1501/102
1508/102
1509/102
MECHANICAL SCIENCE I
AND ELECTRICAL PRINCIPLES
Oct./ Nov. 2022
Time: 3 hours

THE KENYA NATIONAL EXAMINATIONS COUNCIL

CRAFT CERTIFICATE IN MECHANICAL ENGINEERING (PRODUCTION OPTION)
CRAFT CERTIFICATE IN WELDING AND FABRICATION
CRAFT CERTIFICATE IN CONSTRUCTION PLANT ENGINEERING

MODULE I

MECHANICAL SCIENCE I AND ELECTRICAL PRINCIPLES

3 hours

INSTRUCTIONS TO CANDIDATES

You should have the following for this examination:
Answer booklet;
Drawing instruments;
Mathematical tables
Non-programmable scientific calculator.
*This paper consists of **EIGHT** questions in **TWO** sections; **A** and **B**.*
*Answer **FIVE** questions by choosing **TWO** questions from section **A**, **TWO** questions from section **B** and **ONE** question from either section.*
All questions carry equal marks.
Maximum marks for each part of a question are as indicated.
Candidates should answer the questions in English.
Take: $g = 9.81\ m/s^2$;
$\varepsilon_o = 8.85 \times 10^{-12}$ F/m;
$\mu_o = 4\pi \times 10^{-7}$ 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.

Turn over

SECTION A: MECHANICAL SCIENCE I

Answer at least TWO questions from this section.

1. (a) Distinguish between power and work as used in mechanics stating the units for each.

(4 marks)

(b) A body of mass 5 kg is initially at rest on a horizontal frictionless surface. A force of 15 N is applied and accelerates it to a final velocity of 12 m/s. Calculate the:

(i) distance travelled;
(ii) workdone by the force;
(iii) final kinetic energy of the body.

(8 marks)

(c) (i) Differentiate between centrifugal and centripetal forces.

(ii) A car whose wheels diameter is 600 mm travels at 64.8 km/h. Determine the angular velocity of the wheels in:

(I) rad/s;
(II) rev/min.

(8 marks)

2. (a) State:

(i) **three** laws of friction;
(ii) second law of motion.

(5 marks)

(b) A beam AB measures 150 cm and weighs 1.6 N. It is placed on two supports C and D such that they are 20 cm from each end of the beam. A 0.3 N weight hangs on the beam 40 cm from C and a 0.7 N weight hangs 50 cm from D respectively towards the centre.

(i) Sketch the beam indicating the forces;

(ii) Determine the reactions at the supports.

(11 marks)

(c) State:

(i) the principle of moments;
(ii) moments of a couple.

(4 marks)

3. (a) Differentiate between potential energy and kinetic energy. (4 marks)

(b) A car hauls a trailer at 90 km/h when exerting a steady pull of 600 N. Calculate the:

(i) work done in 30 minutes;
(ii) power required.

(10 marks)

(c) A motor supplies a constant force of 1 kN which is used to move a load to a distance of 5 m. The force is then changed to a constant of 5000 N and the load is moved a further 15 m.

(i) Draw the force-distance graph for the operation;

(ii) from the graph, determine the work done by the motor.

(6 marks)

4. (a) Define each of the following terms:

(i) speed;
(ii) velocity.

(2 marks)

(b) A vehicle is accelerated uniformly at 1.5 m/s^2 from a speed of 27 km/h to 81 km/h. Determine the:

(i) time required to attain the final speed;

(ii) distance travelled.

(6 marks)

(c) A machine exerts a force of 240 N to move an object at a constant speed through a distance of 600 cm in 2 minutes. Determine its power. (4 marks)

(d) **Figure 1** shows a force system at equilibrium. Determine:

(i) force A;
(ii) force B.

(8 marks)

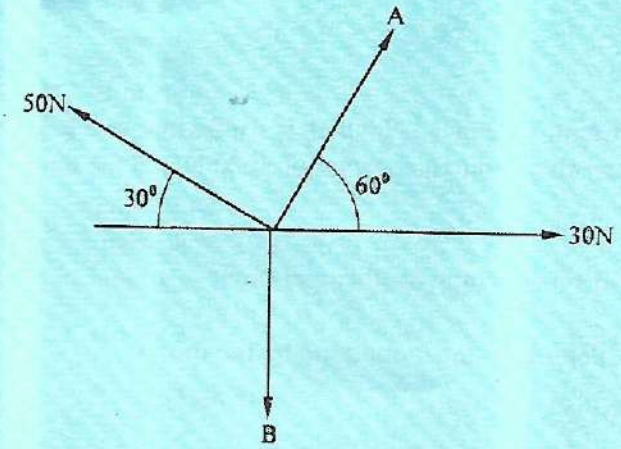

Fig. 1

SECTION B: ELECTRICAL PRINCIPLES

Answer at least TWO questions from this section.

5. (a) State the **two** Faraday's laws of electromagnetic induction. (4 marks)

(b) Outline **three** characteristics of a parallel resistive d.c. circuit. (3 marks)

(c) **Figure 2** is a series - parallel electric circuit. Determine the:

(i) supply voltage (V);
(ii) supply current (I);
(iii) power dissipated by resistor R_1.

(10 marks)

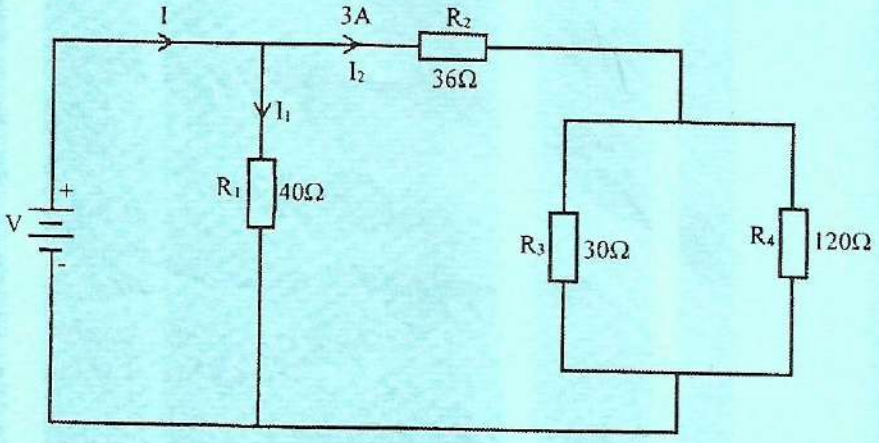

Fig. 2

(d) Name **three** classifications of electrical materials. (3 marks)

6. (a) Define each of the following terms as used in electrostatics:

(i) capacitance;

(ii) electric flux density.

(4 marks)

(b) **Figure 3** shows an electric circuit. Determine the:

(i) total capacitance;
(ii) charge stored by the whole circuit.
(iii) voltage across capacitor C_1;
(iv) energy stored by capacitor C_2.

(9 marks)

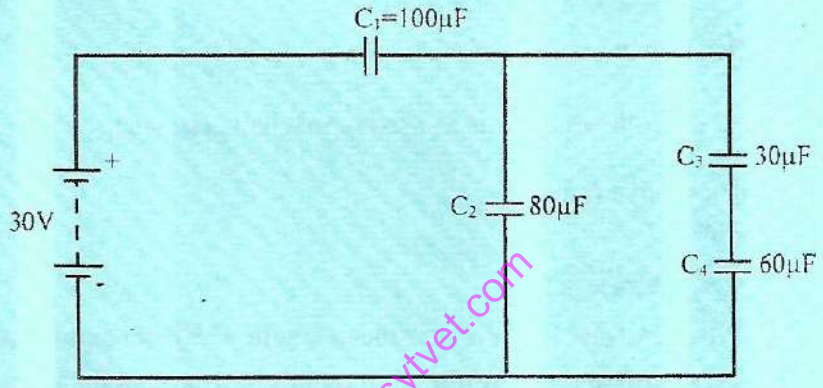

Fig. 3

(c) (i) List **three** methods of connecting cells in electrical circuits.

(ii) Four dry cells have an internal resistance of 0.8 Ω each. The e.m.f of each cell is 2 V. A load of 4 Ω is supplied by the cells while connected in parallel. Determine the:

(I) total internal resistance;
(II) voltage across the load.

(7 marks)

7. (a) Define each of the following terms with respect to alternating quantities:

(i) frequency;
(ii) power factor.

(4 marks)

(b) **Figure 4** shows an R-L-C series circuit. Determine the:

(i) circuit impedance;
(ii) voltage across the capacitor;
(iii) circuit power factor;
(iv) active (real) power.

(12 marks)

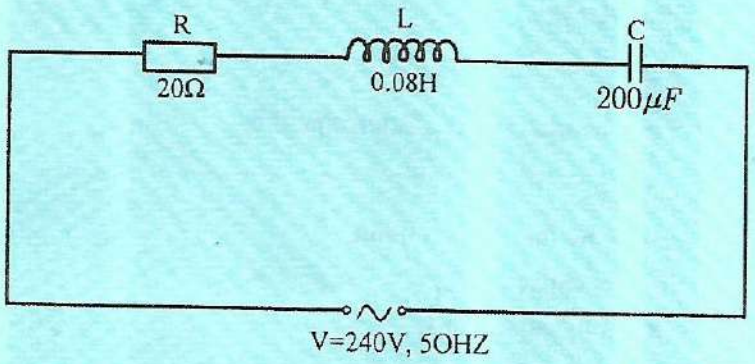

Fig. 4

(c) Draw a lebelled circuit diagram of a D.C shunt motor. (4 marks)

8. (a) Define each of the following terms as used in magnetic circuits:

(i) magnetomotive force;
(ii) reluctance.

(4 marks)

(b) A mild steel closed magnetic circuit has mean length of 50 mm and a cross-sectional area 480 mm^2. A current of 0.5 A flows through the coil wound uniformly around the mild steel and a flux of 300 μWb is established. If the relative permeability of steel is 400, calculate the:

(i) reluctance of the magnetic circuit.

(ii) number of turns of the coil.

(iii) flux density.

(9 marks)

(c) A transformer has 800 turns and 50 turns on the primary and secondary sides respectively. If the primary voltage is 200 V and a current of 10 A flows on the secondary side, determine the:

(i) secondary voltage;
(ii) primary current;
(iii) secondary load resistance.

(7 marks)

THIS IS THE LAST PRINTED PAGE.