2601/102
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2603/102
PHYSICAL SCIENCE, MECHANICAL SCIENCE AND ELECTRICAL ENGINEERING PRINCIPLES
June/ July 2016
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:
Mathematical tables/ non programmable scientific calculator;
Answer booklet.
Take $U^\circ = 2\pi \times 10^{-7}\ H/m$ *and* $\varepsilon^\circ = 8.85 \times 10^{-12} F/m$.
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 shown.
Candidates should answer the questions in English.

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: PHYSICAL SCIENCE

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

1. (a) Define the following terms as used in wave propagation:
   (i) wavelength;
   (ii) frequency. (4 marks)

   (b) A medium radio waveband lies between two wavelengths, 100 m and 1000 m. Determine the corresponding frequency range.
   [Take the velocity of the wave to be 299.8×10^6 m/s]. (4 marks)

   (c) (i) Distinguish between transverse and longitudinal electromagnetic waves.
   (ii) State **two** examples of each of the waves in c(i). (4 marks)

   (d) (i) Explain the term 'Simple Harmonic Motion'.
   (ii) A light spiral spring extends by 10 cm when loaded with a mass of 50 g. Determine the period of the vertical oscillations.
   [Take acceleration due to gravity as 10 ms^{-2}) (8 marks)

2. (a) Define the following terms as used in heating:
   (i) heat capacity;
   (ii) specific heat capacity. (2 marks)

   (b) (i) List the **four** steps in the calorimeter method of measuring specific heat capacity of a solid.

   (ii) Derive the expression for specific heat capacity of the solid in b(i). (9 marks)

   (c) (i) State Faraday's laws of electrolysis.
   (ii) **Table 1** shows the electrochemical equivalent for various materials. Using the table, determine the mass of hydrogen released by an electrolytic cell when a constant current of 3 A is passed through the cell for a time of 2 hours. (9 marks)

Table 1

Material	Electrochemical equivalent mg/C
Carbon	0.0623
Hydrogen	0.01044
Iron	0.193

SECTION B: MECHANICAL SCIENCE

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

3. (a) (i) State Archimedes principle.

(ii) With the aid of a U-tube manometer diagram, show that pressure due to a column of a liquid depends upon the density of the liquid and the height of the column. (8 marks)

(b) (i) Distinguish between 'momentum' and 'impulse'.

(ii) A railway truck A of mass 2×10^4 kg travelling at 0.5 m/s collides with another truck B of half its mass and moving in the opposite direction at a velocity of 0.4 m/s. The trucks couple automatically on collision. Determine the common relative velocity which they move. (6 marks)

(c) With aid of a T-S diagram explain the processes in the carnot cycle. (6 marks)

4. (a) State **three** types of coupling devices used in power transmission. (3 marks)

(b) (i) Explain how a centrifugal governor operates to control the speed of a steam engine.

(ii) List **two** merits of governors in b(i). (6 marks)

(c) Explain the following terms as used in dynamics:

(i) moment;
(ii) couple. (6 marks)

(d) The velocity of a body increases uniformly from a velocity of u m/s to v m/s in time t seconds. The body accelerates uniformly at a m/s^2. Derive an expression for displacement s of the body in terms of acceleration. (5 marks)

SECTION C: ELECTRICAL ENGINEERING PRINCIPLES

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

5. (a) (i) Define the term 'Permittivity' as used in electrostatics.

(ii) Draw a labelled constructional diagram of a Tantalum electrolytic capacitor.

(6 marks)

(b) **Figure 1** shows an electric circuit.

(i) Explain its operation.

(ii) The switch in the circuit is operated 100 times every second. Determine the average:

(I) current through the switching operations;
(II) power dissipated in the resistor R.

(8 marks)

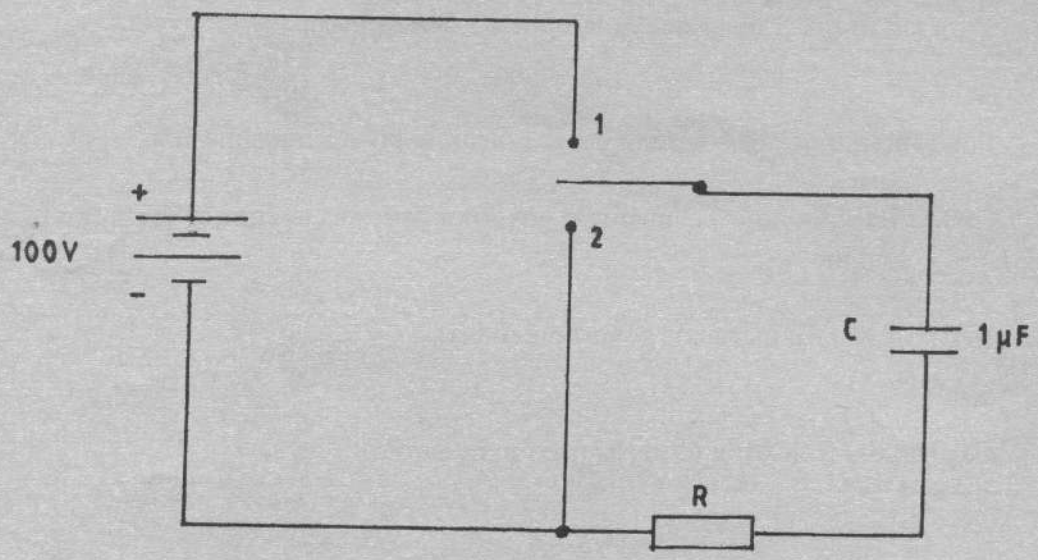

Fig. 1

(c) (i) Define the term 'mean value' as used in a.c systems.

(ii) Derive the values of form and peak factors of a sine-wave.

(6 marks)

6. (a) **Table 2** shows an analogy between electric and magnetic quantities. Fill in the missing quantities. (10 marks)

Table 2

MAGNETIC			ELECTRIC		
Quantity	Symbol	Unit	Quantity	Symbol	Unit
mmF					
			Electric flux density		
	S				
		Weber (wb)			

(b) State Faraday's laws of electromagnetic induction. (4 marks)

(c) A current ***I*** Amperes flows in an iron ring of constant permeability ***u***, mean circumference ***l*** meters and cross-sectional area ***a*** m^2. The ring is uniformly wound with ***N*** turns of a coil. If the reluctance of the ring is ***S*** A/wb, derive an expression for the inductance ***L*** of the coil. (6 marks)

7. (a) State Kirchoff's voltage law. (2 marks)

(b) **Figure 2** shows an electric circuit. Using super position theorem, determine the branch currents. (11 marks)

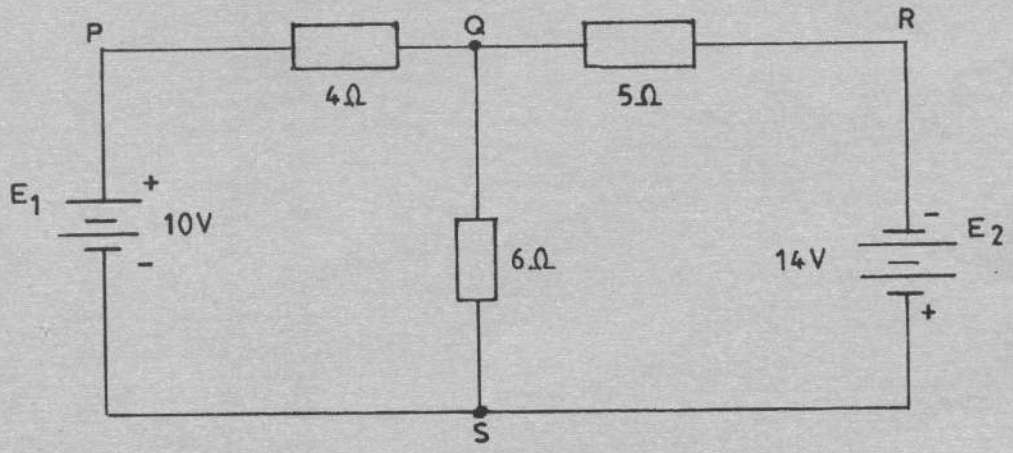

Fig. 2

(c) Derive the expression for the tuns ratio of a transformer. (Assume the transformer has negligible losses. (7 marks)

8. (a) List **three** important features of full-scale deflection (fsd) current in a measuring instrument.

(3 marks)

(b) With aid of a circuit diagram illustrate the following methods of resistance measurements by Voltmeter - Ammeter method:

(i) long shunt;
(ii) short shunt.

(4 marks)

(c) (i) State **four** requirements of the lead-Acid cell separator.

(ii) Draw a labelled diagram of a dry cell (zinc - carbon).

(13 marks)

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