

1601/102

1602/102

APPLIED SCIENCE, ELECTRICAL
PRINCIPLES I AND ELECTRONICS

Oct./Nov. 2016

Time: 3 hours

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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: $\epsilon_0 = 8.85 \times 10^{-12} \text{ F/m}$

$\mu_0 = 4\pi \times 10^{-7} \text{ H/m}$

$g = 9.81 \text{ m/s}^2$

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.

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)

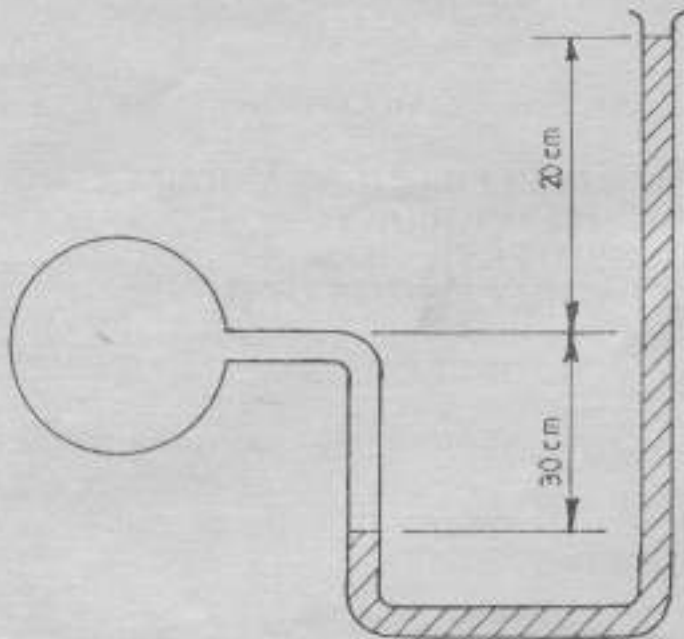


Fig. 1

- (c) 2.5 Kg of a metal block of specific heat capacity $10.5 \text{ KJ/Kg } ^\circ\text{C}$ 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 $10 \text{ KJ}^\circ\text{C}$ and the specific heat capacity of water is $4.18 \text{ KJ/Kg } ^\circ\text{C}$. 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 $0.00428/^\circ\text{C}$, 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 0.1Ω , calculate the:
- (i) minimum charging voltage required;
 - (ii) initial charging current. (3 marks)

4. (a) State:
- Ohm's law;
 - 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:

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

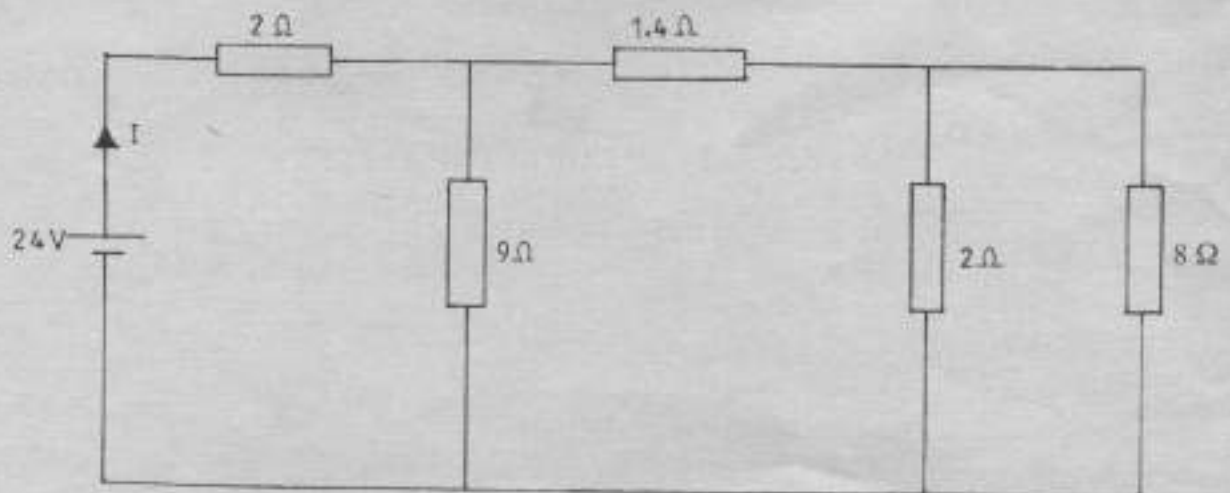


Fig. 2

- (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 $0.195\ \text{m}^2$, with a plate separation of $0.5\ \text{mm}$ and the relative permittivity of dielectric is 2.5 . C_2 has a capacitance of $0.03\ \mu\text{F}$. Determine the potential difference across the two capacitors that will give rise to an electric field strength of $115\ \text{V/mm}$ in the dielectric of C_1 . (7 marks)

5. (a) State any:
- Three** advantages of auto transformers over double-wound transformers.
 - 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 mm² 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:

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

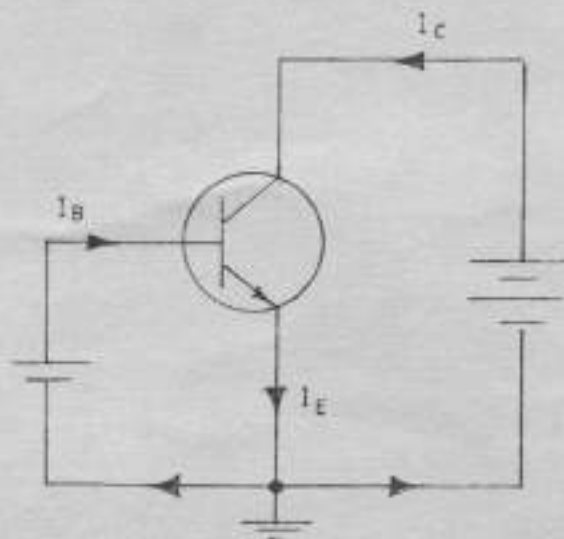


Fig. 3

- (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:

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

- (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)

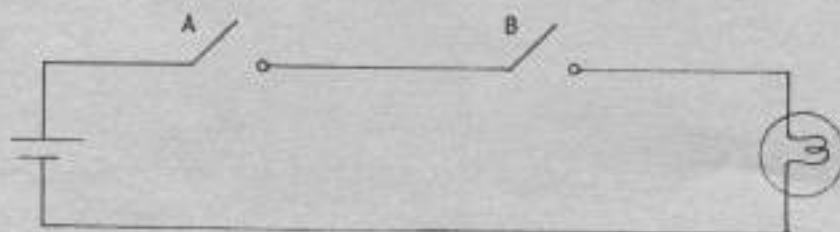


Fig. 4 (a)

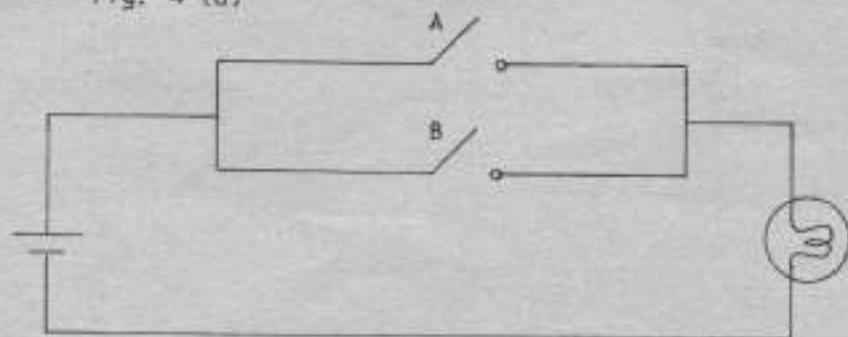


Fig. 4 (b)

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

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