



# MERU UNIVERSITY OF SCIENCE AND TECHNOLOGY

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## UNIVERSITY EXAMINATIONS 2023/2024

### FIRST YEAR, SECOND SEMESTER, EXAMINATION FOR DIPLOMA IN MECHATRONIC TECHNICIAN LEVEL 6, MECHANICAL PLANT & MECHANICAL PRODUCTION TECHNICIAN LEVEL 6

#### ENG/OS/AUT/CR/3/6/A: AUTOMOTIVE SCIENCE PRINCIPLES

DATE: APRIL 2024

TIME: 3 HOURS

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**INSTRUCTIONS: Answer Question ONE and any other Three questions.**

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1. State the moment of a force. (3 Marks)
  2. Give four mechanical properties of automotive materials. (4 Marks)
  3. Name four laws of friction. (4 Marks)
  4. List four methods of minimizing friction. (4 Marks)
  5. 7. State three types of motions exhibited by moving bodies. (3 Marks)
  6. Define the following terms:
    - a. Speed (2 Marks)
    - b. Acceleration (2 Marks)
  7. Give three mechanical properties of automotive materials. (3 Marks)
  8. Name three modes of heat transfer. (3 Marks)
  9. Differentiate the following terms.
    - i. Heat capacity (2 Marks)
    - ii. Specific heat capacity (2 Marks)
  10. Define the following terms:
    - I. Density (2 Marks)
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II. Pressure (2marks)

11. A block of glass of mass 187.5g is 5.0cm long, 2.0cm thick and 7.5 cm high. Calculate the density of the glass in  $\text{kgm}^{-3}$  (4marks)

**QUESTION ONE (40 MARKS)**

**SECTION B (60 MARKS)**

The candidate should answer any 3 questions in this section

12.

- a) The main journal bearings of an engine crankshaft carry a total load of 10kn when the engine speed is 3500 rev/min. If the coefficient of friction between each bearing and the shaft is 0.015 and the diameter of the shaft is 60mm, calculate:
- i. The friction torque on the shaft. (2 Marks)
  - ii. The power absorbed by the friction. (3 Marks)
  - iii. The heat energy generated in the bearings per minute. (2 Marks)
- b) Use the cosine and sine rules to determine the magnitude and direction of a force of 8 kN acting at an angle of  $50^\circ$  to the horizontal and a force of 5 kN acting at an angle of  $-30^\circ$  to the horizontal. (6 Marks)
- c) The principle of moments. (2 Marks)
- d) Two vertical, equal and opposite forces act on a meter rule at the 12cm and 80cm marks respectively. If each of the forces has a magnitude of 3.6n, calculate their moment on the meter rule about the 28cm mark. (5 Marks)

13.

- a) A vehicle has a mass of 1325 kg and the coefficient of friction between the tyres and ground is 0.4. What is the maximum retarding force which can be used to stop it without causing it to skid? If the actual retarding force at the ground is 0.75 of the maximum, and is constant, determine the work done in bringing the vehicle to rest in a distance of 20m (6 Marks)
- b) A wheel is rotating at 2000 rev/min and when a brake is applied the wheel is brought to



rest with uniform retardation in 400 revolutions. Find the time taken to rest and the angular retardation in  $\text{rad/s}^2$  (6Marks)

- c) A steel component having a mass of 20kg and a temperature of  $700^\circ\text{C}$  is dropped into a tank containing 40kg of water at  $15^\circ\text{C}$ . Neglecting the heat energy absorbed by the tank and any loss of heat energy to the surrounding air, determine:
- The final temperature of the water. (4 Marks)
  - The heat energy absorbed by the water. (4 Marks)

14.

- a) A furnace produces 30 MJ of heat energy per hour. How long will it take to heat 60 kg of steel from  $20^\circ\text{C}$  to  $200^\circ\text{C}$ ? (Specific heat capacity of steel =  $0.48 \text{ kJ/kg K}$ ). (7 Marks)
- b) A given mass of gas occupies a volume of 200 litre at a temperature of  $27^\circ\text{C}$ . What would the volume of this mass of gas be at  $90^\circ\text{C}$  and  $-30^\circ\text{C}$  under the same pressure conditions? (7 Marks)
- c) A volume of  $0.5\text{m}^3$  of air at a gauge pressure of 1500 kPa is allowed to expand in a cylinder until the volume is  $2\text{m}^3$ . If the temperature remains constant, what is the new gauge pressure? (6 Marks)

(Take atmospheric pressure to be  $100 \text{ kPa} = 1 \text{ bar}$ ).

15.

- a) List four examples of simple machines (4marks)
- b) Define the following terms
- Machine (2 Marks)
  - Velocity Ratio (2 Marks)
  - Mechanical Advantage (2 Marks)
  - Efficiency (2 Marks)
- c) A load of 1.26Kn is lifted by means of a pulley block system consisting of three pulleys in the upper block and two pulleys in the lower block. If the efficiency of the system at this load is 80%, determine
- The Velocity Ratio (2 Marks)
  - The Mechanical Advantage (2 Marks)
  - The Effort required to lift the load (2 Marks)
  - The Effort required to overcome the resistances (2 Marks)





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