Theorem • Proving the deMoivre's Theorem • Proving trigonometrical identities using deMoivre's Theorem • Solving equations using the deMoivre's Theorem • Solving problems involving complex numbers • Representing life phenomena using mathematical models involving complex numbers and exploring their applications in life	• ICT Tools • Relevant Texts

9.0 ASSESSMENT

The Heritage-based Pure Mathematics syllabus learning area for form 5 and 6 shall be assessed through School Based Continuous Assessment (SBCA) and Summative Assessment (SA). These assessments shall be guided by the principles of inclusivity, practicability, authenticity, transparency, flexibility, validity and reliability. The principles are crucial for creating a supportive and effective learning environment that fosters growth and development in learners at secondary school level. Arrangements, accommodations and modifications shall be visible to enable candidates with special needs to access assessments.

This section covers the assessment objectives, the assessment model, the scheme of assessment, and the specification grid.

9.1 Assessment Objectives

By the end of the Heritage-based Pure Mathematics syllabus learning area for form 5 and 6, learners will be assessed on their ability to:

9.1.1 make effective use of a variety of mathematical skills (including graphing, proving, modelling, finding pattern and problem solving) in the learning and application of pure mathematics.
9.1.2 communicate pure mathematical ideas and information, clearly and effectively
9.1.3 produce imaginative and creative work arising from pure mathematical ideas
9.1.4 choose appropriate strategies to construct arguments and proofs in both concrete and abstract settings
9.1.5 construct and use appropriate mathematical models in solving problems in life
9.1.6 demonstrate perseverance, diligence, cooperation and intellectual honesty.
9.1.7 use I.C.T tools to solve pure mathematical problems
9.1.8 conduct research projects including those related to enterprise

9.2 Assessment Model

Assessment of learners at Upper Secondary School Level for Heritage-based Pure Mathematics Syllabus shall be both Continuous and Summative as illustrated in Figure 1. School Based Continuous Assessment shall include recorded activities from the School Based Projects done by the learners. The mark shall be included on learners' end of term and year reports. Summative assessment at school level shall include terminal examinations which are at the end of the term and year.

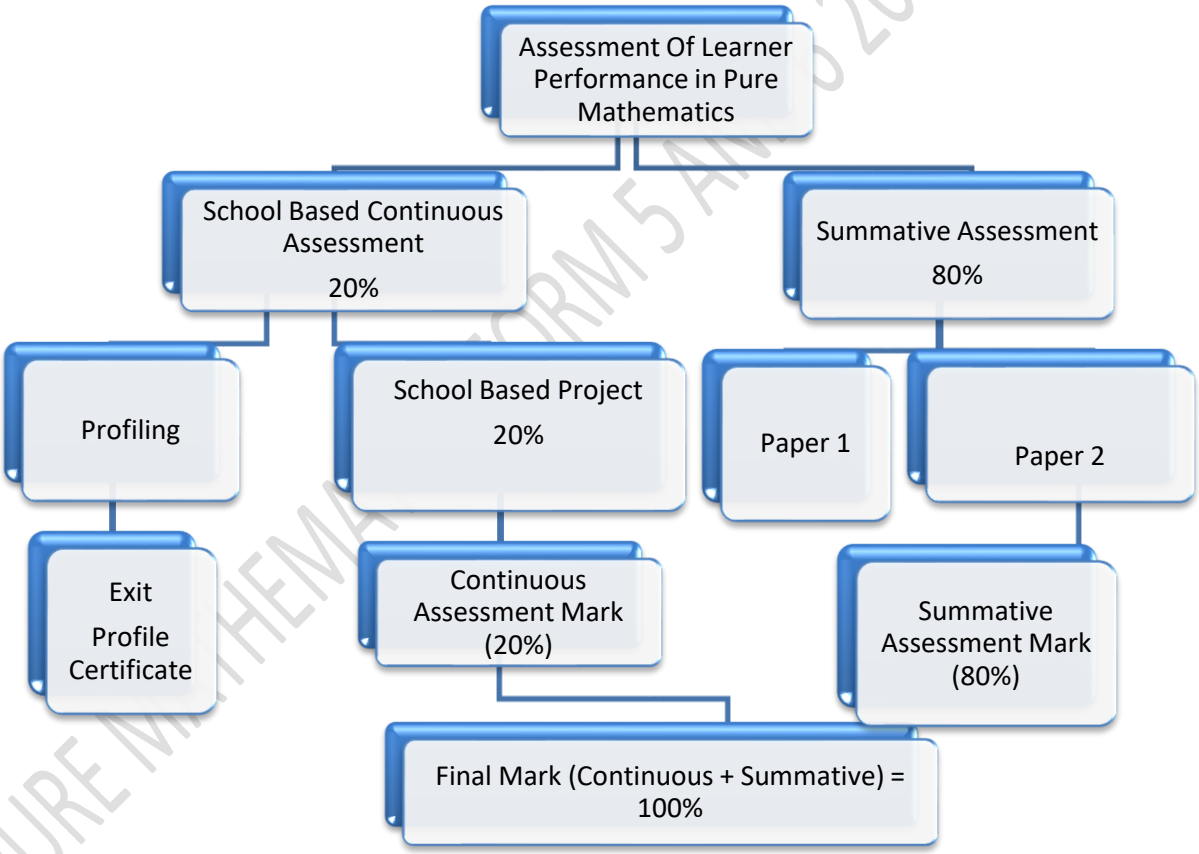

Fig. 1 Assessment Model

In addition, learners shall be profiled and learner profile records established. Learner profile certificates shall be issued for checkpoints assessment in schools as per the dictates of the Teacher's Guide to Learning and Assessment. The aspects to be profiled shall include

learner's prior knowledge, values and skills, and subsequently the new competences acquired at any given point.

9.3 Scheme of Assessment

The Assessment Model shows that learners shall be assessed using both School Based Continuous Assessment and Summative Assessment for both School and ZIMSEC assessments.

The table shows the Scheme of Assessment where 20% is allocated to School Based Continuous Assessment and 80% to School or ZIMSEC Summative Assessment.

FORM OF ASSESSMENT	WEIGHTING
School Based Continuous Assessment	**20%**
Summative Assessment	**80%**
Total	**100%**

9.3.1 Description of School Based Continuous Assessment

Learners shall do one school-based project per form which contributes to 20% of the end of year final mark. The end of year summative assessment shall then contribute 80%. However, for ZIMSEC public examinations, two (2) school-based projects shall be considered as School Based Continuous Assessment at form 6. The two School Based Projects shall include those done during form 5 and 6 sessions. Each will contribute 10%.

9.3.1.1: School – Based Project Continuous Assessment Scheme

The Table given below shows the Learning are Assessment Scheme for the School Based Project.

Project Execution Stages	Project Stage Description	Timelines	Marks
1	Problem Identification	January	5
2	Investigation of related ideas to the problem/innovation	February	10
3	Generation of possible solutions	March	10
4	Selecting the most suitable solution	April-May	5
5	Refinement of selected solution	June	5
6	Presentation of the final solution	July	10
7	Evaluation of the solution and Recommendations	August-September	5
	TOTAL		**50**

9.3.2 Description of the ZIMSEC Summative Assessment

ZIMSEC Summative Assessment shall be a public examination at form 6. The examination shall consist of 2 papers of equal weighting

Paper	Paper type	Marks	Duration	Weighting
1	Short answer questions	120	3 hours	40%
2	Short and long answer questions	120	3 hours	40%
TOTAL				**80%**

Paper 1: Short answer questions
Duration: 3 hours

Approximately 15 short answer question where candidates answer all questions.

Paper 2: Short and long answer questions
Duration: 3 hours
Sixteen questions where candidates answer any ten, each question carrying 12 marks.

9.4 Specification Grid

Skill	Paper 1	Paper 2
Knowledge and comprehension	50%	50%
Application and Analysis	40%	40%
Problem solving	10%	10%
TOTAL	**100%**	**100%**