

2507/207

ELECTRIC CIRCUIT ANALYSIS

June/July 2022

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 any **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 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) Define each of the following A.C quantities:

- (i) period;
- (ii) amplitude;
- (iii) form factor.

(3 marks)

(b) A series R.L.C circuit is connected to a 240 V, 50Hz supply. The resistor, inductor and capacitor values are 10Ω , 0.15 H and $100 \mu\text{F}$ respectively.

(i) Draw the circuit diagram.

(ii) Determine the circuit's:

- (I) impedance;
- (II) current;
- (III) power factor;
- (IV) total active power.

(11 marks)

(c) **Figure 1** shows a 3-phase circuit diagram supplying a balanced load.

With reference to the circuit:

(i) Draw the phasor diagram.

(ii) Derive the equation for the relation between phase voltage and line voltage.

(6 marks)

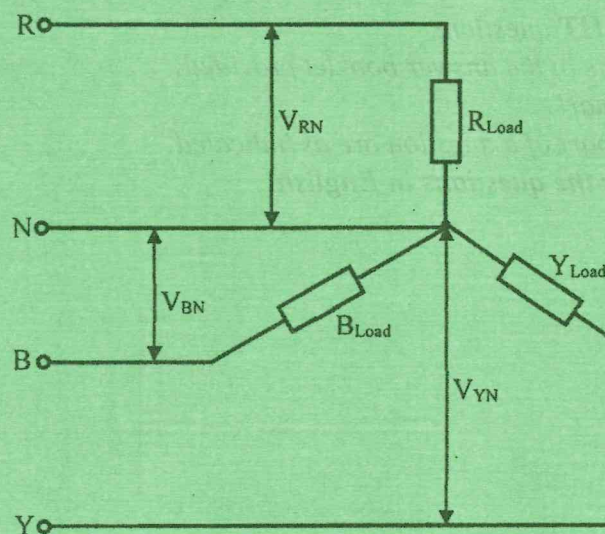


Fig. 1

2. (a) List **two** applications of synchronous machines citing an example in each case. (4 marks)
- (b) With aid of a labelled circuit diagram, describe the pony motor starting method of a three phase synchronous motor. (8 marks)
- (c) A 3-phase induction motor draws 100 kW of power. It has a synchronous speed of 1400 r.p.m, stator loss is 20 kW and the rotor runs at 1300 r.p.m.

Determine the:

- (i) power transmitted to the rotor;
- (ii) slip;
- (iii) rotor copper loss. (6 marks)

- (d) State **two** factors to be considered when starting an induction motor. (2 marks)

3. (a) With the aid of a labelled diagram, describe each of the following parameters as used in symmetrical networks:

- (i) characteristics impedance;
- (ii) balanced networks;
- (iii) unbalanced networks. (9 marks)

- (b) **Figure 2** shows a 2-port network. Determine the four Z-parameters and represent the results in a Z-matrix.

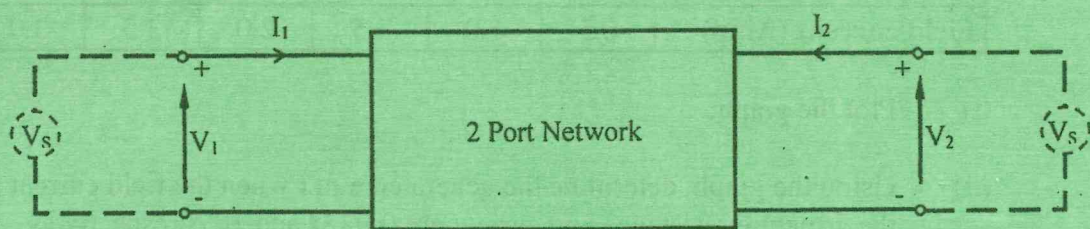


Fig. 2

(5 marks)

- (c) (i) Define a lattice network in a symmetrical balanced network.

- (ii) A lattice network has the following features:

- series arms = $Z_A = 80 \Omega$
- shunt arms = $Z_B = 60 \Omega$

- (I) Draw the resulting network;
- (II) Determine the impedance of the network.

(6 marks)

4. (a) Explain 'excitation' in D.C machines. (2 marks)
- (b) Figure 3 shows an equivalent circuit of a D.C shunt generator whose armature resistance is R_a .

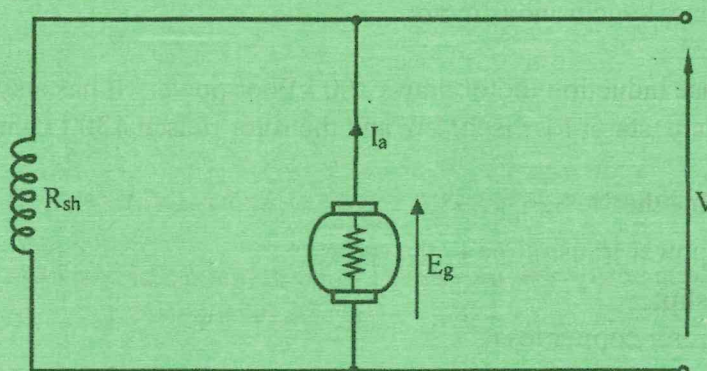


Fig. 3

Derive the expressions for:

- (i) generated e.m.f (E_g);
(ii) output power equation.

(6 marks)

- (c) Table 1 shows open circuit characteristics of a D.C shunt generator.

Table 1

Terminal Voltage (V)	120	240	334	400	445	470
Field current (Amp)	0.5	1.0	1.5	2.0	2.5	3.0

- (i) Plot the graph;
(ii) Using the graph, determine the generated e.m.f when the field current is 2.2 A if the armature resistance and current are 0.02Ω and 10 A respectively.

(8 marks)

- (d) Describe a compound wound D.C machine. (4 marks)

5. (a) Explain why a single phase A.C induction motor is not self-starting. (3 marks)

- (b) With the aid of a labelled diagram, describe how a single phase inductor motor can be made self-starting. (6 marks)

- (c) Sketch the Torque speed characteristic curve of an A.C single phase induction motor that is self starting.

4 marks)

(d) Two AC voltages where v_1 leads v_2 by 60° voltages are given as:

$$v_1 = 20 V$$

$$v_2 = 30 V$$

Obtain the:

- (i) rectangular expression for the two voltages
- (ii) resultant voltages of v_1 and v_2 in polar form.

(7 marks)

6. (a) State **three** causes of transients in electric circuits.

(3 marks)

(b) **Figure 4** shows an electric circuit. Derive the equation for the instantaneous current flowing in the circuit when switch S is switched to position 1.

(9 marks)

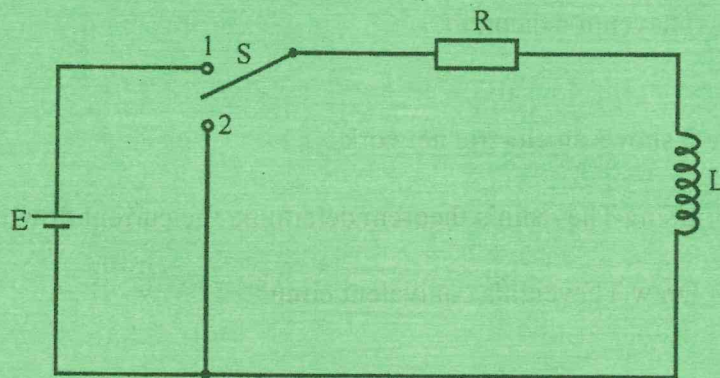


Fig. 4

(c) A coil of inductance 40 mH and a resistance of 2Ω is connected across a 20 V d.c supply. Determine the

- (i) time constant;
- (ii) transient time;
- (iii) instantaneous current 10 ms after the circuit is switched on.

(6 marks)

(d) Sketch the current discharge curve of a series R.C d.c. circuit.

(2 marks)

7. (a) List **two** features of stepper motors.

(2 marks)

(b) A stepper motor rotates at 300 r.p.m and has a step angle of 10 per step. Determine the:

- (i) number of steps per revolutions;
- (ii) input pulse rate in seconds.

(6 marks)

(c) A 3-phase transformer has 400 turns on the primary and 36 turns on the secondary. The supply voltage is 3300 V. Determine the secondary phase and line voltages on full load when the transformer is connected as:

- (i) Star - Delta.
- (ii) Delta - Star.

(9 marks)

(d) State **three** conditions that must be met to have transformers operating in parallel.

(3 marks)

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

- (i) maximum power transfer;
- (ii) Thevenin's theorem.

(4 marks)

(b) **Figure 5** shows an electric network.

(i) Using Thevenin's theorem determine the current flowing through 15 Ω resistor

(ii) Draw Thevenin's equivalent circuit.

(9 marks)

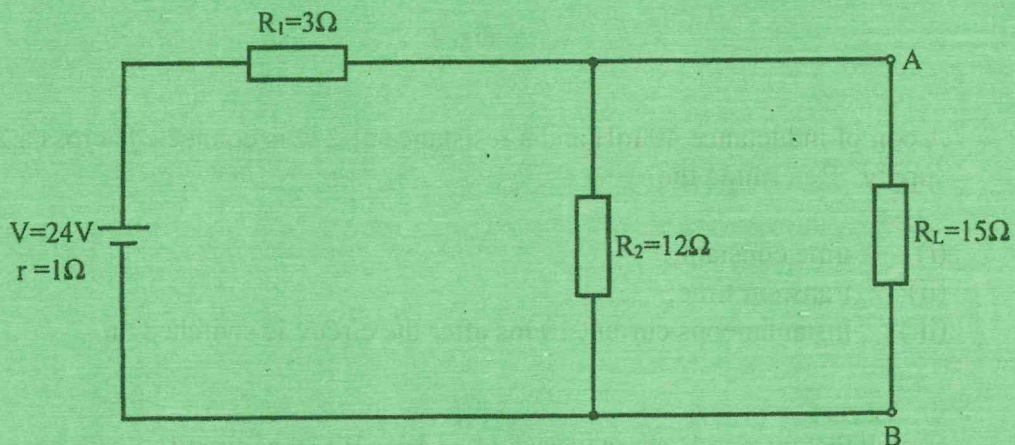


Fig. 5

(c) List **four** types of passive networks.

(4 marks)

(d) Draw a labelled diagram describing the one-wattmeter method of measuring power in a three phase four wire circuit.

(3 marks)

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