

2501/102 2503/102 2509/102

2502/102 2508/102

**MECHANICAL SCIENCE, ELECTRICAL AND
ELECTRONIC PRINCIPLES**

Oct./Nov. 2021

Time: 3 hours



THE KENYA NATIONAL EXAMINATIONS COUNCIL

**DIPLOMA IN MECHANICAL ENGINEERING
(PRODUCTION OPTION)
(PLANT OPTION)**

**DIPLOMA IN AUTOMOTIVE ENGINEERING
DIPLOMA IN WELDING AND FABRICATION
DIPLOMA IN CONSTRUCTION PLANT ENGINEERING**

MODULE I

MECHANICAL SCIENCE, ELECTRICAL AND ELECTRONIC PRINCIPLES

3 hours

INSTRUCTIONS TO CANDIDATES

You should have the following for this examination:

drawing instruments;

scientific calculator/mathematical tables;

answer booklet.

*This paper consists of **EIGHT** questions in **TWO** sections; **A** and **B**.*

*Answer **FIVE** questions taking at least **TWO** questions from each section.*

All questions carry equal marks.

Maximum marks for each part of a question are indicated.

*Candidates should answer the questions in **English**.*

Take $\mu_0 = 4\pi \times 10^{-7} \text{ H/m}$

This paper consists of 6 printed pages.

**Candidates should check the question paper to ascertain that
all the pages are printed as indicated and that no questions are missing.**

SECTION A: MECHANICAL SCIENCE

Answer at least **TWO** questions from this section.

1. (a) State:

- (i) **three** forms of energy; *Human, Electrical, Water*
(ii) the law of conservation of energy. (5 marks)

(b) Show that the kinetic energy of a body of mass M , that accelerates uniformly from rest to final velocity V , is given by $KE = \frac{1}{2}MV^2$. (6 marks)

(c) A planing machine has a cutting stroke of 2 m and the stroke takes 4 seconds. If the constant resistance to the cutting tool is 900 N, calculate for each cutting stroke:

- (i) the power consumed;
(ii) the power input to the system if the efficiency is 75%. (9 marks)

2. (a) Define the following terms with reference to forces:

- (i) statics;
(ii) equilibrium. (2 marks)

(b) **Figure 1** shows a system of coplanar forces. Determine their resultant force using resolution of forces method. (10 marks)

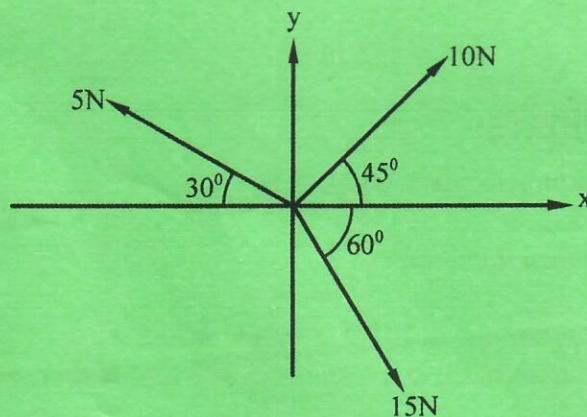


Fig. 1

- (c) A uniform horizontal bar is suspended on a fulcrum as shown in **Figure 2**. Determine the magnitude of:
- load W at equilibrium;
 - R at the support.
- (8 marks)

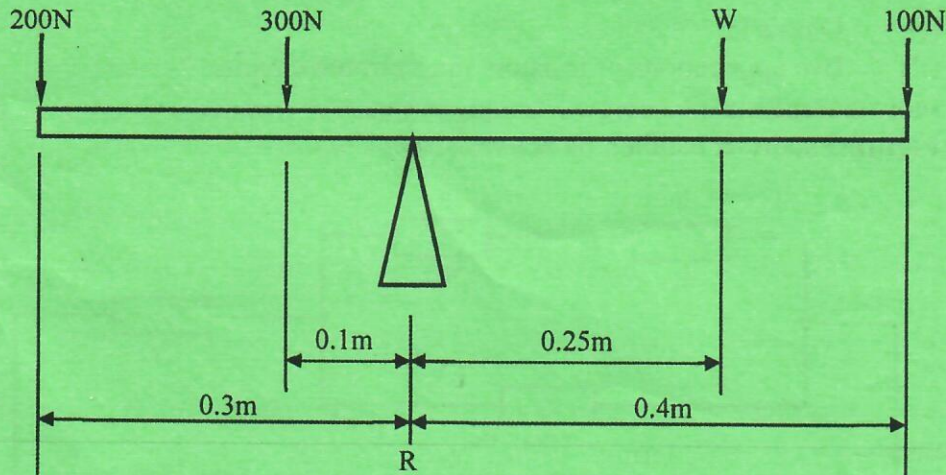


Fig. 2

3. (a) (i) Distinguish between isothermal and isobaric processes.
(ii) State Dalton's law of partial pressure. (4 marks)
- (b) With aid of a diagram, explain the operation of liquid in glass thermometer. (6 marks)
- (c) 100 g of water at 70°C is added to 200 g of cold water at 10°C and well stirred. If specific heat capacity of water is 4200 J/kgK and neglecting heat absorbed by the container, determine the final temperature of the mixture. (10 marks)
4. (a) State **three**:
- laws of friction;
 - advantages of friction. *- It makes work easier* (6 marks)
- (b) A lifting machine has a velocity ratio of 50. Tests were carried out on the machine and it was found that an effort of 180 N lifted a load of 2000 N while an effort of 300 N lifted a load of 5000 N.
- Derive the expression for law of the machine;
 - Given a load of 10,000 N, determine the:
 - effort,
 - mechanical advantage;
 - percentage efficiency.
 - Limiting efficiency of the machine. (14 marks)

SECTION B: ELECTRICAL AND ELECTRONIC PRINCIPLES

Answer at least **TWO** questions from this section.

5. (a) State:

- (i) Ohm's law;
- (ii) **two** applications of resistors in electronic circuits.

(4 marks)

(b) **Figure 3** shows a parallel - series resistance circuit.

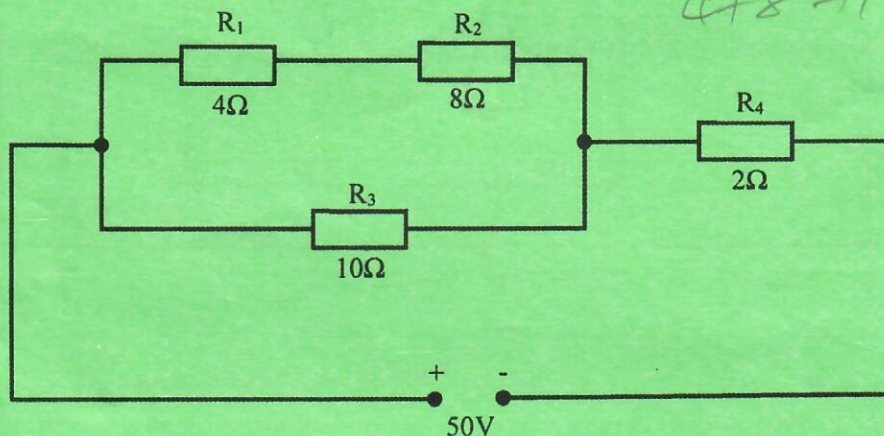


Fig. 3

Determine the:

- (i) total circuit resistance;
- (ii) potential difference across the 8Ω resistor;
- (iii) power dissipated by the 2Ω resistor.

(12 marks)

(c) A copper wire of length 600 mm has a cross-sectional area of 4 mm^2 . If the resistivity of copper is $1.7 \times 10^{-8} \Omega\text{ m}$, determine the:

- (i) resistance;
- (ii) conductance.

(4 marks)

6. (a) State Faraday's laws of electromagnetic induction.

(4 marks)

(b) Define each of the following terms with reference to magnetic circuits:

- (i) magnetic flux density;
- (ii) permeability;
- (iii) magnetomotive force.

(3 marks)

- (c) (i) A coil of 400 turns is wound on a closed iron former with a mean magnetic length of 25 cm and a cross-sectional area of 4 cm². The relative permeability of the iron is 750, determine the self inductance of the coil.
- (ii) Two coils when connected in series aiding and series opposing have a total inductance of 0.8 H and 3.2 H respectively. If the self inductance of the second coil is 0.4 H, determine:
- mutual inductance between the coils;
 - self inductance of the first coil;
 - coupling coefficient between the coils.
- (13 marks)

7. (a) Define the following terms as applied to semi-conductors:

- (i) donor atom; *= H atom the high energy level for energy*
- (ii) acceptor atom. *= acceptor*
- (2 marks)


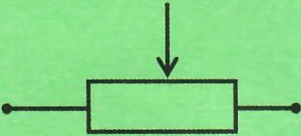

(b) Draw the characteristic graph of bipolar junction transistor and hence explain how it performs the function of:

- (i) switching; *= H*
- (ii) amplification.
- (9 marks)

(c) Table 1 shows symbols of different semi-conductor devices. Complete the table.

(6 marks)

Table 1

Symbol	Component name	Application
		
		
		

(d) Draw a sinusoidal waveform and show the following:

(i) cycle;

(ii) amplitude.

(3 marks)

8. (a) With the aid of circuit diagrams, distinguish between series wound and shunt wound d.c motor. (4 marks)

(b) Derive the equation for torque of a d.c motor. (9 marks)

(c) A current of 250 mA flows in a circuit when the applied voltage is 100 V at a frequency of 50 Hz. If the power dissipated by the circuit is 25 W, determine the:

(i) apparent power;

(ii) power factor;

(iii) reactive power.

(7 marks)

THIS IS THE LAST PRINTED PAGE.