



ZIMBABWE

**MINISTRY OF HIGHER AND TERTIARY EDUCATION,
INNOVATION, SCIENCE AND TECHNOLOGY
DEVELOPMENT**

**HIGHER EDUCATION EXAMINATIONS COUNCIL
(HEXCO)**

NATIONAL CERTIFICATE

IN

**CIVIL ENGINEERING / SURVEYING AND GEOMATICS WATER RESOURCES
AND IRRIGATION ENGINEERING**

SUBJECT: Engineering Mathematics

PAPER NO: 363/18/S05

DURATION: 3 Hours

NOVEMBER/DECEMBER 2022 EXAMINATION

REQUIREMENTS

1. Graph papers
2. Mathematical set

INSTRUCTIONS TO CANDIDATE

1. Answer question 1 and any other four.
2. Show your working.

This paper consists of 7 printed pages.

QUESTION 1

- a) Solve $2x^2 - 3x - 9 = 0$ by completing the square. (3 marks)
- b) Solve for a and b using determinants $\frac{1}{2}a - \frac{1}{3}b = \frac{1}{3}$; $\frac{1}{4}a + \frac{1}{7}b = 1\frac{5}{7}$ (4 marks)
- c) Find the equation of the perpendicular bisector of the straight line joining the points P (12; -5) and Q (-4; 11). (4 marks)
- d) Differentiate $y = 3x^2 - x + 4$ with respect to x from first principles. (4 marks)
- e) Find the locus of a point P(x; y) which moves in such a way that its distance from the line $x = -3$ is equal to its distance from the point (4; -2) (4 marks)
- f) Three groups of athletes consisting of 10; 9 and 11 individuals reported mean weights of 84, 80 and 72kgs respectively. Determine the mean weight of all the athletes. (3 marks)
- g) Find the equation of the tangent to the curve $y = x^3 - 2x$ at the point (2; 4) (4 marks)
- h) Evaluate $\int_0^1 3 \sin 2t + 4t - \cos t \, dt$ (5 marks)
- i) Solve for $0^\circ \leq x \leq 180^\circ$
 $\sin 3x - 2 \sin 2x + \sin x = 0$ (5 marks)
- j) Solve for x ;
 $2^{x+2} - 3 = 4^x$, correct to 2d.p (4 marks)

QUESTION 2

- a) Draw the graph of the function $x^2 + 2x - 2$ from $x = -4$ to $x = +2$.
(5 marks)
- b) Using the graph in (a) above, find the approximate roots of the equations
- i) $x^2 + 2x - 2 = 0$ (2 marks)
- ii) $x^2 + 3x - 1 = 0$ (3 marks)
- c) Calculate the mean and standard deviation for the data shown in the table below.

Shoe size	6	7	8	9	10	11	12
Frequency	3	6	9	8	13	4	5

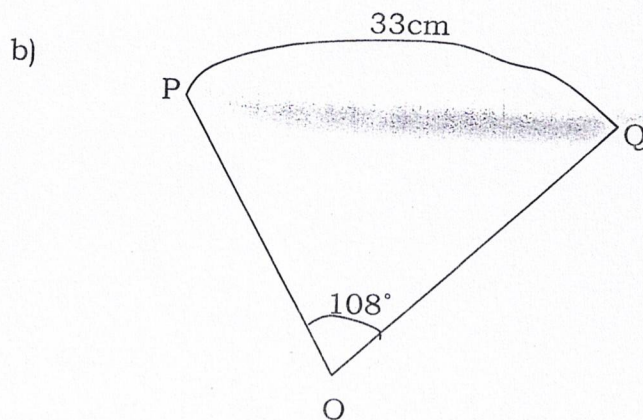
(5 marks)

QUESTION 3

- a) Express $2 \cos 5x \cos 3x$ as a sum of two cosines and hence evaluate
 $\int_0^{\pi/4} 2 \cos 5x \cos 3x \, dx$ (5 marks)
- b) Find the radius and the coordinates of the centre of the circle defined by
 $\frac{1}{2}x^2 + \frac{1}{2}y^2 + x - 2y = 8$ (4 marks)
- c) Find the Cartesian equation for the locus: $\cos \theta + 2 \sin \theta = \frac{1}{r}$
(3 marks)
- d) Solve for x : $\log_x \frac{1}{32} = -5/3$ (3 marks)

QUESTION 4

- a) Find $\int_1^3 \left(\sqrt{x} + \frac{1}{\sqrt{x}} \right) dx$ (4 marks)



In the diagram OPQ is a sector of a circle centre O in which $\angle POQ = 108^\circ$ and arc PQ = 33cm.

Calculate the:

- i) Radius of the sector (3 marks)
 - ii) The area of the sector (3 marks)
- c) Determine the area between the curve $y = 8 + 2x$, the lines $x = -2$ and $x = 4$ and the x -axis. (5 marks)

QUESTION 5

The resistance R (kilo Ohms) of a sample of 40 similar resistors drawn from a large batch was measured and the results are as shown:

R(kΩ)	1.24 – 1.26	1.27 – 1.29	1.30 – 1.32	1.33 – 1.35	1.36 – 1.38
Frequency	3	8	14	9	6

- a) Draw the “less than” cumulative frequency curve (ogive) and use it to estimate the median. (6 marks)
- b) Draw up a table and use it to calculate:
 - i) The mean (4 marks)
 - ii) The standard deviation (5 marks)

QUESTION 6

a) A particle moves in a straight line so that its distance x_m from a point A at time t seconds is given by $x = 2t - 2t^2 + 3t^3$

- i) Calculate the distance of the particle from A at time / second and at time 3 seconds. (2 marks)
- ii) Calculate the average speed of the particle between the times when $t = 1$ and $t = 2$. (4 marks)
- iii) Calculate the actual speed of the particle when $t = 2$. (2 marks)
- iv) Find the value of t for which the acceleration of the particle is zero. (4 marks)

b) Solve for x

$$\log_a(-11x + 2) = \log_a(x + 30) \quad (3 \text{ marks})$$

APPENDIX

LIST OF FORMULAE

1. $\bar{x} = \frac{\Sigma fx}{\Sigma f}$
2. $S = \sqrt{\left(\frac{\Sigma fx^2}{\Sigma f} - \bar{x}^2\right)}$
3. Mean Deviation = $\frac{\Sigma f |x - \bar{x}|}{\Sigma f}$
4. Quartile Deviation = $\frac{Q_3 - Q_1}{2}$
5. $\sin^2 x + \cos^2 x = 1$
6. $1 + \cot^2 x = \operatorname{cosec}^2 x$
7. $\tan^2 x + 1 = \sec^2 x$
8. $\sin 2x = 2 \sin x \cos x$
9. $\cos 2x = \cos^2 x - \sin^2 x$
10. $\tan 2x = \frac{2 \tan x}{1 - \tan^2 x}$
11. $\sin(A + B) = \sin A \cos B + \cos A \sin B$
12. $\sin(A - B) = \sin A \cos B - \cos A \sin B$
13. $\cos(A + B) = \cos A \cos B - \sin A \sin B$
14. $\cos(A - B) = \cos A \cos B + \sin A \sin B$
15. $\tan(A + B) = \frac{\tan A + \tan B}{1 - \tan A \tan B}$
16. $\tan(A - B) = \frac{\tan A - \tan B}{1 + \tan A \tan B}$
17. $\sin P + \sin Q = 2 \sin\left(\frac{P + Q}{2}\right) \cos\left(\frac{P - Q}{2}\right)$
18. $\sin P - \sin Q = 2 \cos\left(\frac{P + Q}{2}\right) \sin\left(\frac{P - Q}{2}\right)$
19. $\cos P + \cos Q = 2 \cos\left(\frac{P + Q}{2}\right) \cos\left(\frac{P - Q}{2}\right)$

$$20. \quad \cos P - \cos Q = -2 \sin\left(\frac{P+Q}{2}\right) \sin\left(\frac{P-Q}{2}\right)$$

$$21. \quad \frac{d}{dx} (uv) = u \frac{dv}{dx} + v \frac{du}{dx}$$

$$22. \quad \frac{d}{dx} \left(\frac{u}{v} \right) = \frac{v \frac{du}{dx} - u \frac{dv}{dx}}{v^2}$$

$$23. \quad \frac{d}{dx} (u) = \frac{du}{dy} \cdot \frac{dy}{dx}$$

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