



ZIMBABWE

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

**HIGHER EDUCATION EXAMINATIONS COUNCIL
(HEXCO)**

NATIONAL CERTIFICATE

IN

**MACHINESHOP, FABRICATION, POWERPLANT OPERATIONS, REFRIGERATION,
VEHICLE BODY BUILDING, DRAUGHTING AND DESIGNING, FOUNDRY,
TECHNICAL GRAPHICS, MILLWRIGHTS**

SUBJECT: Engineering Mathematics

PAPER NO: 340/18/S02

DURATION: 3 hours

MARCH/APRIL 2021 EXAMINATION

REQUIREMENTS

1. Answer booklet
2. Scientific non-programmable calculator
3. Graph paper

INSTRUCTIONS TO CANDIDATE

1. Section A: Answer all parts of question 1. Each part carries 5 marks.
2. Section B: Answer four (4) questions out of six (6). Each question carries 15 marks.

This paper consists of 4 printed pages.

SECTION A

QUESTION 1

1.1 Prove that $\log_a b^2 \times \log_b a^3 = \log_2 64$ (5 marks)

1.2 Given that $p + q = \frac{p+r}{d}$, transpose to make p the subject of formula. (5 marks)

1.3 Show that $\tan \theta + \cot \theta = \sec \theta \operatorname{cosec} \theta$ (5 marks)

1.4 Fig Q1.4 shows a sector of a circle which subtends an angle of $\frac{2}{5}$ radians at the centre. Determine the shaded area.

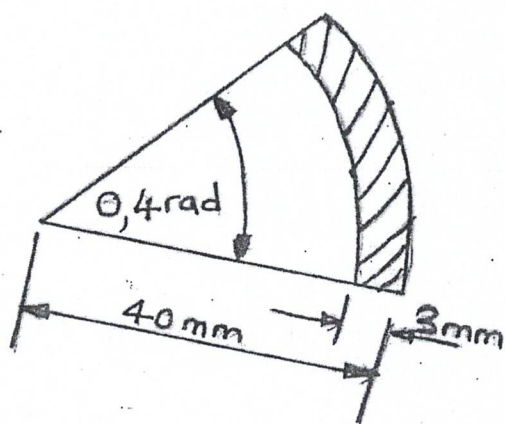


Fig. Q1.4

1.5 Differentiate from first principles:

$$f(x) = 5x^2 + 3x \quad (5 \text{ marks})$$

1.6 Find the equation of a line perpendicular to $y = 3x + 4$ passing through point (2; 5). (5 marks)

1.7 Solve the following simultaneous equations using Cramer's rule:

$$3x = 2y$$

$$4x + y + 11 = 0 \quad (5 \text{ marks})$$

1.8 Expand $(2x - 3y)^4$ using Pascal's triangle. (5 marks)

Handwritten signature

SECTION B

QUESTION 2

- a) When an effort E is applied to the gear box on a diesel motor it is found that a resistance R can be overcome and that E and R are connected by a formula $E = a + bR$ where a and b are constants. An effort of 3.5N overcomes a resistance of 5N and an effort of 5.3N overcomes a resistance of 8N . Find the values of a and b . (6 marks)
- b) A classroom measuring 11m by 24m is surrounded by a flower bed of constant width. If the total area of the classroom and the flower bed is 378m^2 , find the width of the flower bed. (9 marks)

QUESTION 3

A buoy consists of a frustum of a cone whose ends have radii $1,0\text{m}$ and $1,8\text{m}$ and whose height is $2,0\text{m}$, to which is attached, at the larger end, a hemisphere of radius $1,8\text{m}$. Calculate the volume and surface area of the buoy. (15 marks)

QUESTION 4

- a) A cooling tower is 20m high. The inside diameter of the tower at different heights is given in the following table.

Height (m)	0	5	10	15	20
Diameter (m)	16	13,3	10,7	8,6	8

Estimate the capacity of the tower.

(8 marks)

- b) A steel disc has a diameter of $8,00\text{cm}$ and is of thickness $1,80\text{cm}$. A triangular groove is machined centrally around the rim to form a pulley. If the triangular shape is isosceles, with base $1,80\text{cm}$ (coinciding with the edges of the rim) and perpendicular height $1,20\text{cm}$. Find the volume of metal removed and the mass of the pulley if steel has a density of $7,80\text{g/cm}^3$. (7 marks)

QUESTION 5

- a) For a moving body $S = 4t^3 + 3t^2 - 2$ where s is the distance travelled in metres and t is the time taken in seconds. Find:
- i). The velocity after 4 seconds (3 marks)
 - ii) Acceleration after 4 seconds (3 marks)
 - iii) The value of t when acceleration is $140m/s^2$ (3 marks)
- b) Resistance to motion F of a moving vehicle is given by $F = \frac{5}{x} + 100x$. Determine the minimum value of the resistance. (6 marks)

QUESTION 6

Determine the area between curve $Y = x^3 - 2x^2 - 8x$ and the x -axis. (15 marks)

QUESTION 7

Plot a graph of $y = 2x^2 - 4x - 8$ for values of x between $x = -2$ and $x = 4$. From the graph:

- a) Find the value of y when $X = 1,75$.
- b) Find the value of x when $y = 2,4$
- c) Determine the coordinates of the turning point and its nature.
- d) Solve the equation $2x^2 - 4x - 8 = 0$.
- e) Find the roots of the equation $2x^2 - 7x + 4 = 0$ (15 marks)

.../jl