THE KENYA NATIONAL EXAMINATIONS COUNCIL

DIPLOMA IN AERONAUTICAL ENGINEERING (AVIONICS OPTION)

MODULE II

ELECTRIC CIRCUIT ANALYSIS

3 hours

INSTRUCTIONS TO CANDIDATES

You should have the following for this examination:
Answer booklet;
Non-programmable Scientific calculator.
*Answer any **FIVE** of the **EIGHT** questions 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.

1. (a) Differentiate between fundamental frequency and harmonics as used in complex wave forms. (2 marks)

(b) The instantaneous value of a complex voltage wave V is given by the general equation $V = V_1 \sin(\omega t + \theta_1) + V_2 \sin(2\omega t + \theta_2) + \ldots + V_n \sin(n\omega t + \theta_n)$ Volts.
Determine the:

(i) fundamental component;
(ii) frequency in the n^{th} harmonic component. (3 marks)

(c) (i) State **three** sources of harmonic in a.c circuits.
(ii) Figures 1(a) and (b) show periodic complex waveforms. State with reasons the type of harmonics present in each case. (8 marks)

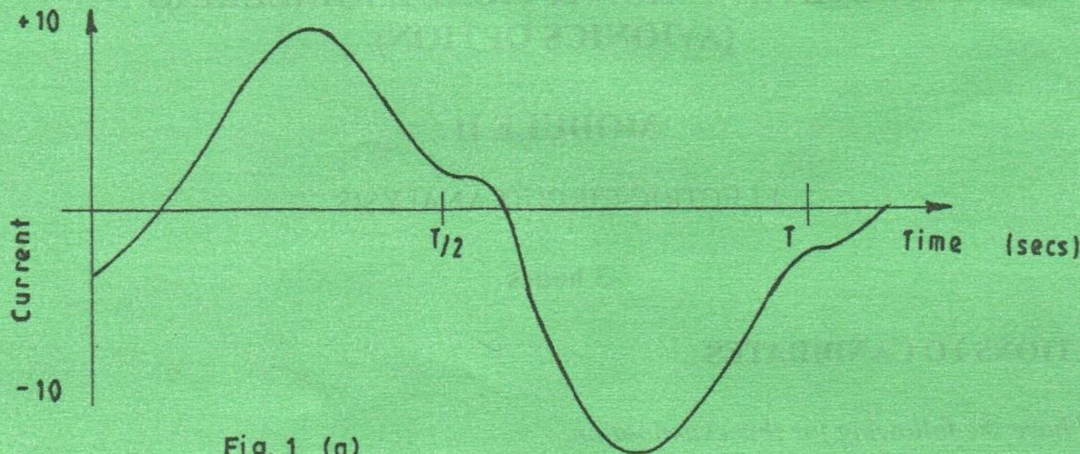

Fig. 1 (a)

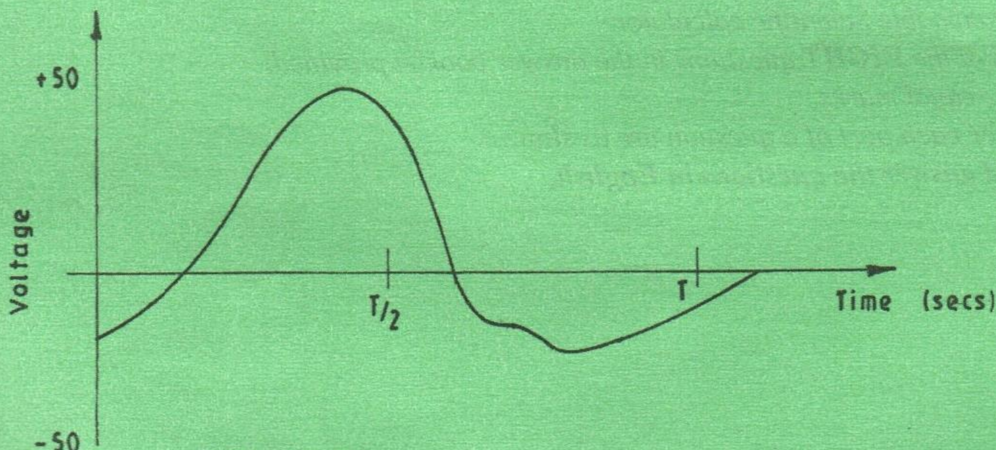

Fig. 1 (b)

(d) A complex voltage is represented by the expression.
$V = 10 \sin \omega t + 3 \sin 3\omega t + 2 \sin 5\omega t$ volts

Determine the:

(i) rms value;
(ii) mean value;
(iii) form factor. (7 marks)

2. (a) Figure 2 shows a circuit diagram of an R - C network. Explain the state of the:

(i) capacitor voltage (V_c), at the instant of closing switch S.
(ii) capacitor voltage a short time later after closing switch S.
(iii) voltage across the resistor at steady state. (6 marks)

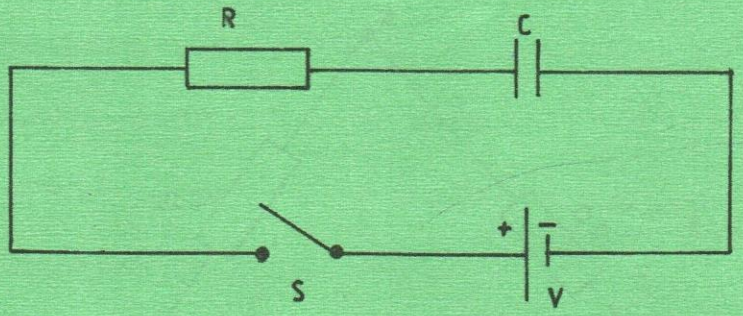

Fig. 2

(b) (i) Define 'time-constant' as used in d.c. transients.

(ii) A 20 μF capacitor is connected in series with 40 kΩ resistor and the circuit is connected to a 10 V d.c. supply. Determine the:

(I) initial value of current flowing;
(II) time - constant of the circuit.

(iii) Value of current one second after connection. (7 marks)

(c) For an R -L circuit:

(i) draw on the same axes the induced voltage and current transient curves;
(ii) write down the expression for the time constant;
(iii) a 10 mH coil has a time constant of 0.2 mSeconds. Determine its equivalent resistance. (7 marks)

3. (a) Draw the circuit diagram for the following:

(i) π - Network;
(ii) T - Network. (4 marks)

(b) Figure 3 shows a circuit diagram of delta connected loads.

(i) determine the equivalent star connected loads;
(ii) sketch the resultant circuit diagram. (8 marks)

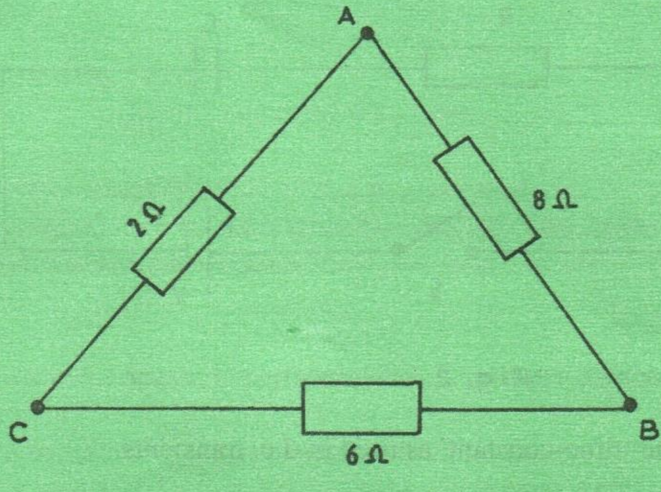

Fig. 3

(c) Figure 4 shows a circuit diagram of a d.c. network. Derive the Thevenin's equivalent circuit. (8 marks)

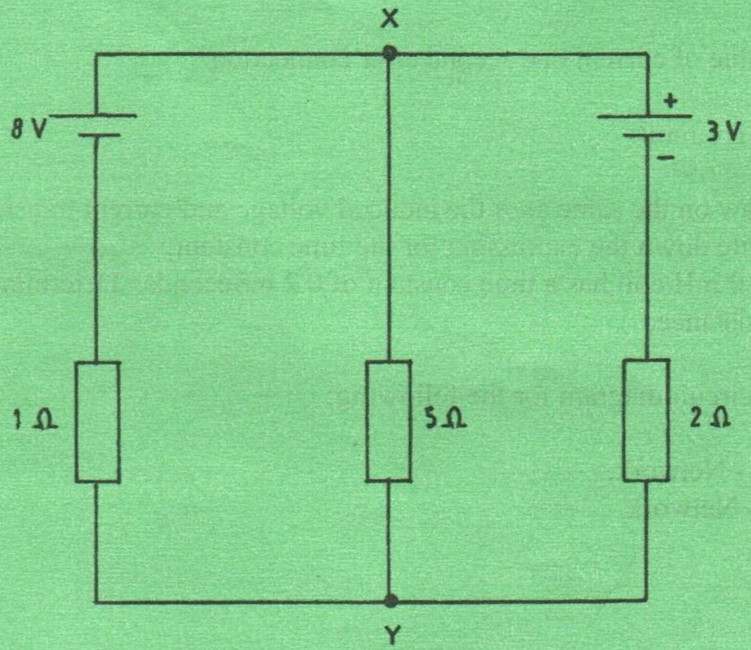

Fig. 4

4. (a) With the aid of a circuit diagram, illustrate the following three-phase transformer connections:

(i) Delta - Star;
(ii) Delta - Delta. (6 marks)

(b) A 3 phase 50 Hz transformer has a delta connected primary and star connected secondary. The primary and secondary voltages are 22,000 V and 400 V respectively. The primary line current is 5 A while the secondary connected load has a power factor of 0.8 lagging. Determine the:

(i) secondary line current;
(ii) transformer output power in kW. (12 marks)

(c) State **two** merits of three phase power systems. (2 marks)

5. (a) Define the following terms as used in three phase induction motors:

(i) synchronous speed;
(ii) slip. (2 marks)

(b) Draw a diagram to show power flow in a three phase Induction Motor. (6 marks)

(c) A six-pole three-phase induction motor is fed from a 50 Hz supply. The frequency of the rotor emf at full-load is 2 Hz. Determine the:

(i) full-load slip;
(ii) speed of the rotor. (7 marks)

(d) (i) Sketch the torque-speed characteristic curve for a three phase Induction motor.
(ii) State **two** areas of application of the motor in d(i). (5 marks)

6. (a) State **two** examples in electrical engineering where two-port networks are applied. (2 marks)

(b) The transmission parameters ABCD relate the voltage and current at one port to voltage and current at the other port of a two-port network as follows:

$$V_1 = AV_2 - BI_2$$
$$I_1 = CV_2 - DI_2$$

(i) Write the port equations in matrix form.
(ii) Figure 5 shows a series impedance network. Using the matrix method, determine the ABCD constants. (8 marks)

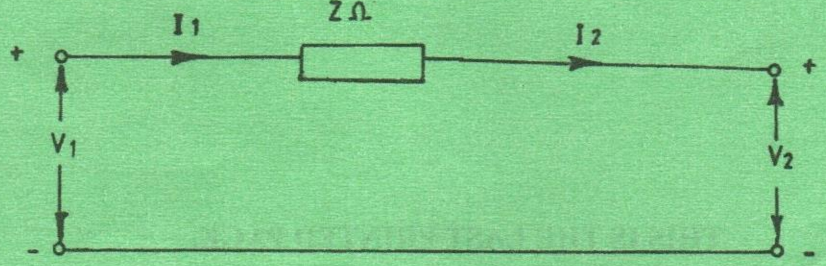

Fig. 5

(c) A series a.c circuit consists of an inductor of 0.2 H and a resistor of 5 Ω connected to 240 V 50 Hz supply. Determine for the circuit:

(i) impedance;
(ii) current;
(iii) Power factor;
(iv) Power dissipated. (10 marks)

7. (a) State **two** applications of synchronous motors. (2 marks)

(b) Explain why a synchronous motor is not self starting. (4 marks)

(c) Sketch the phasor diagrams for a synchronous motor operating under the following excitations:

(i) normal;
(ii) under excitation. (6 marks)

(d) (i) List **two** requirements necessary when synchronising a three-phase synchronous motor to a supply system.
(ii) With aid of a circuit diagram, describe the lamps dark method of synchronisation. (8 marks)

8. (a) Define the following terms as used in direct current machines:

(i) armature reaction;
(ii) commutation. (2 marks)

(b) (i) Explain the principle of operation of a d.c. motor.
(ii) Draw a labelled circuit diagram of a d.c shunt generator.
(iii) Sketch the open circuit characteristic of the d.c. machine in b(ii). (12 marks)

(c) (i) State the need for a starter in a d.c. motor circuit.
(ii) An 8 pole lap-wound generator has 1200 conductors and a flux per pole of 0.03wb. Determine the emf generated when the armature runs at 500 rpm. (6 marks)

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