2507/207
ELECTRIC CIRCUIT ANALYSIS
June/July 2017
Time: 3 hours

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 indicated.
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.

Turn over

1. (a) State each of the following network theorems:

(i) Norton's;

(ii) Millman's.

(4 marks)

(b) Figure 1 shows a circuit diagram of a d.c network.

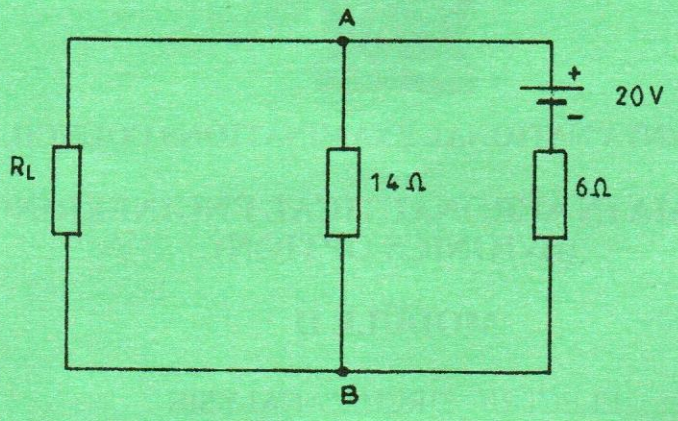

Fig. 1

(i) Determine the value of the equivalent Thevenins resistance.

(ii) Draw the Thevenins equivalent circuit diagram.

(10 marks)

(c) Table 1 shows various values of load resistance (R_L) and currents in an electric circuit.

Table 1

R_L (Ω)	0	1.0	2.5	4.0
I (Amperes)	2.4	1.71	1.2	0.92
Power (watts)				

(i) Complete the table.

(ii) Plot a graph of power versus load resistance.

(iii) State the maximum value of power.

(6 marks)

2. (a) (i) State **two** types of rotors found in three phase induction motors.

(ii) For a three-phase induction motor, derive the expression for the relationship between the rotor current frequency (f_r) and supply frequency (f).

(7 marks)

(b) With aid of a labelled circuit diagram, explain the Star-Delta method of starting a three phase squirrel cage induction motor. (8 marks)

(c) A three phase induction motor is fed from a 50 Hz supply and runs at 732 rpm. The per unit slip is 0.024.

Determine the:

(i) synchronous speed;

(ii) total number of poles for which the machine is wound.

(5 marks)

3. (a) Define the term "Transient' as used in d.c circuits. (1 mark)

(b) A 0.2 μF capacitor is connected in series with a 10 kΩ resistor across a 10 V a.c supply. Determine the:

(i) circuit time constant;

(ii) initial rate of change of voltage across the capacitor.

(6 marks)

(c) (i) Explain why it is necessary to take precaution while switching off inductive loads.

(ii) Sketch the following for a purely capacitive single phase a.c circuit:

(I) current and voltage waveforms on the same axes;

(II) graph of capacitive reactance (X_C) versus supply frequency (f).

(7 marks)

(d) A coil of resistance 5 Ω and inductance 0.5 H is connected in parallel with a capacitor across a 240 V, 50 Hz a.c supply. Determine the following at resonance:

(i) value of the capacitor;

(ii) total circuit current;

(iii) quality factor of the circuit.

(6 marks)

4. (a) (i) With reference to Faradays laws, state the principle of operation of a d.c generator.

(ii) List **three** types of connections for self-excited d.c generators.

(5 marks)

(b) Table 2 shows the values of field current and generated emf for a separately excited d.c generator. The machine is connected as a shunt generator with a shunt field resistance of 150 Ω.

Table 2

I_f (A)	0	0.2	0.4	0.6	0.8	1.0	1.2
Emf (V)	8	31	64	97	126	145	158

(i) Plot the open circuit characteristics.

(ii) From the graph, determine the emf generated.

(7 marks)

(c) (i) State **two** reasons why a d.c generator may fail to excite.

(ii) List **two** losses in d.c machines.

(4 marks)

(d) A d.c generator runs at 30 rev/sec while generating an emf of 200 V. Determine the percentage increase in flux per pole required to generate 250 V at 20 rev/sec.

(4 marks)

5. (a) State:

(i) **two** ways in which the phases of a three phase supply can be interconnected;

(ii) the National Standard Phase sequence for a three phase supply.

(3 marks)

(b) Show that the expressions for power developed in star and delta connected three phase systems are the same. (7 marks)

(c) In a two-wattmeter method of power measurement in a three phase load, the wattmeters indicated 16 kW and -11 kW respectively. Determine the:

(i) total power;

(ii) load power factor.

(5 marks)

(d) Draw a line diagram showing three-domestic and two-industrial loads supplied from a three phase system. (5 marks)

6. (a) Distinguish between an Amplidyne and a Metadyne electric machine. (2 marks)

(b) With aid of a diagram, explain the operation of a four-pole permanent magnet type stepper motor. (8 marks)

(c) (i) Explain why a.c series motor is referred to as a universal motor.

(ii) Differentiate between a linear induction motor, and rotary induction motor. (6 marks)

(d) For a three phase induction motor state **two:**

(i) methods of speed control;

(ii) types of power losses.

(4 marks)

7. (a) (i) Figure 2 shows a fundamental wave form. Sketch on the same axes the 2nd and 3rd harmonic wave forms. (4 marks)

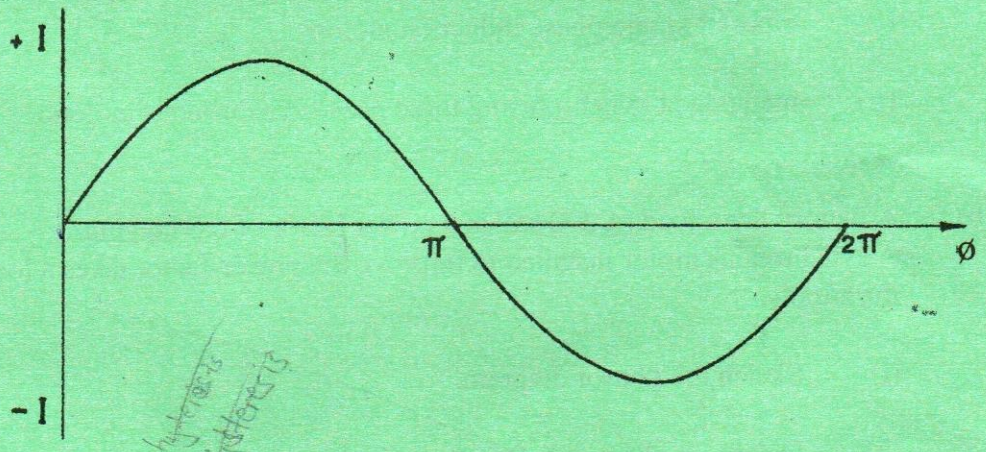

Fig. 2

(b) The general expression of a complex wave is given as $V_1 = V_m \sin(\omega t + \theta_1)$. Write the expression for the:

(i) second even harmonic;

(ii) third odd harmonic.

(4 marks)

(c) (i) Distinguish between Active and Passive two-port networks.

(ii) List **one** example of each of the networks in c (i).

(4 marks)

(d) (i) Figure 3 shows a symmetrical-T network terminated in a characteristic impedance Z_0.
Obtain the expression for Z_0 in terms of Z_1 and Z_2.

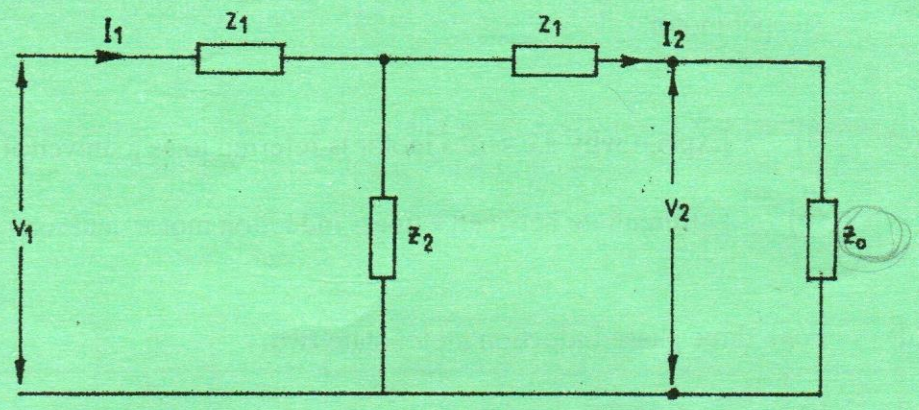

Fig. 3

(ii) Draw a labelled diagram of two "Two-port networks in cascade.

(8 marks)

8. (a) State **three**:

(i) types of single phase induction motors;

(ii) methods of synchronising three phase synchronous motors.

(6 marks)

(b) A factory has a load of 200 kW at a power factor of 0.8 lagging.
A synchronous motor installed to improve the power-factor takes a load of 50 kW from the supply.

(i) Sketch the phasor diagram.

(ii) Determine the power factor at which the motor must be operated to improve the power factor to 0.9.

(14 marks)

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