GENERAL MATHEMATICS/MATHEMATICS (CORE)

1. AIMS OF THE SYLLABUS

The aims of the syllabus are to test candidates':

(1) mathematical competency and computational skills;
(2) understanding of mathematical concepts and their relationship to the acquisition of entrepreneurial skills for everyday living in the global world;
(3) ability to translate problems into mathematical language and solve them using appropriate methods;
(4) ability to be accurate to a degree relevant to the problem at hand;
(5) logical, abstract and precise thinking.

This syllabus is not intended to be used as a teaching syllabus. Teachers are advised to use their own National teaching syllabuses or curricular for that purpose.

1. EXAMINATION SCHEME

There will be two papers, Papers 1 and 2; both of which must be taken.

PAPER 1: Will consist of fifty multiple choice objective questions drawn from the common areas of the syllabus. All the questions are to be answered in 1½ hours for 50 marks.

PAPER 2: Will be an essay paper of two sections, Sections I and II**.** The paper will take 2½ hours and will carry 100 marks.

Section 1 - Will contain five compulsory questions, elementary in nature and drawn from the common areas of the syllabus. It will carry a total of 40 marks.

Section II - Will contain eight questions of greater length and difficulty. The questions shall include a maximum of two which shall be drawn from parts of the syllabuses which are peculiar to candidates' home countries. Candidates will be expected to answer five questions for 60marks.

2. DETAILED SYLLABUS

The topics, contents and notes are intended to indicate the scope of the questions which will be set. The notes are not to be considered as an exhaustive list of illustrations/limitations.

TOPICS	CONTENTS	NOTES
A. NUMBER AND NUMERATION		
(a) Number bases	(i) conversion of numbers from one base to another	Conversion from one base to base 10 and vice versa. Conversion from one base to another base .
	(ii) Basic operations on number bases	Addition, subtraction and multiplication of number bases.
(b) Modular Arithmetic	(i) Concept of Modulo Arithmetic.	Interpretation of modulo arithmetic e.g. $6 + 4 = k(\text{mod}7)$, $3 \times 5 = b(\text{mod}6)$, $m = 2(\text{mod } 3)$, etc.
	(ii) Addition, subtraction and multiplication operations in modulo arithmetic.	
	(iii) Application to daily life	Relate to market days, clock, shift duty, etc.
(c) Fractions, Decimals and Approximations	(i) Basic operations on fractions and decimals.	
	(ii) Approximations and significant figures.	Approximations should be realistic e.g. a road is not measured correct to the nearest cm.
(d) Indices	(i) Laws of indices	e.g. $a^x \times a^y = a^{x+y}$, $a^x \div a^y = a^{x-y}$, $(a^x)^y = a^{xy}$, etc where x, y are real numbers and $a \neq 0$. Include simple examples of negative and fractional indices.
	(ii) Numbers in standard form (scientific notation)	Expression of large and small numbers in standard form e.g. $375300000 = 3.753 \times 10^8$ $0.00000035 = 3.5 \times 10^{-7}$ Use of tables of squares, square roots and reciprocals

		is accepted.
(e) Logarithms	(i) Relationship between indices and logarithms e.g. $y = 10^k$ implies $\log_{10} y = k$. (ii) Basic rules of logarithms e.g. $\log_{10}(pq) = \log_{10} p + \log_{10} q$ $\log_{10}(p/q) = \log_{10} p - \log_{10} q$ $\log_{10} p^n = n\log_{10} p$. (iii) Use of tables of logarithms and antilogarithms.	Calculations involving multiplication, division, powers and roots.
(f) Sequence and Series	(i) Patterns of sequences. (ii) Arithmetic progression (A.P.) Geometric Progression (G.P.)	Determine any term of a given sequence. The notation U_n = the nth term of a sequence may be used. Simple cases only, including word problems. (Include sum for A.P. and exclude sum for G.P).
(g) Sets	(i) Idea of sets, universal sets, finite and infinite sets, subsets, empty sets and disjoint sets. Idea of and notation for union, intersection and complement of sets. (ii) Solution of practical problems involving classification using Venn diagrams.	Notations: $\mathcal{E}$, $\subset$, $\cup$, $\cap$, { }, $\emptyset$, P'(the compliment of P). ♦• properties e.g. commutative, associative and distributive Use of Venn diagrams restricted to at most 3 sets.
(h) Logical Reasoning	Simple statements. True and false statements. Negation of statements, implications.	Use of symbols: $\Rightarrow, \Leftarrow,$ use of Venn diagrams.
(i) Positive and negative integers, rational numbers	The four basic operations on rational numbers.	Match rational numbers with points on the number line. Notation: Natural numbers (N), Integers (Z), Rational numbers (Q).
(j) Surds (Radicals)	Simplification and rationalization of simple surds.	Surds of the form $\frac{a}{\sqrt{b}}$, a$\sqrt{b}$ and $a \pm \sqrt{b}$ where a is a rational number and b is a positive integer. Basic operations on surds

		(exclude surd of the form $\frac{a}{b+c\sqrt{d}}$).
•* (k) Matrices and Determinants	(i) Identification of order, notation and types of matrices. (ii) Addition, subtraction, scalar multiplication and multiplication of matrices. (iii) Determinant of a matrix	Not more than 3 x 3 matrices. Idea of columns and rows. Restrict to 2 x 2 matrices. Application to solving simultaneous linear equations in two variables. Restrict to 2 x 2 matrices.
(l) Ratio, Proportions and Rates	Ratio between two similar quantities. Proportion between two or more similar quantities. Financial partnerships, rates of work, costs, taxes, foreign exchange, density (e.g. population), mass, distance, time and speed.	Relate to real life situations. Include average rates, taxes e.g. VAT, Withholding tax, etc
(m) Percentages	Simple interest, commission, discount, depreciation, profit and loss, compound interest, hire purchase and percentage error.	Limit compound interest to a maximum of 3 years.
* (n) Financial Arithmetic	(i) Depreciation/ Amortization. (ii) Annuities (iii) Capital Market Instruments	Definition/meaning, calculation of depreciation on fixed assets, computation of amortization on capitalized assets. Definition/meaning, solve simple problems on annuities. Shares/stocks, debentures, bonds, simple problems on interest on bonds and debentures.
(o) Variation	Direct, inverse, partial and joint	Expression of various types of

	variations.	variation in mathematical symbols e.g. direct ($z \propto n$), inverse ($z \propto \frac{1}{n}$), etc. Application to simple practical problems.
B. ALGEBRAIC PROCESSES		
(a) Algebraic expressions	(i) Formulating algebraic expressions from given situations	e.g. find an expression for the cost C Naira of 4 pens at x Naira each and 3 oranges at y naira each. Solution: $C = 4x + 3y$
	(ii) Evaluation of algebraic expressions	e.g. If x =60 and y = 20, find C. $C = 4(60) + 3(20) = 300$ naira.
(b) Simple operations on algebraic expressions	(i) Expansion	e.g. $(a+b)(c+d)$, $(a+3)(c-4)$, etc.
	(ii) Factorization	factorization of expressions of the form ax + ay, $a(b+c) + d(b+c)$, $a^2 - b^2$, $ax^2 + bx + c$ where a, b, c are integers. Application of difference of two squares e.g. $49^2 - 47^2 = (49 + 47)(49 - 47) = 96 \times 2 = 192$.
	♦• ♣♠ (iii) Binary Operations	Carry out binary operations on real numbers such as: a*b = $2a + b - ab$, etc.
(c) Solution of Linear Equations	(i) Linear equations in one variable	Solving/finding the truth set (solution set) for linear equations in one variable.
	(ii) Simultaneous linear equations in two variables.	Solving/finding the truth set of simultaneous equations in two variables by elimination, substitution and graphical methods. Word problems involving one or two variables

(d) Change of Subject of a Formula/Relation	(i) Change of subject of a formula/relation (ii) Substitution.	e.g. if $\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$, find v. Finding the value of a variable e.g. evaluating v given the values of u and f.
(e) Quadratic Equations	(i) Solution of quadratic equations (ii) Forming quadratic equation with given roots. (iii) Application of solution of quadratic equation in practical problems.	Using factorization i.e. $ab = 0$ $\Rightarrow$ either $a = 0$ or $b = 0$. •*♣♠ By completing the square and use of formula Simple rational roots only e.g. forming a quadratic equation whose roots are -3 and $\frac{5}{2} \Rightarrow$ $(x + 3)(x - \frac{5}{2}) = 0$.
(f) Graphs of Linear and Quadratic functions.	(i) Interpretation of graphs, coordinate of points, table of values, drawing quadratic graphs and obtaining roots from graphs. (ii) Graphical solution of a pair of equations of the form: $y = ax^2 + bx + c$ and $y = mx + k$ *♣♠ (iii) Drawing tangents to curves to determine the gradient at a given point.	Finding: (i) the coordinates of maximum and minimum points on the graph. (ii) intercepts on the axes, identifying axis of symmetry, recognizing sketched graphs. Use of quadratic graphs to solve related equations e.g. graph of $y = x^2 + 5x + 6$ to solve $x^2 + 5x + 4 = 0$. Determining the gradient by drawing relevant triangle.
(g) Linear Inequalities	(i) Solution of linear inequalities in one variable and representation on the number line. *(ii) Graphical solution of linear inequalities in two variables. *(iii) Graphical solution of simultaneous linear inequalities in two variables.	Truth set is also required. Simple practical problems Maximum and minimum values. Application to real life situations e.g. minimum cost, maximum profit, linear programming, etc.

(h) Algebraic Fractions	Operations on algebraic fractions with: (i) Monomial denominators (ii) Binomial denominators	Simple cases only e.g. $\frac{1}{x}+\frac{1}{y}=\frac{x+y}{xy}$ (x ≠0, y≠ 0). Simple cases only e.g. $\frac{1}{x-a}+\frac{1}{x-b}=\frac{2x-a-b}{(x-a)(x-b)}$ where *a* and *b* are constants and $x \neq a$ or *b*. Values for which a fraction is undefined e.g. $\frac{1}{x+3}$ is not defined for $x = -3$.
♦●♣♠(i) Functions and Relations	Types of Functions	One-to-one, one-to-many, many-to-one, many-to-many. Functions as a mapping, determination of the rule of a given mapping/function.
C. MENSURATION (a) Lengths and Perimeters	(i) Use of Pythagoras theorem, *♣♠sine and cosine rules to determine lengths and distances. (ii) Lengths of arcs of circles, perimeters of sectors and segments. ♦*♣♠(iii) Longitudes and Latitudes.	No formal proofs of the theorem and rules are required. Distances along latitudes and Longitudes and their corresponding angles.
(b) Areas	(i) Triangles and special quadrilaterals – rectangles, parallelograms and trapeziums (ii) Circles, sectors and segments of circles. (iii) Surface areas of cubes, cuboids, cylinder, pyramids, right triangular prisms, cones and spheres.	Areas of similar figures. Include area of triangle = ½ base x height and ½absinC. Areas of compound shapes. Relationship between the sector of a circle and the surface area of a cone.

(c) Volumes	(i) Volumes of cubes, cuboids, cylinders, cones, right pyramids and spheres. (ii) Volumes of similar solids	Include volumes of compound shapes.
D. PLANE GEOMETRY (a) Angles	(i) Angles at a point add up to 360^{o}. (ii) Adjacent angles on a straight line are supplementary. (iii) Vertically opposite angles are equal.	The degree as a unit of measure. Consider acute, obtuse, reflex angles, etc.
(b) Angles and intercepts on parallel lines.	(i) Alternate angles are equal. (ii)Corresponding angles are equal. (iii)Interior opposite angles are supplementary *♣♠(iv) Intercept theorem.	Application to proportional division of a line segment.
(c) Triangles and Polygons.	(i) <u>The sum of the angles of a triangle is 2 right angles.</u> (ii) <u>The exterior angle of a triangle equals the sum of the two interior opposite angles.</u> (iii) Congruent triangles. (iv) Properties of special triangles - Isosceles, equilateral, right-angled, etc (v) Properties of special quadrilaterals – parallelogram, rhombus, square, rectangle, trapezium. (vi)Properties of similar triangles. (vii) The sum of the angles of a polygon	*The formal proofs of those underlined may be required. Conditions to be known but proofs not required e.g. SSS, SAS, etc. Use symmetry where applicable. Equiangular properties and ratio of sides and areas. Sum of interior angles = $(n - 2)180^{o}$ or $(2n – 4)$right

	(viii) Property of exterior angles of a polygon. (ix) Parallelograms on the same base and between the same parallels are equal in area.	angles, where n is the number of sides
(d) Circles	(i) Chords. (ii) The angle which an arc of a circle subtends at the centre of the circle is twice that which it subtends at any point on the remaining part of the circumference. (iii) Any angle subtended at the circumference by a diameter is a right angle. (iv) Angles in the same segment are equal. (v) Angles in opposite segments are supplementary. (vi)Perpendicularity of tangent and radius. (vii) If a tangent is drawn to a circle and from the point of contact a chord is drawn, each angle which this chord makes with the tangent is equal to the angle in the alternate segment.	Angles subtended by chords in a circle and at the centre. Perpendicular bisectors of chords. *the formal proofs of those underlined may be required.
♦*♣♠(e) Construction	(i) Bisectors of angles and line segments (ii) Line parallel or perpendicular to a given line. (iii)Angles e.g. 90^o, 60^o, 45^o, 30^o, and an angle equal to a	Include combination of these angles e.g. 75^o, 105^o,135^o,

	given angle. (iv) Triangles and quadrilaterals from sufficient data.	etc.
♦*♣♠(f) Loci	Knowledge of the loci listed below and their intersections in 2 dimensions. (i) Points at a given distance from a given point. (ii) Points equidistant from two given points. (iii)Points equidistant from two given straight lines. (iv)Points at a given distance from a given straight line.	Consider parallel and intersecting lines. Application to real life situations.
E. COORDINATE GEOMETRY OF STRAIGHT LINES	(i) Concept of the x-y plane. (ii) Coordinates of points on the x-y plane.	Midpoint of two points, distance between two points i.e. |PQ| = $\sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$, where P($x_1$,$y_1$) and Q($x_2$, y_2), gradient (slope) of a line m= $\frac{y_2 - y_1}{x_2 - x_1}$, equation of a line in the form y = mx + c and $y - y_1 = m(x - x_1)$, where m is the gradient (slope) and c is a constant.
F. TRIGONOMETRY (a) Sine, Cosine and Tangent of an angle.	(i) Sine, Cosine and Tangent of acute angles. (ii) Use of tables of trigonometric ratios. (iii) Trigonometric ratios of 30^o, 45^o and 60^o. (iv) Sine, cosine and tangent of angles from 0^o to 360^o. (v)Graphs of sine and cosine. (vi) Graphs of trigonometric ratios.	Use of right angled triangles Without the use of tables. Relate to the unit circle. $0^o \leq x \leq 360^o$. e.g. $y = a\sin x$, $y = b\cos x$ Graphs of simultaneous linear and trigonometric equations.

		e.g. y = asin x + bcos x, etc.
(b) Angles of elevation and depression	(i) Calculating angles of elevation and depression. (ii) Application to heights and distances.	Simple problems only.
♦∗♣♠(c) Bearings	(i) Bearing of one point from another. (ii) Calculation of distances and angles	Notation e.g. 035°, N35°E Simple problems only. Use of diagram is required.∗♣ ♠Sine and cosine rules may be used.
∗**G. INTRODUCTORY CALCULUS**	(i) Differentiation of algebraic functions. (ii) Integration of simple Algebraic functions.	Concept/meaning of differentiation/derived function, $\frac{dy}{dx}$, relationship between gradient of a curve at a point and the differential coefficient of the equation of the curve at that point. Standard derivatives of some basic function e.g. if $y = x^2$, $\frac{dy}{dx} = 2x$. If $s = 2t^3 + 4$, $\frac{ds}{dt} = v = 6t^2$, where s = distance, t = time and v = velocity. Application to real life situation such as maximum and minimum values, rates of change etc. Meaning/ concept of integration, evaluation of simple definite algebraic equations.
H. STATISTICS AND PROBABILITY. (A) Statistics	(i) Frequency distribution (ii) Pie charts, bar charts, histograms and frequency polygons	Construction of frequency distribution tables, concept of class intervals, class mark and class boundary. Reading and drawing simple inferences from graphs, interpretation of data in

	(iii) Mean, median and mode for both discrete and grouped data.	histograms. Exclude unequal class interval. Use of an assumed mean is acceptable but not required. For grouped data, the mode should be estimated from the histogram while the median, quartiles and percentiles are estimated from the cumulative frequency curve.
	(iv) Cumulative frequency curve (Ogive).	Application of the cumulative frequency curve to every day life.
	(v) Measures of Dispersion: range, semi inter-quartile/inter-quartile range, variance, mean deviation and standard deviation.	Definition of range, variance, standard deviation, inter-quartile range. Note that mean deviation is the mean of the absolute deviations from the mean and variance is the square of the standard deviation. Problems on range, variance, standard deviation etc. *♣♠Standard deviation of grouped data
(b) Probability	(i) Experimental and theoretical probability.	Include equally likely events e.g. probability of throwing a six with a fair die or a head when tossing a fair coin.
	(ii) Addition of probabilities for mutually exclusive and independent events.	With replacement. *♣♠without replacement.
	(iii) Multiplication of probabilities for independent events.	Simple practical problems only. Interpretation of "and" and "or" in probability.
♦♣♠ I. VECTORS AND TRANSFORMATION		
(a) Vectors in a Plane	Vectors as a directed line segment.	(5, 060^{o})

	Cartesian components of a vector	e.g. $\begin{pmatrix} 5\sin 60^o \\ 5cos60^o \end{pmatrix}$.
	Magnitude of a vector, equal vectors, addition and subtraction of vectors, zero vector, parallel vectors, multiplication of a vector by scalar.	Knowledge of graphical representation is necessary.
(b) Transformation in the Cartesian Plane	Reflection of points and shapes in the Cartesian Plane.	Restrict Plane to the *x* and *y* axes and in the lines *x* = k, *y* = x and y = k*x*, where k is an integer. Determination of mirror lines (symmetry).
	Rotation of points and shapes in the Cartesian Plane.	Rotation about the origin and a point other than the origin. Determination of the angle of rotation (restrict angles of rotation to -180^o to 180^o).
	Translation of points and shapes in the Cartesian Plane.	Translation using a translation vector.
	Enlargement	Draw the images of plane figures under enlargement with a given centre for a given scale factor. Use given scales to enlarge or reduce plane figures.

3. UNITS

Candidates should be familiar with the following units and their symbols.

(1) Length

1000 millimetres (mm) = 100 centimetres (cm) = 1 metre(m).
1000 metres = 1 kilometre (km)

(2) Area

10,000 square metres (m^2) = 1 hectare (ha)

(3) Capacity

1000 cubic centimeters (cm^3) = 1 litre (l)

(4) Mass

1000 milligrammes (mg) = 1 gramme (g)

1000 grammes (g) = 1 kilogramme (kg)

1000 ogrammes (kg) = 1 tonne.

(5) Currencies

The Gambia	–	100 bututs (b) = 1 Dalasi (D)
Ghana	-	100 Ghana pesewas (Gp) = 1 Ghana Cedi (GH¢)
Liberia	-	100 cents (c) = 1 Liberian Dollar (LD)
Nigeria	-	100 kobo (k) = 1 Naira (₦)
Sierra Leone	-	100 cents (c) = 1 Leone (Le)
UK	-	100 pence (p) = 1 pound (£)
USA	-	100 cents (c) = 1 dollar ($)
French Speaking territories		100 centimes (c) = 1 Franc (fr)

Any other units used will be defined.

4. OTHER IMPORTANT INFORMATION

(1) Use of Mathematical and Statistical Tables

Mathematics and Statistical tables, published or approved by WAEC may be used in the examination room. Where the degree of accuracy is not specified in a question, the degree of accuracy expected will be that obtainable from the mathematical tables.

(2) Use of calculators

The use of non-programmable, silent and cordless calculators is allowed. The calculators must, however not have a paper print out **nor be capable of receiving/sending any information. Phones with or without calculators are not allowed.**

(3) Other Materials Required for the examination

Candidates should bring rulers, pairs of compasses, protractors, set squares etc required for papers of the subject. They will **not** be allowed to borrow such instruments and any other material from other candidates in the examination hall.

Graph papers ruled in 2mm squares will be provided for any paper in which it is required.

(4) Disclaimer

In spite of the provisions made in paragraphs 4 (1) and (2) above, it should be noted that some questions may prohibit the use of tables and/or calculators.