2507/207
ELECTRIC CIRCUIT ANALYSIS
June/July 2023
Time: 3 hours

THE KENYA NATIONAL EXAMINATIONS COUNCIL

DIPLOMA IN AERONAUTICAL ENGINEERING (AVIONICS OPTION)

MODULE III

ELECTRIC CIRCUIT ANALYSIS

3 hours

INSTRUCTIONS TO CANDIDATES

You should have the following for this examination:
Answer booklet;
Non-programmable scientific calculator;
Drawing instruments.
*This paper consists of **EIGHT** questions.*
*Answer **FIVE** 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 5 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) Define each of the following quantities with respect to symmetrical two-port networks:

(i) Characteristic impedance;

(ii) Propagation coefficient (γ);

(iii) Insertion loss.

(3 marks)

(b) **Figure 1** shows a T two-port network. Determine the expressions of each of the following:

(i) $\tanh\gamma$;

(ii) Z_{oc};

(iii) Z_{sc}. (6 marks)

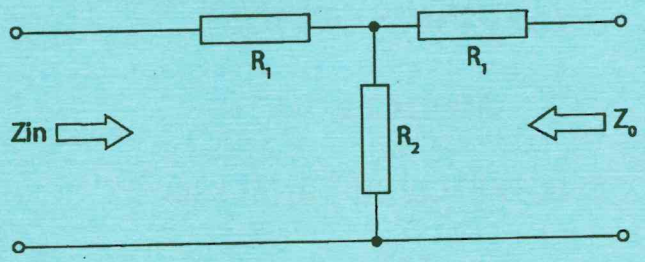

Fig. 1

(c) **Figure 2** shows a π two-port network. Determine the:

(i) characteristic impedance, Z_o;

(ii) insertion loss if the input power is 2 kW and output voltage and current is 8 V and 2 A respectively.

(9 marks)

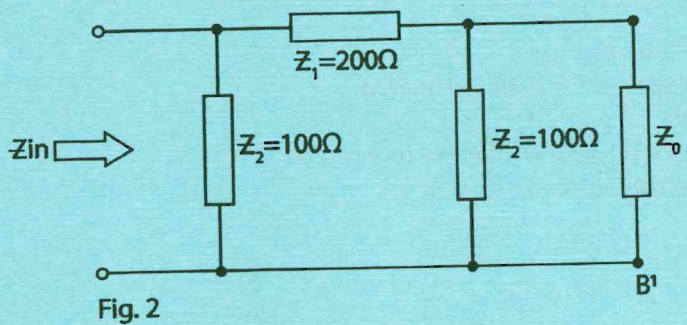

Fig. 2

(d) Explain an asymmetrical network as applied to two-port networks. (2 marks)

2. (a) With the aid of a labelled diagram, explain the construction of a d.c machine.

(8 marks)

(b) A 6-pole d.c lap-wound shunt motor is connected to a 240 V d.c source. The resistance of the armature is 2 Ω and has 400 conductors. The magnetic flux produced is 20 mWb per pole. If the armature current is 50 A, determine the:

(i) back e.m.f;
(ii) speed;
(iii) torque.

(8 marks)

(c) Sketch each of the following characteristic curves for a d.c series motor:

(i) speed-armature current;
(ii) torque-armature current.

(4 marks)

3. (a) State **three** merits of a capacitor start capacitor run motor. (3 marks)

(b) With the aid of a labelled diagram, explain the operation of a shaded-pole single phase motor. (6 marks)

(c) Describe how a single phase induction motor can be modified to be self starting motor.

(4 marks)

(d) A 240 V, 50 Hz, 250 W capacitor-start single phase motor has the following impedances:

- main winding $Z_m = (4 + j3)\,\Omega$;
- Auxiliary winding $Z_a = (9 + j3)\,\Omega$

Determine the value of the starting capacitor that will place the main winding and auxiliary winding currents in quadrature at starting. (7 marks)

4. (a) List **three** merits of using three phase transformers. (3 marks)

(b) A 3-phase, 22 kV/300 V, 50 Hz delta-star connected transformer is connected to a balanced star connected three phase load at 0.8 power factor lagging. The line current on the primary is 6 A.

(i) Draw the connection diagram;

(ii) Determine the:

(I) current in each coil of primary and secondary.
(II) output of the transformer.

(10 marks)

(c) With the aid of a labelled circuit diagram, describe the open-circuit test of a single phase transformer. (7 marks)

5. (a) Describe the production of torque in a three phase induction motor. (5 marks)

(b) A 3 phase, 50 Hz, induction motor has 4 slots per pole per phase. Determine the:

(i) number of stator poles produced;
(ii) total number of slots on the stator;
(ii) speed of the rotating magnetic field.

(6 marks)

(c) With the aid of a labelled diagram describe the operation of a star-delta starter for the three phase induction motor. (7 marks)

(d) State **two** applications of three phase synchronous machine. (2 marks)

6. (a) List **three** characteristics of three phase synchronous machines. (3 marks)

(b) With the aid of a labelled connection diagram, describe the pony motor starting of synchronous machines. (6 marks)

(c) A 10 pole, 600 V, 50 Hz, 3 phase star connected synchronous motor is operating at no load with normal excitation. It has armature resistance of 10 Ω per phase. The rotor is retarded by 0.5° (mechanical) from its synchronous position. Determine the:

(i) rotor displacement in electrical degrees;
(ii) phase voltage;
(iii) armature e.m.f per phase.

(8 marks)

(d) With the aid of a diagram, show how a three phase synchronous machine is synchronised using the lamps dark method. (3 marks)

7. (a) With the aid of a labelled diagram, describe the two-wattmeter method of power measurement. (6 marks)

(b) With the aid of a labelled diagram, describe the 3-phase 4-wire system. (6 marks)

(c) A balanced 3 phase, 3 wire system with star connected load has a line voltage of 240 V. The impedance of each phase is (4 + j 5) ohms. Determine the:

(i) magnitude of phase impedance;
(ii) phase voltage;
(iii) phase current;
(iv) power absorbed by the phase load.

(8 marks)

8. (a) State Thevenin's theorem. (2 marks)

(b) **Figure 3** shows a resistive network. Using Thevenin's theorem, determine the current flowing through the load, R_L. (8 marks)

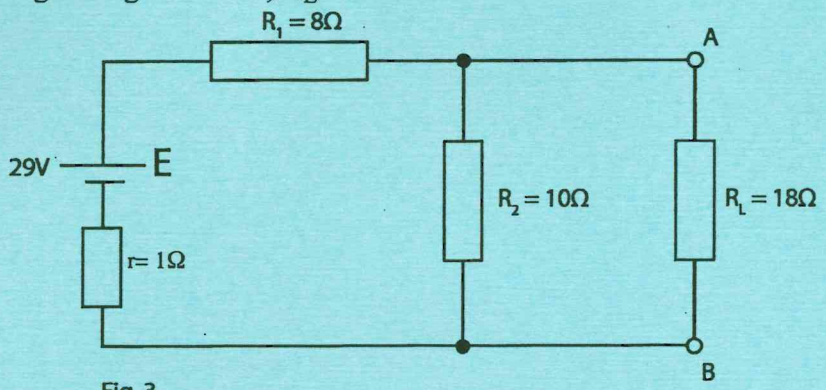

Fig. 3

(c) An e.m.f represented by the equation $e = 150\sin 314t + 60\sin 942t$ volts is applied to a capacitor having a capacitance of 31 μF. Determine the:

(i) capacitive reactive due to fundamental frequency;
(ii) amplitude of the fundamental current;
(ii) amplitude of the 3rd harmonic current.

(7 marks)

(d) Define each of the following transients:

(i) Initiation transients;
(ii) Subsidence transients;
(iii) Transition transients.

(3 marks)

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