1503/102
APPLIED SCIENCE AND
ELECTRICAL PRINCIPLES
June/July 2018
Time: 3 hours

THE KENYA NATIONAL EXAMINATIONS COUNCIL

CRAFT CERTIFICATE IN AUTOMOTIVE ENGINEERING

MODULE I

APPLIED SCIENCE AND ELECTRICAL PRINCIPLES

3 hours

INSTRUCTIONS TO CANDIDATES

You should have the following for this examination:
Answer booklet;
Scientific calculator;
Drawing instruments.
*This paper consists of **TWO** sections; **A** and **B**.*
*Answer **FIVE** questions by choosing at least **TWO** questions from each section.*
All questions carry equal marks.
Maximum marks for each part of a question are indicated.
Take: $g=9.81\ m/s^2$
$\mu_0 = 4\pi \times 10^{-7}$ H/M
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: APPLIED SCIENCE

*Answer at least **TWO** questions from this section.*

1. (a) (i) Define the following:

(I) pressure;
(II) density. (2 marks)

(ii) State **three** characteristics of pressure in liquids. (3 marks)

(b) With the aid of a diagram, explain the principle of transmission of pressure in a hydraulic brake. (8 marks)

(c) Convert standard atmospheric pressure form mmHg to:

(i) Newtons per metre square;
(ii) bar. (7 marks)

2. (a) Define the following:

(i) specific heat capacity;
(ii) heat capacity;
(iii) latent heat of fusion. (3 marks)

(b) A piece of iron of mass 50g and specific heat capacity of 460 J/kg is cooled from 80 °C to 20 °C. Determine the heat produced. (5 marks)

(c) (i) State the laws of reflection. (2 marks)

(ii) Explain the following methods of heat transfer:

(I) radiation;
(II) convention. (4 marks)

(iii) In an isothermal process, 0.55 m^3 of air at a pressure of 101 kN/m^2 and temperature of 25 °C is compressed to 909 kN/m^2. Taking the characteristic gas constant, R = 0.288 kJ/kgK, determine the:

(I) mass of the gas compressed;
(II) final volume of the gas. (6 marks)

3. (a) Define the following:

(i) mechanical advantage;
(ii) velocity. (2 marks)

(b) Derive an expression of kinetic energy of a body of mass, M, moving from rest to a final velocity, V. (6 marks)

(c) A load of 1.26 kN is lifted by means of a pulley block system consisting of three pulleys in the upper block and two pulleys in the lower block. The efficiency of the system at this load is 84%. Determine the:

(i) velocity ratio;
(ii) mechanical advantage;
(iii) effort required to lift the load.

(6 marks)

(d) **Table 1** shows data obtained from an experiment carried out on a machine to determine the effort (E) required to lift the load (W) for the range of values shown.

Table 1

W (kN)	0	1	2	4	6	8	10
E (kN)	0.11	0.33	0.59	0.11	1.61	2.07	2.62
W/E	0	3.03	3.39	36.36	9.84	3.86	3.82

(i) complete table 1; (2 marks)
(ii) plot the graph of E against W. (4 marks)

4. (a) Define the following;

(i) atomic number;
(ii) mass number;
(iii) isotope. (3 marks)

(b) With the aid of diagrams, describe the following;

(i) reflection;
(ii) refraction. (8 marks)

(c) A screw jack has a single start thread with a pitch of 3 mm. The load to be raised is 1 tonne. The efficiency at this load is 18%. Determine the torque required at the jack handle to raise the load. (9 marks)

SECTION B: ELECTRICAL PRINCIPLES

*Answer at least **TWO** questions from this section.*

5. (a) Define the following:
   (i) resistivity;
   (ii) conductivity. (2 marks)

   (b) Two copper wires are used to connect a d.c supply to a motor which is 150 m away. The total resistance of the wire used is 0.722 Ω and the resistivity of copper is $1.7 \times 10^{-8} \Omega - m$. . Determine the diameter of the wire. (5 marks)

   (c) With the aid of a diagram, explain the method of minimizing armature reaction using compensating windings. (7 marks)

   (d) **Figure 1** shows an A.C. series circuit. Determine the impedance of the circuit. (6 marks)

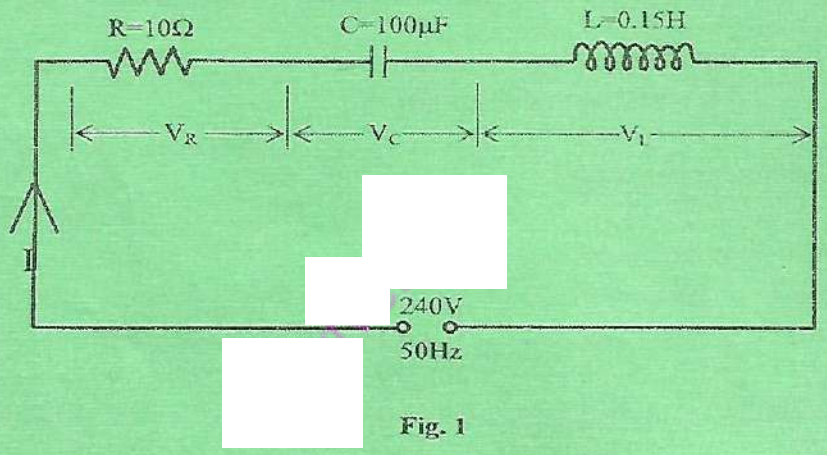

Fig. 1

6. (a) With the aid of chemical equations, describe the process of charging and discharging a lead acid battery. (9 marks)

   (b) **Figure 2** shows three capacitors connected in series to a d.c supply. Determine the:

   (i) total capacitance;
   (ii) charge stored on each capacitor;
   (iii) p.d across capacitor C_2;
   (iv) energy stored in capacitors C_3. (8 marks)

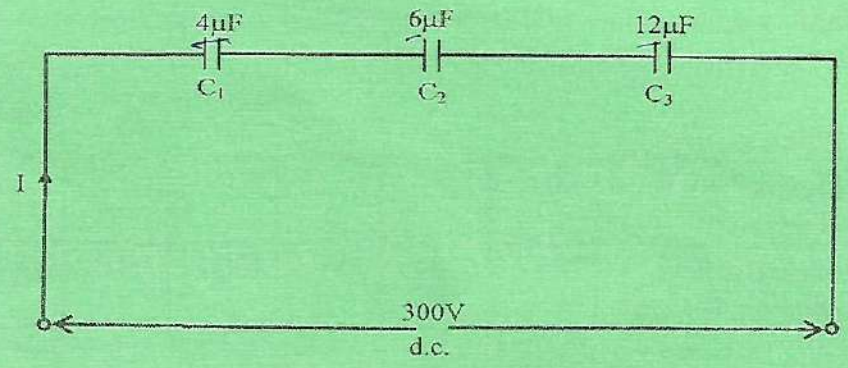

Fig. 2

(c) **Table 2** shows the bands of a colour coded resistor. Determine its resistance.

Table 2

1st Band	2nd Band	3rd Band	4th Band
Yellow	Violet	Black	Gold

(3 marks)

7. (a) **Table 3** shows magnetic quantities. Complete the table.

Magnetic Quantity	Electric Quantity
Reluctance	
Permeability	
Flux density	

(3 marks)

(b) **Figure 3** shows the configurations of a magnetic circuit. The limb has a cross-sectional area of 10 cm^2. The air-gap is 1.2 mm long. The coil has 500 turns and the flux in the air-gap is 1×10^{-3} Wb. Determine the:

(i) magnetic flux density in the air-gap;
(ii) magnetic field strength in the air-gap;
(iii) mmf in the air-gap. (6 marks)

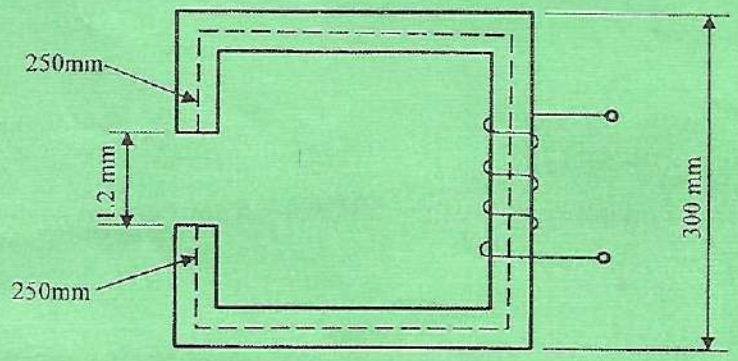

Fig. 3

(c) **Table 4** shows values of flux density (B) and magnetic field strength (H) obtained from an experimental setup.

Table 4

Flux density B (Tesla)	1.0	1.2	1.3	1.35	1.42	1.45	1.5	1.55
Magnetic field strength, H (A/M)	200	450	700	1000	1500	200	3000	4500

Plot the B - H curve using the values in **table 4**. (4 marks)

(d) With the aid of a diagram, describe the construction of a single phase shell type transformer. (7 marks)

8. (a) Distinguish between the following giving an example in each case:

(i) N-type semi-conductor;
(ii) P-type semi-conductor. (4 marks)

(b) With the aid of a diagram, explain the operation of a reverse biased P-N junction diode. (6 marks)

(c) **Figure 4** shows a silicon transistor regulator. Determine the:

(i) load voltage;
(ii) load current;
(iii) current through R_1. (6 marks)

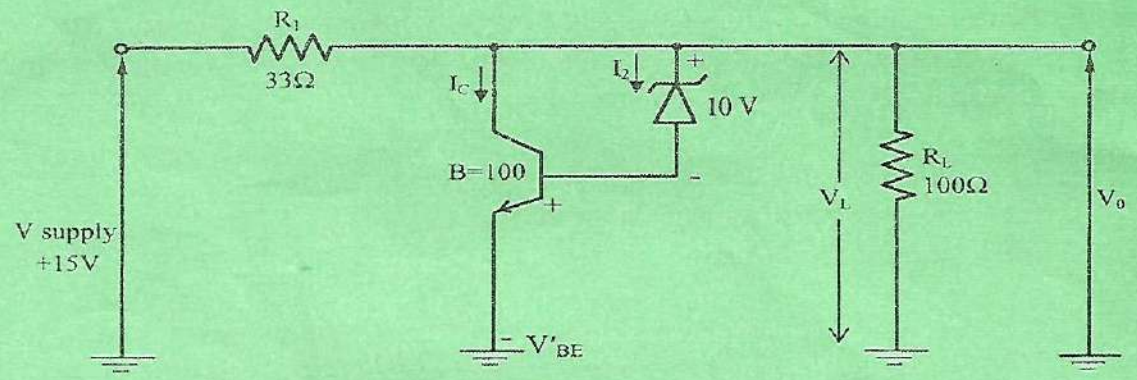

Fig. 4

(d) Sketch the output signals of the following amplifiers for a sinusoidal input voltage:

(i) class A;
(ii) class B. (4 marks)

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