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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  $U^\circ = 2\pi \times 10^{-7} \text{ H/m}$  and  $\epsilon^\circ = 8.85 \times 10^{-12} \text{ F/m}$ .*

*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.**



## 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  $299.8 \times 10^6$  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  $10 \text{ ms}^{-2}$ ] (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  $2 \times 10^4$  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<sup>2</sup>. Derive an expression for displacement  $s$  of the body in terms of acceleration. (5 marks)

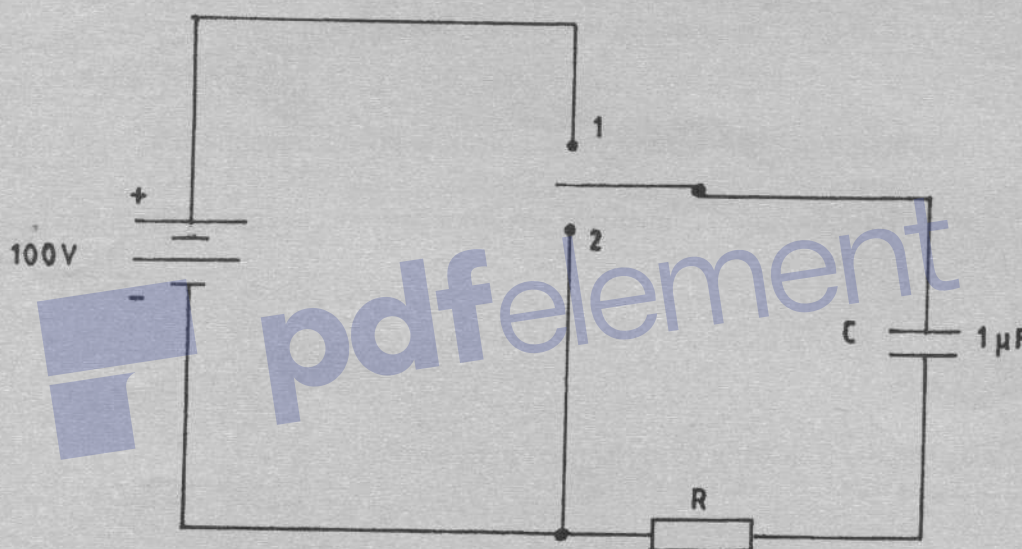


**SECTION C: ELECTRICAL ENGINEERING PRINCIPLES**

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  $\mu$ , mean circumference  $l$  meters and cross-sectional area  $a$  m<sup>2</sup>. 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)

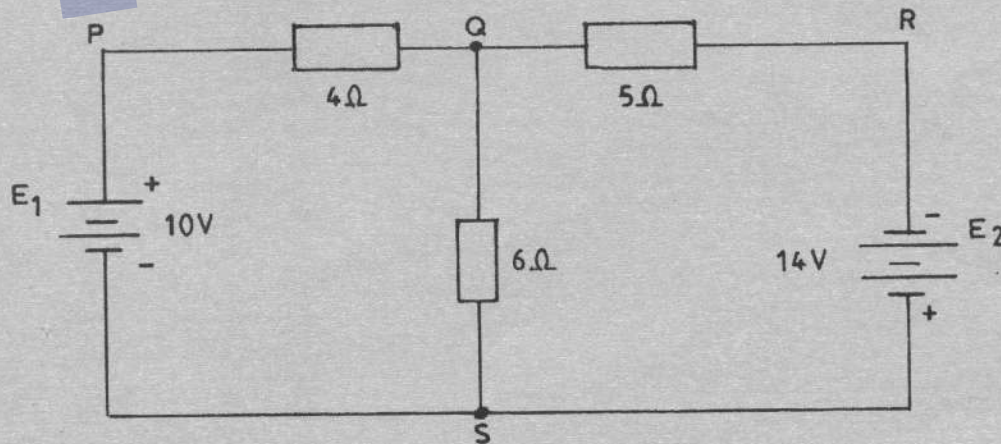


Fig. 2

- (c) Derive the expression for the turns 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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