1601/102
1602/102
APPLIED SCIENCE, ELECTRICAL
PRINCIPLES I AND ELECTRONICS
Oct./Nov. 2016
Time: 3 hours

THE KENYA NATIONAL EXAMINATIONS COUNCIL

CRAFT CERTIFICATE IN ELECTRICAL AND ELECTRONIC TECHNOLOGY
(POWER OPTION)
(TELECOMMUNICATION OPTION)

MODULE I

APPLIED SCIENCE, ELECTRICAL PRINCIPLES I AND ELECTRONICS

3 hours

INSTRUCTIONS TO CANDIDATES

You should have the following for this examination:
Answer booklet;
Drawing instruments.
*This paper consists of **THREE** sections: **A**, **B** and **C**.*
*Answer **ONE** question from section **A** and **TWO** questions each from section **B** and **C**.*
All questions carry equal marks.
Maximum marks for each part of a question are indicated.
Candidates should answer the questions in English.
Take: $\varepsilon_0 = 8.85 \times 10^{-12}$ F/m
$\mu_o = 4\pi \times 10^{-7}$ H/m
$g = 9.81$ m/s^2

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: APPLIED SCIENCE

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

1. (a) State the:

(i) Principle of Archimedes;
(ii) Law of floatation. (4 marks)

(ii) Figure 1 shows a U-tube manometer, connected to a water pipe. If the density of mercury is 1360 Kg/m^3, calculate the gauge pressure of the water. (6 marks)

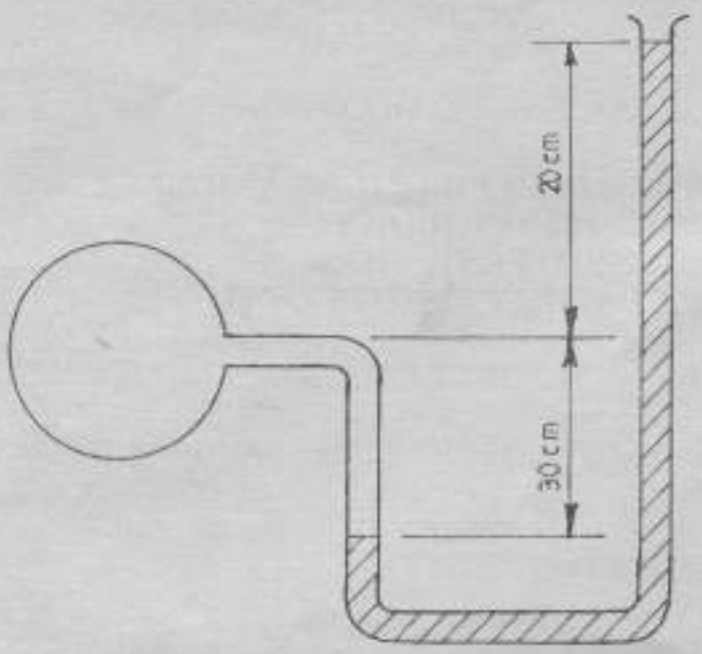

Fig. 1

(c) 2.5 Kg of a metal block of specific heat capacity 10.5 KJ/Kg °C was heated to 80° C. The block was then immersed into a lagged calorimeter containing water at 18° C. The maximum temperature attained by the water was 42°C. The heat capacity of the calorimeter is 10 KJ/°C and the specific heat capacity of water is 4.18 KJ/Kg °C. Determine the mass of the water in the vessel if:

(i) heat loss to the surroundings are negligible;
(ii) 10% of the heat is lost to the surroundings. (8 marks)

(d) Explain the method of heat transfer in solids. (2 marks)

2. (a) State the following gas laws:

(i) Boyle's law;
(ii) Charles' law. (4 marks)

(b) Derive the ideal gas equation: PV = MRT, where:

P = Pressure,
V = Volume
M = Mass
T = absolute temperature. (8 marks)

(c) (i) Distinguish between work and power.
(ii) A crane raises a load of 3.5 tonne vertically through a height of 20 metres, in one minute. If the efficiency of the crane is 68%, determine the:

(I) Power developed by the crane;
(II) Energy input to the crane, in KW. (8 marks)

SECTION B: ELECTRICAL PRINCIPLES I

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

3. (a) State:

(i) the **two** Faraday's laws of electrolysis;
(ii) any **two** advantages of nickel-iron cell over lead acid cell. (6 marks)

(b) With the aid of a labelled diagram, describe the construction of a "wet type" leclanché cell. (6 marks)

(c) The resistance of the shunt winding of a d.c. machine is measured before and after a run of several hours. The average values are 55 ohms and 63 ohms respectively. If the temperature coefficient of resistance of the winding is 0.00428/°C, and the ambient temperature is 20°C, determine the rise in temperature of the winding. (5 marks)

(d) Fourty lead acid secondary cells are to be charged at a constant voltage. The e.m.f. of each cell at the beginning and end of charge are 1.9 V and 2.7 V respectively. If the internal resistance of each cell is 0.1 Ω, calculate the:

(i) minimum charging voltage required;
(ii) initial charging current. (3 marks)

4. (a) State:

(i) Ohm's law;
(ii) any **two** materials with negative temperature coefficient. (4 marks)

(b) Three resistors R_1, R_2 and R_3 are connected in parallel across a d.c. supply of V volts. If R is the total circuit resistance, with the aid of a labelled circuit diagram, show that:

$$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

(4 marks)

(c) Figure 2 shows an electric circuit connected to a 24 V d.c. supply. Determine the:

(i) total circuit resistance;
(ii) supply current (I). (5 marks)

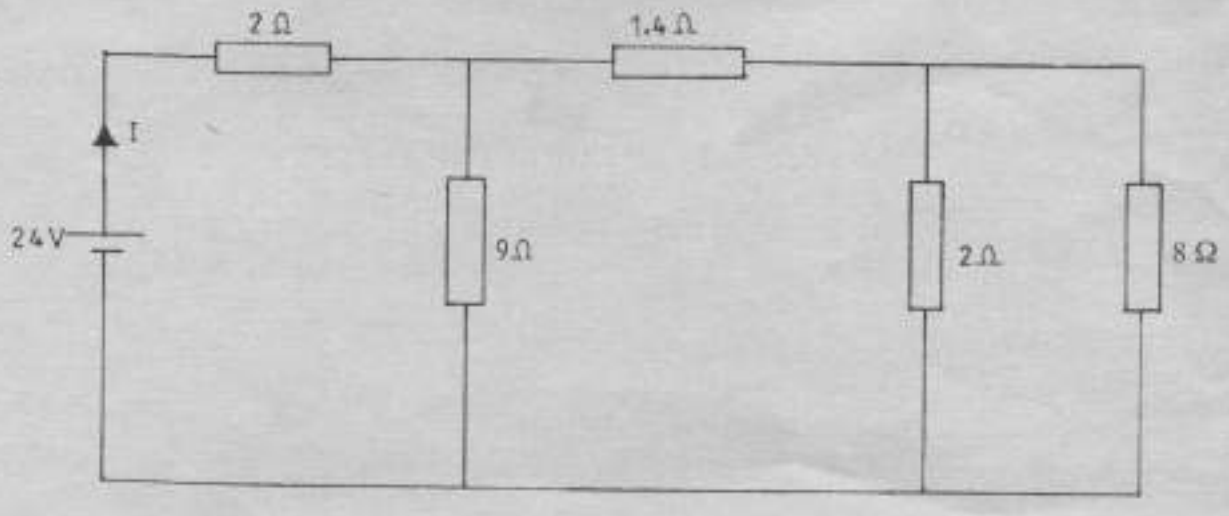

Fig. 2

(d) Two parallel plate capacitors C_1 and C_2 are connected in series across a d.c. supply of V volts. C_1 has a plate area of 0.195 m^2, with a plate separation of 0.5 mm and the relative permittivity of dielectric is 2.5. C_2 has a capacitance of 0.03 μF. Determine the potential difference across the two capacitors that will give rise to an electric field strength of 115 V/mm in the dielectric of C_1. (7 marks)

5. (a) State any:

(i) **Three** advantages of auto transformers over double-wound transformers.
(ii) **Two** applications of isolating transformers. (5 marks)

(b) With the aid of a labelled characteristic curve, explain the B-H curve forming hysteresis loop. (7 marks)

(c) An iron ring of cross sectional area 600 mm^2 is closely wound with an insulated wire and has a saw-cut of 2 mm. If the mean length of the magnetic path is 300 mm and the relative permeability of iron is 470, determine the total magneto-motive force required to produce a flux of 0.1 mWb in the magnetic circuit. (8 marks)

SECTION C: ELECTRONICS

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

6. (a) Differentiate between intrinsic and extrinsic semi-conductors. (4 marks)

(b) With the aid of a labelled circuit diagram, explain the operation of a class B push-pull amplifier. (8 marks)

(c) For the bipolar junction transistor shown in figure 3, show that:

$$\beta = \frac{\alpha}{1-\alpha}$$ (4 marks)

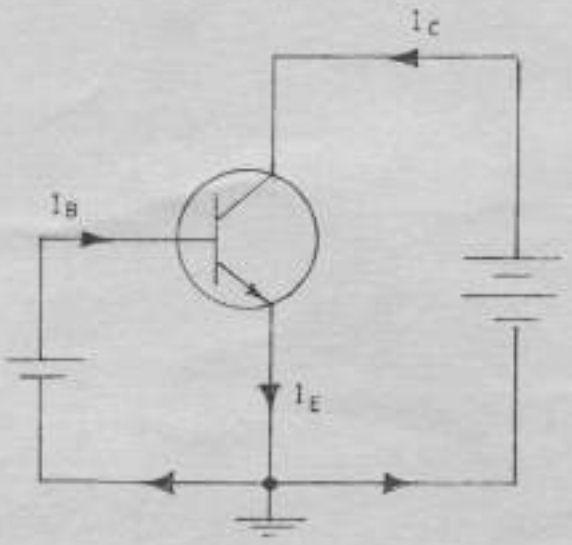

Fig. 3

(d) Describe, with the aid of a block diagram, the current series feedback connection as applied to negative feedback amplifiers. (4 marks)

7. (a) (i) State any **two** applications of oscillators.

(ii) With the aid of labelled circuit diagrams and frequency response curves, explain the operation of the following types of filters:

(I) low pass filter;
(II) high pass filter. (10 marks)

(b) With the aid of circuit and waveform diagrams, explain the operation of a full wave bridge rectifier. (10 marks)

8. (a) Perform the following conversions:

(i) 1011010111_2 into hexadecimal.
(ii) 205.103_8 into decimal. (6 marks)

(b) Simplify the Boolean expression:

$A\bar{B}C + A\bar{B}\bar{C} + \bar{A}BC + ABC + A\bar{B}C$. (4 marks)

(c) Figures 4 (a) and (b) are circuit diagrams of switching systems. For each circuit, determine the:

(i) truth table;
(ii) logic expression. (8 marks)

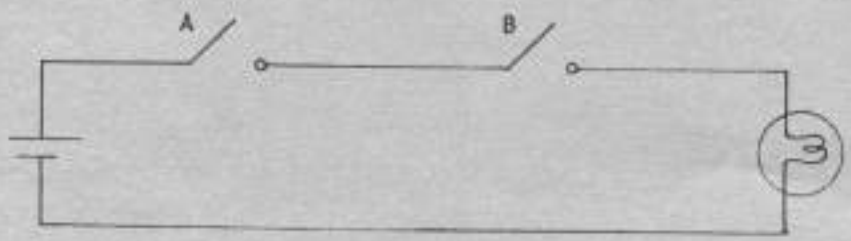

Fig. 4 (a)

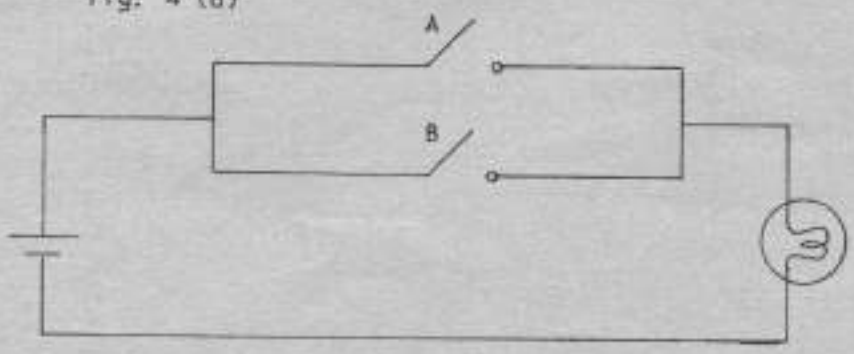

Fig. 4 (b)

(d) State any **two** applications of flip-flops. (2 marks)

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