2507/207
ELECTRIC CIRCUIT ANALYSIS
Oct./Nov. 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) Explain each of the following quantities with respect to two port networks:

(i) Image impedance;
(ii) Iterative impedance;
(iii) Lattice network.

(6 marks)

(b) A series R-L circuit has an instantaneous current i = 1.4 Sin 2π ft A. The values of the resistance and inductance are 50 Ω and 0.4 H respectively. The frequency 50 Hz.
Determine the:

(i) voltage across the resistor in polar form;
(ii) Expression of voltage across the inductor in polar form.

(8 marks)

(c) **Figure 1** shows an RC circuit. Derive the expression for transient current flowing in the circuit when the switch is moved to position 2 after charging the capacitor. (6 marks

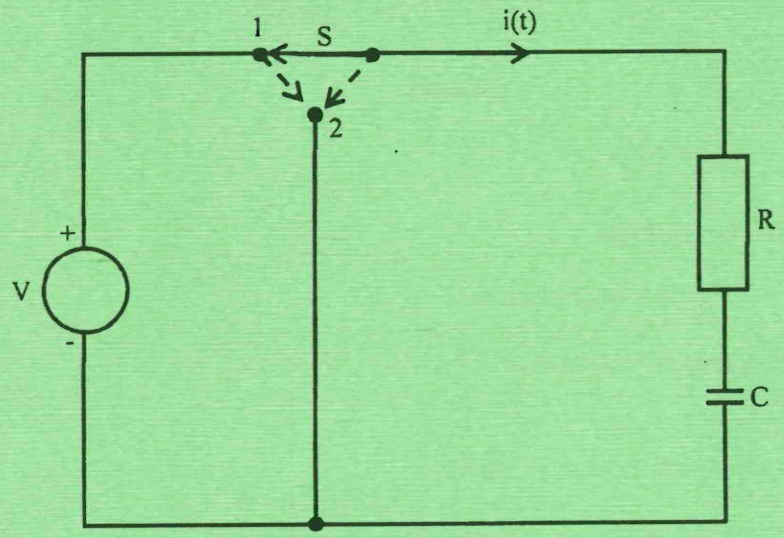

Fig. 1

2. (a) State **two** reasons why face-plate starter is required in DC motor. (2 marks)

(b) With the aid of a labelled diagram, describe the construction of a 3 point DC face-plate starter. (8 marks)

(c) A 400 V shunt motor has armature resistance of 0.4 Ω and field resistance of 100 Ω . It gives an output of 7kW at 85% efficiency.
Determine the:

(i) Input power;
(ii) Input current;
(iii) Armature current
(iv) Back e.m.f. (8 marks)

(d) Draw the Torque-current characteristics curve of a series DC motor.
(2 marks)

3. (a) Describe each of the following parts of a single phase repulsion motor:

(i) stator;
(ii) Rotor (slotted core type);
(iii) Commutator;
(iv) carbon brushes. (8 marks)

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

(c) A 3 phase generator produces the following phase voltage when star connected:
$V_{(t)} = 250 \cos 314t$ volts.
Determine the:
(i) operating frequency;
(ii) r.m.s phase voltage
(iii) r.m.s line voltage.
(6 marks)

4. (a) With the aid of a labelled diagram describe the short-circuit test of a transformer.
(6 marks)

(b) A 400 KVA, 33/11kV, 50 Hz, 3-phase transformer is delta-star connected.

(i) Draw the schematic circuit diagram for the transformer;

(ii) Determine the:

(I) transformation ratio, k;
(II) secondary phase current. (8 marks)

(c) Sketch the Torque-speed characteristic curve for a 3-phase induction motor.
(3 marks)

(d) Table 1 shows faults in 3-phase induction motors.

Type of fault in 3 phase induction motor	**Cause**
• Single phasing	
• Overloading	
• unbalanced supply voltage	

Copy and complete the table. (3 marks)

5. (a) With the aid of labelled characteristic curves, explain the effect of varying excitation current on the armature of a synchronous motor. (6 marks)

(b) A 200 V star connected synchronous motor is rotating with a light load.
The load angle is 5°. Excitation is adjusted for generated e.m.f to be 100 V.
The armature has a resistance and inductive reactance of $0.2\,\Omega$ and $0.8\,\Omega$ respectively.
Determine the:

(i) resultant per phase voltage;
(ii) synchronous impedance;
(ii) armature current.

(8 marks)

(c) With the aid of a labelled diagram describe, the synchronization of three phase synchronous machine using the synchroscope method. (6 marks)

6. (a) State **three** applications of stepper motors. (3 marks)

(b) With the aid of a labelled diagram, describe the construction of a stepper motor. (6 marks)

(c) With the aid of a labelled schematic diagram, describe the functions of each of the following windings of an Amplidyne machine:

(i) compensating winding;
(ii) quadrature winding;
(iii) control field winding.

(8 marks)

(d) List **three** areas of application of Metadynes. (3 marks)

7. (a) State the Norton's Theorem. (2 marks)

(b) **Figure 2** shows network of resistive elements with two sources.
Using Norton's Theorem determine the voltage across terminals A and B. (8 marks)

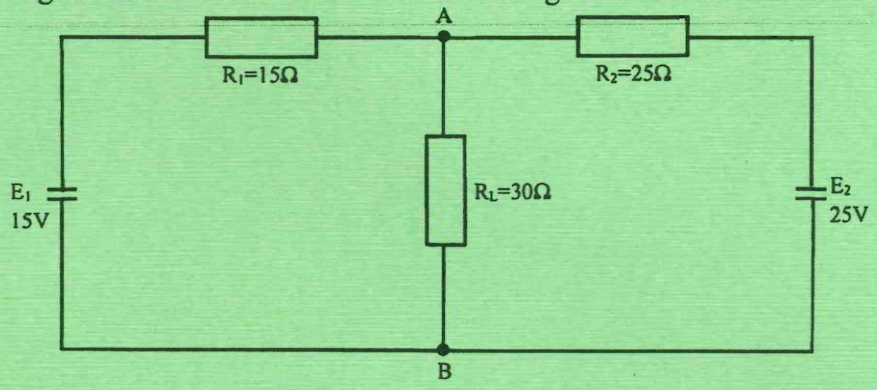

Fig. 2

(c) Given **two** currents:

$$i_1 = 20\,\text{Sin}\left[\omega t + \frac{\pi}{4}\right]$$

$$i_2 = 15\cos\left[\omega t - \frac{\pi}{2}\right]$$

Determine the RMS value of $i_1 + i_2$ using the complex number notation. (8 marks)

(d) Using power triangle, deduce the relationship between kW, kVA and KVAR.
2 marks)

8. (a) Distinguish between DC motors and AC induction motors. (4 marks)

(b) With the aid of a labelled diagram describe the operation of an autotransformer starter as used in induction motor starting. (6 marks)

(c) A 6 pole, 3 phase induction motor operates from a supply whose frequency is 50 Hz.
Determine the:
(i) Speed at which magnetic field of the stator is rotating;
(ii) Speed of the rotor when the slip is 0.2;
(iii) Frequency of the rotor currents when the slip is 0.4.
(6 marks)

(d) Describe the effects of selective resonance in single phase circuits involving series and parallel electric circuits. (4 marks)

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