

2507/207
ELECTRIC CIRCUIT ANALYSIS
March/April 2024
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;

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.

1. (a) State **three** applications of linear induction motors: (3 marks)
- (b) State **three** differences between variable reluctance stepper motor and switched reluctance stepper motor: (6 marks)
- (c) Explain each of the following torques as applied to synchronous motors:
 (i) running torque;
 (ii) pull-in torque;
 (iii) pull-out torque. (6 marks)
- (d) A hybrid VR stepping motor has 8 main poles which have been castleated to have 5 teeth each. If the rotor has 50 teeth, determine the stepping angle. (5 marks)
2. (a) State Thevenin's theorem. (2 marks)
- (b) Outline the procedure of determining the current through a load using Norton's theorem. (5 marks)
- (c) An inductive circuit draws 10A and 1.5KW from a 240V, 50Hz a.c supply. Determine the:
 (i) Impedance in cartesian form, $(a + jb)$.
 (ii) Impedance in polar form, $(Z \angle \theta)$.
 (iii) Power factor.
 (iv) Reactive power.
 (v) Apparent power. (10 marks)
- (d) Convert the Delta connected load in **figure 1** into a star connected load. (3 marks)

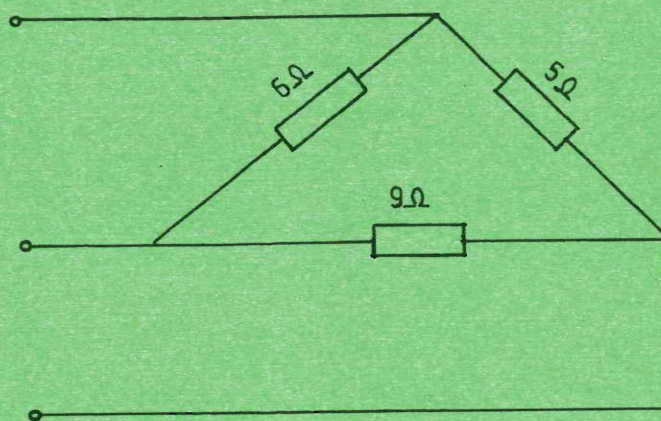


Fig. 1

3. (a) Draw each of the following symmetrical two port networks:-

- (i) Π - network;
- (ii) T - network;
- (iii) Lattice - network

(6 marks)

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

- (i) Input resistance when the output port is open-circuited.
- (ii) Input resistance when the output port is short-circuited.
- (iii) Characteristic impedance.

(6 marks)

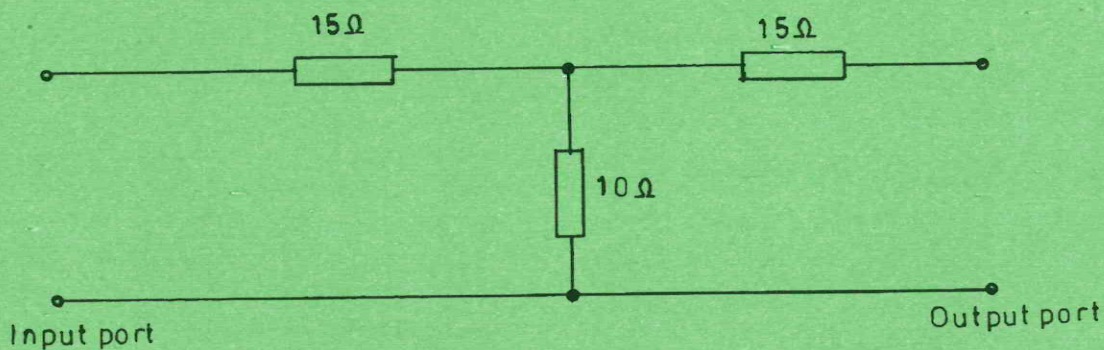


Fig.2

(c) A 400V, 10Hp, 7.46kW, 3-phase synchronous motor has negligible armature resistance and a synchronous reactance of $10\ \Omega$ per phase, with an efficiency of 85%. Determine the:

- (i) Minimum current.
- (ii) Corresponding induced e.m.f for full load condition.
- (iii) Draw the phasor diagram.

(8 marks)

4. (a) State **three** sources of harmonics in electrical circuits.

(3 marks)

(b) (i) List **three** possible causes of a d.c. motor failing to start when connected to a power supply.

(ii) State a remedy for each cause in b (i).

(6 marks)

(c) Explain armature reaction with reference to d.c generators.

(3 marks)

(d) The winding of an electromagnet has an inductance of 4H and a resistance of $16\ \Omega$. If it is connected to a 110V, d.c supply, determine the:

- (i) Steady state value of current flowing in the circuit;
- (ii) Time constant of the circuit.

- (iii) Value of induced e.m.f after 0.1S
 - (iv) Value of the current after 0.3s.
- (8 marks)

5. (a) State three applications for each of the following D.C. motors:-

- (i) Shunt.
 - (ii) Series.
- (6 marks)

(b) With the aid of a labelled diagram, describe the construction of a three-phase core-type transformer. (6 marks)

(c) A three-phase transformer has 400 primary turns and 50 secondary turns. If the supply voltage is 2.5KV, determine the secondary line voltage on no load when the windings are connected in:

- (i) Star-delta
 - (ii) Delta-star
- (8 marks)

6. (a) State **two**:

- (i) Main parts of a three-phase induction motor;
 - (ii) Differences between squirrel cage and wound-type three phase induction motors.
- (6 marks)

(b) With the aid of a labelled schematic diagram, describe the star-delta method of starting a three-phase induction motor. (8 marks)

(c) An auto-transformer starter for an induction motor is to start the motor with 35% of its full-load torque. The short-circuited current of the motor is 5 times the full load current with a full load slip of 0.03. Determine the:

- (i) Suitable tapping.
 - (ii) Current drawn from the mains as a fraction of the full-load current.
- (6 marks)

7. (a) Draw a connection diagram for each of the following:

- (i) Delta-connected load supplied from a 3-phase supply.
 - (ii) Two wattmeter method for balanced or unbalanced load power measurement.
- (9 marks)

(b) Three identical coils, each of resistance 10Ω and inductance 42mH are connected in star to a 415V, 50Hz three phase supply. Determine the:

- (i) Phase impedance.
 - (ii) Power factor.
 - (iii) Power dissipated.
- (11 marks)

8. (a) State **three** performance characteristic of capacitor run motors. (3 marks)
- (b) Describe **three** constructional features of repulsion type motors. (6 marks)
- (c) A 8-KW, 4-pole, 240-V, 50Hz reluctance motor has a torque angle of 30° when operating under-rated load conditions. Determine the:
- (i) Synchronous speed, N_s
 - (ii) Load torque.
 - (iii) Torque angle if the voltage drops to 215V. (8 marks)
- (d) Explain the function of a compensating windings in a DC machine. (3 marks)

THIS IS THE LAST PRINTED PAGE.