2601/102
2602/102
2603/102
PHYSICAL SCIENCE, MECHANICAL SCIENCE AND ELECTRICAL ENGINEERING PRINCIPLES
Oct./Nov. 2022
Time: 3 hours

THE KENYA NATIONAL EXAMINATIONS COUNCIL

DIPLOMA IN ELECTRICAL AND ELECTRONICS ENGINEERING
(POWER OPTION)
(TELECOMMUNICATION OPTION)
(INSTRUMENTATION OPTION)

MODULE I

PHYSICAL SCIENCE, MECHANICAL SCIENCE AND ELECTRICAL ENGINEERING PRINCIPLES

3 hours

INSTRUCTIONS TO CANDIDATES

You should have the following for this examination:
drawing instruments;
non-programmable scientific calculator
*This paper consists of **EIGHT** questions in **THREE** sections; **A**, **B** and **C**.*
*Answer **ONE** question from section **A**, **ONE** question from section **B** and **THREE** questions from section **C** in the answer booklet provided.*
All questions carry equal marks.
Maximum marks for each part of a question are as indicated.
Candidates should answer the questions in English.

Take gravitational force g = 9.81 N/Kg.

This paper consists of 7 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: PHYSICAL SCIENCE

*Answer **ONE** question from this section.*

1. (a) Define each of the following with respect to radioactivity:

(i) half life;
(iii) nuclear fission. (2 marks)

(b) (i) State:
(I) Hess's law;
(II) **three** properties of acids.
(ii) Distinguish between ionic bonding and covalent bonding. (6 marks)

(c) A body moves in a harmonic motion from point A to point B. When the body is 0.75 m from the mid-point, its velocity is 11 m/s and when it is 2 m away from the mid-point, its velocity is 3 m/s. Determine the:

(i) Amplitude of the body;
(ii) angular velocity of the body;
(iii) periodic time. (9 marks)

(d) Draw a labelled diagram of an electromagnetic wave propagating in the Z-direction. (3 marks)

2. (a) (i) Define the term specific heat capacity.

(ii) A copper container of mass 500 g contains 1 litre of water at 20 °C. Determine the quantity of heat required to raise the temperature of the water to boiling point. Assume that there are no losses.
Take: Specific heat capacity of copper = 0.39 kJ/kgk.
Specific heat capacity of water = 4.2 kJ/kgk
1 litre of water has a mass of 1 kg. (7 marks)

(b) State:
(i) Pressure law of a gas.
(ii) Charles law of a gas. (4 marks)

(c) (i) State **two** properties of X-rays.

(ii) With the aid of a diagram, explain the principle of operation of Geiger Muller tube for detecting radiations. (9 marks)

SECTION B: MECHANICAL SCIENCE

*Answer **ONE** question from this section.*

3. (a) (i) Define angular velocity.

(ii) A body moves in a circular path of radius 20 m in 1 second. The radius from the centre of the body sweeps an angle of 36°. Determine the:

(I) average angular velocity of the body;
(II) linear velocity of the body. (6 marks)

(b) (i) State;
(I) Hooke's law;
(II) Newton's second law of motion.

(ii) A mass of 8 kg is dropped vertically to a horizontal plane. The mass falls with a velocity of 10 m/s hitting the plane in 40 milliseconds and bounces back at a velocity of 6 m/s. Determine the average impulse force on the plane. (8 marks)

(c) (i) State the first law of thermodynamics.
(ii) Explain each of the following terms with reference to thermodynamics.
(I) Enthalpy;
(II) Entropy. (6 marks)

4. (a) State Archimedes principle. (2 marks)

(b) With the aid of a diagram, explain the principle of operation of a bourdon tube gauge. (6 marks)

(c) (i) Define each of the following:

I. moment;
II. torque.

(ii) **Figure 1** shows a beam supported at points A and B. Loads of 600 N, 800 N and 400N act on the beam as shown. Determine the magnitude of the reactions at point A and B. (8 marks)

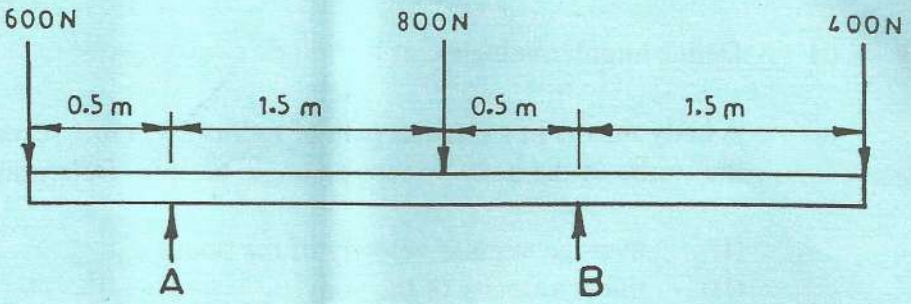

Fig.1

(d) Distinguish between each of the following types of forces:

(i) Equilibrium and equilibrant;
(ii) Coplanar and concurrent. (4 marks)

SECTION C: ELECTRICAL ENGINEERING PRINCIPLES

*Answer any **THREE** questions from this section.*

5. (a) (i) Define the term electrolysis citing two areas of its application.

(ii) An e.m.f source of 5 V supplies a current of 3 A for 10 minutes to a given load. Determine the amount of energy generated. (5 marks)

(b) Ten 1.5 V cells, each having an internal resistance of 0.2 Ω are connected in series to a load of 58 Ω. Determine the:

(i) current flowing in the circuit;

(ii) potential difference between the battery terminals. (7 marks)

(c) State **two** merits of thermocouples. (2 marks)

(d) With the aid of a labelled diagram, explain the operation of an attraction type moving iron instrument. (6 marks)

6. (a) State the superposition theorem. (2 marks)

(b) **Figure 2** shows a resistor network. Using superposition theorem determine the current flowing through each resistor. (11 marks)

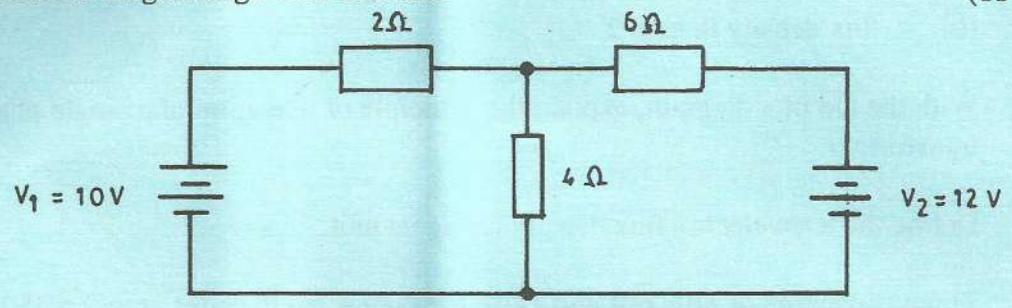

Fig. 2

(c) An alternating voltage is given by the expression:
$v = 282.8 \sin 414t$ volts. Determine the:
(i) r.m.s voltage;
(ii) frequency;
(iii) instantaneous value of voltage when t = 4 ms. (7 marks)

7. (a) With the aid of a labelled diagram, explain the hytereis loop of a magnetic material. (6 marks)

(b) **Figure 3** shows a magnetic circuit of cast steel of relative permittivity 750. A coil of 200 turns is wound on path 1.

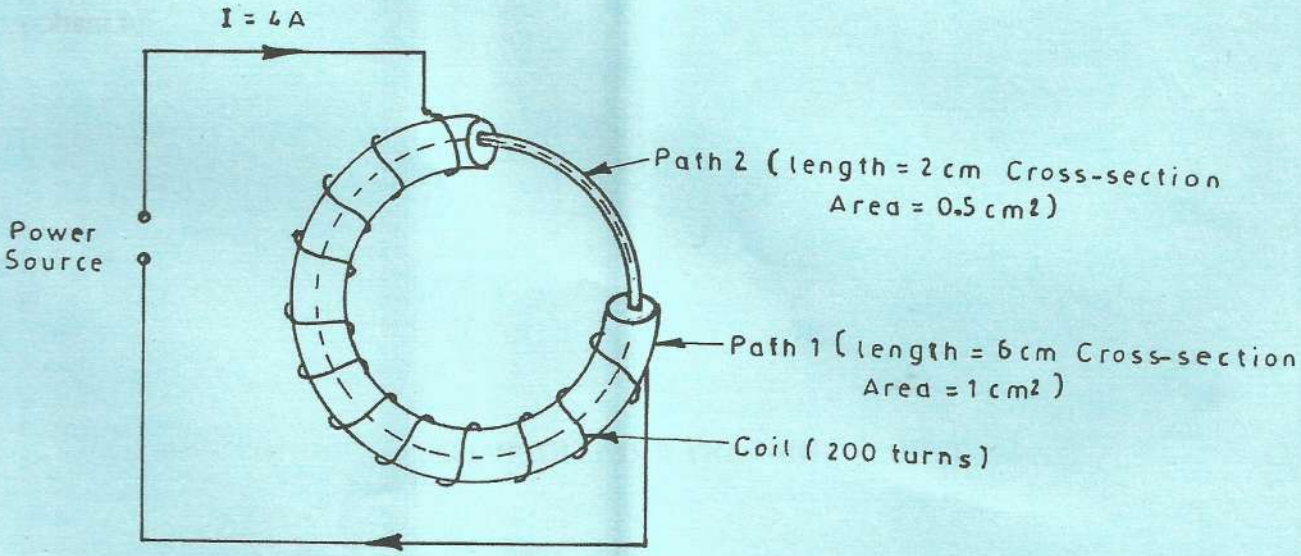

Fig. 3

Determine the:

(i) total reluctance in the circuit;
(ii) total flux in the circuit;
(iii) flux density in path 2. (8 marks)

(d) With the aid of a diagram, explain the principle of operation of a single phase transformer. (6 marks)

8. (a) Define the term electric flux density citing its unit. (2 marks)

(b) Three capacitors of 3μF, 6μf and 12μF are connected in series across a 350 V supply. Determine the:

(i) equivalent circuit capacitance;

(ii) charge on the 12μF capacitor;

(iii) potential difference across the 3μF capacitor.

(6 marks)

(c) A coil of resistance 5 Ω and inductance 120 mH is connected in series with a 100 μF capacitor to a 300 V, 50 Hz a.c supply. Determine the circuit's:

(i) total impedance
(ii) phase angle in degrees.

(8 marks)

(d) Derive the expression for resonant frequency in an ideal R-L-C series circuit. (4 marks)

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