



ZIMBABWE

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

**HIGHER EDUCATION EXAMINATIONS COUNCIL
(HEXCO)**

NATIONAL CERTIFICATE

IN

**MOTOR MECHANICS DPF MVBR, PRECISION MACHINING auto
ELECTRICIS AND ELECTRONICS AND MOTOR CYCLE
MECHANICS**

**MODULE: Automotive Engineering
Mathematics and Science**

**PAPER NO: 346/22/M07
346/25/M07**

DURATION: 3 Hours

JUNE 2026 EXAMINATION

REQUIREMENTS

Blue pen, calculator, drawing set, ruler.

INSTRUCTIONS TO CANDIDATE

- 1. Section A: Answer any five (5) questions. Each question carries 10 marks.**
- 2. Section B: Choose any five questions. Each question carries 10 marks.**

This paper consists of 6 printed pages.

SECTION A

Answer any five (5) questions

QUESTION 1

- (a) Make K the subject

$$T = \frac{2\pi\sqrt{h^2 + k^2}}{gh} \quad (3 \text{ marks})$$

- (b) Convert 132 to binary via octal . (4 marks)

- (c) Factorise and solve for x in $4x^2 - 25 = 0$ (3 marks)

QUESTION 1.2

- (a) Evaluate the expression:-

$$\frac{\frac{1}{2}\log 16 - \frac{1}{3}\log 8}{\log 4} \quad (5 \text{ marks})$$

- (b) Evaluate $5.47 \times 10^{-2} - 6.16 \times 10^{-2}$ (3 marks)

- (c) Solve for x $3^x = 81$ (2 marks)

QUESTION 1.3

- (a) Determine the volume and total surface area of a cone of radius 8.0cm and perpendicular height 10cm. (6 marks)

- (b) Calculate the capacity in litres of a $3 \times 2 \times 1 \text{ m}^3$ tank filled with water. (4 marks)

QUESTION 1.4

- (a) Evaluate $\int_1^4 x^2 dx$ (3 marks)

- (b) Given that $y = 3x + 5$ is equation of a tangent. Find the equation of the normal. (3 marks)

- (c) If a graph has a gradient function of $2x + 4$. Find the equation of the graph if it passes through (1;2). (4 marks)

QUESTION 1.5

(a) Find the remainder using long division if $(5x^2 - 4x + 2) \div (x - 3)$.
(5 marks)

(b) If $a = 2i + 3j$ and $b = 6i - 5j$

Find

(i) $a - b$ (2 marks)

(ii) $|a+b|$ (3 marks)

QUESTION 1.6

Find the adjoint of Matrix A

$$A = \begin{bmatrix} 4 & 1 & 9 \\ 3 & 8 & 6 \\ 7 & 5 & 2 \end{bmatrix} \quad (10 \text{ marks})$$

QUESTION 1.7

A flag pole stands on the edge of the top of a building at a point 200m from the building. The angles of elevation of the top and bottom of the pole are 32° and 30° respectively. Calculate the height of the flag pole. Show the sketch.
(10 marks)

QUESTION 1.8

Find the coordinate of the stationary point on the curve $y = (2 + x)(3 - 4x)$ and sketch the graph.
(10 marks)

SECTION B

Answer any five (5) questions.

QUESTION 2.1

- (a) A 2kg flywheel of 300mm diameter is rotating at 120 revs / min. (2 marks)
- (i) Calculate the angular velocity
 - (ii) The angular distance in rads of a point on the rim of the fly wheel if the speed is increased to 280 rev/min in 3 seconds. (3 marks)
- (b) A vehicle having a mass of 750kg is being propelled along a level road by a force of 1.3kN against a total resistance to motion of 300N. Calculate the acceleration of the vehicle and the distance travelled from rest by this vehicle in the first 15 sec. (5 marks)

QUESTION 2.2

- (a) Calculate the amount of heat energy required to raise 8kg of copper from a temperature of 20°C to 40°C if its specific heat capacity is 390J/kgk. (5 marks)
- (b) An exhaust pipe increases in length by 5.85mm when its temperature is raised from 15°C to 215°C. If the coefficient of linear expansion of the metal used is 0.000117/k, find the original length of the pipe. (5 marks)

QUESTION 2.3

A 6- cylinder, 4-stroke petrol engine having a cylinder bore diameter 82mm and stroke 80mm develops maximum power at a speed of 4800 rev/min. the IMEP at this speed was found to be 1100kPa. The engine being coupled to a hydraulic dynamometer having $k = 16$. The load on the dynamometer was 290. Calculate,

- (a) indicated power , 1P (4 marks)
- (b) brake power , BP (4 marks)
- (c) mechanical efficiency , ME (2 marks)

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QUESTION 2.4

A hand operated lifting machine in a repair shop raises an engine of mass 280kg by means of an effort of 210N at the handle. If the effort moves through a distance of 13 m in raising the engine 440mm,

Calculate;

- (a) the force ratio (3 marks)
- (b) the movement ratio (3 marks)
- (c) the efficiency of the machine (4 marks)

QUESTION 2.5

- (a) Define the following terms
 - (i) Stress (2 marks)
 - (ii) Strain (2 marks)
- (b) A mild steel rod has to carry an axial pull of 47.82KN. The maximum permissible stress is 123.5N/mm². Calculate the suitable diameter of the rod. (6 marks)

QUESTION 2.6

- (a) State the principle of moments. (2 marks)
- (b) The layshaft in a gear-box is supported by two bearings which are 350mm apart. The constant mesh gear is 50mm from the front end of the gearbox and the first speed gear 100mm from the rear end of the gearbox. If the load of the constant mesh gear is 700N and the load on the first gear is 600N. calculate the reactions of each bearing. (8 marks)

QUESTION 2.7

- (a) State any two laws of friction. (2 marks)
- (b) The friction disc of a single plate clutch has a face area of 0.025m² and a mean radius of 0.12m. if the spring pressure is 140KN/m² of face area and the coefficient of friction is 0.35. determine the power which can be transmitted at 2500revs/s. (8 marks)

QUESTION 2.8

- (a) Explain with the aid of sketches BOW's notation as used in graphically resolving of forces. (5 marks)
- (b) Find the resultant force of two concurrent forces at 60° to each other by resolution of forces. The forces are 30N and 45N. (5 marks)

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