2507/207
ELECTRIC CIRCUIT ANALYSIS
Oct./Nov. 2021
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** 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) Explain 'Norton Theorem'. (2 marks)

(b) **Figure 1** shows an electric circuit. Determine the current flowing through 5 Ω resistor using Norton's theorem. (10 marks)

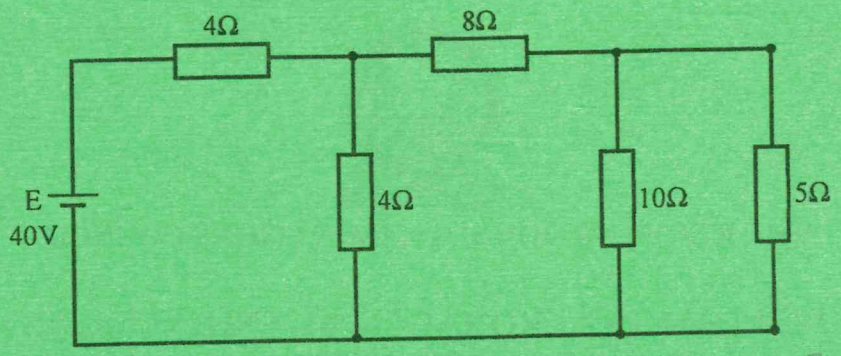

Fig. 1

(c) **Figure 2** shows an electrical network. Determine the supply current flowing in the circuit in polar form;

(8 marks)

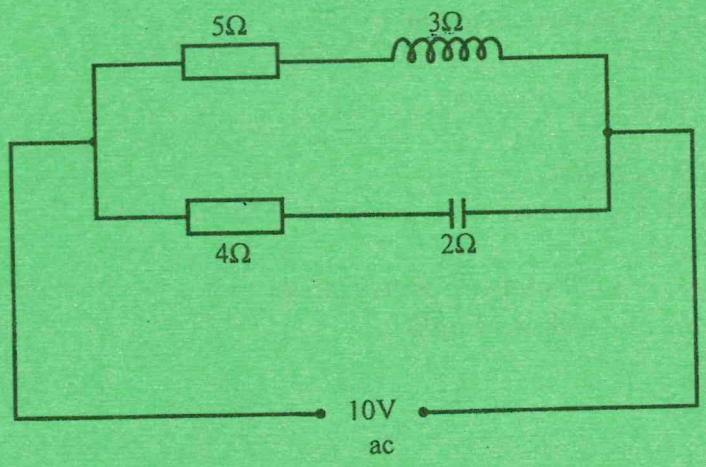

Fig. 2

2. (a) Define each of the following AC quantities:

(i) frequency;

(ii) phase;

(iii) Q-factor.

(3 marks)

(b) A series electric circuit contains resistance and an inductive load. The circuit voltage and current as expressed as follows:

$v_{(t)} = 20\sin\left[314t + \frac{5}{6}\pi\right]$;

$i_{(t)} = 10\,Sin\left[314t + \frac{2\pi}{3}\right]$.

Determine the:

(i) circuit impedance;

(ii) value of the resistance;

(iii) inductance in henrys;

(iv) average power.

(9 marks)

(c) Define 'admittance' of an ac circuit. (2 marks)

(d) Two circuits whose impedances are given by $Z_1 = 6 + j8\Omega$ and $Z_2 = 8 - j6\Omega$ are connected in parallel to an alternating supply voltage of 100 V.

(i) Determine the current flowing in each branch;

(ii) Draw the phasor diagram of the currents.

(6 marks)

3. (a) Explain each of the following transients:

(i) transition transient:

(ii) initiation transients.

(4 marks)

(b) Figure 3 shows an electric circuit. Derive the equation for instantaneous voltage across the capacitor when switch is at position 1. (10 marks)

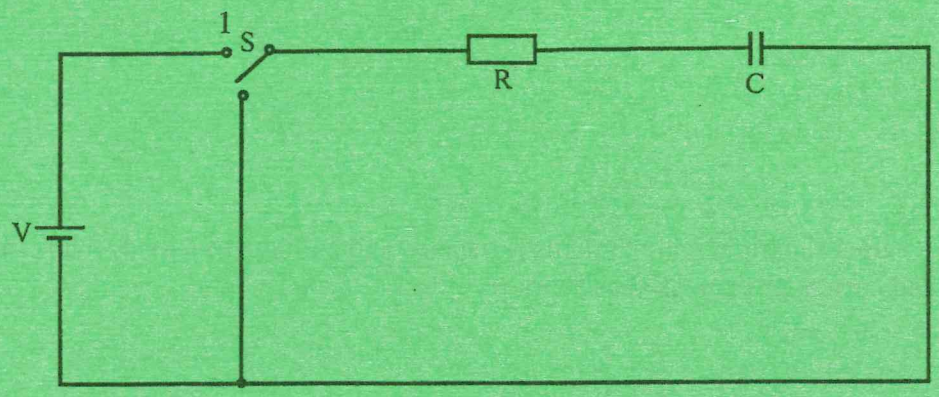

Fig. 3

(c) A circuit has an impedance of 10 + j4 Ohms at a frequency of 50 Hz.

(i) Determine the:

(I) nature of the reactance;

(II) impedance in polar form;

(III) value of the reactive component;

(IV) symbolic expression for the admittance of the circuit.

(ii) Draw the admittance triangle compared to the impedance triangle.

(6 marks)

4. (a) State any **five** components of a transformer. (5 marks)

(b) Derive the transformation ratio of an ideal transformer. (5 marks)

(c) A 3-phase, 100 kVA transformer has 400 turns on the primary and 80 turns on the secondary. The primary winding has a resistance of 0.04 Ω and a reactance of 2.2 Ω while the secondary winding has a resistance and reactance of 0.01Ω and 0.05Ω respectively. The supply voltage is 2200 V. For the transformer determine the:

(i) secondary resistance referred to the primary side;

(ii) equivalent resistance;

(iii) equivalent reactance;

(iv) equivalent impedance;

(v) voltage regulation.

(10 marks)

5. (a) State **four** features of single phase a.c induction motors. (4 marks)

(b) (i) Describe how a single phase induction motor is made self staring;

(ii) **Figure 4** shows a π symmetrical network.

Determine the total impedance seen from the output.

(6 marks)

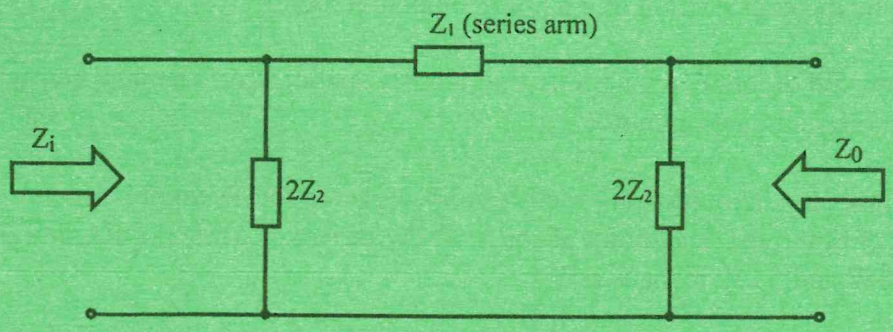

Fig. 4

(c) (i) Describe the major components of a repulsion type a.c induction motor.

(ii) Sketch the characteristic curve of a repulsion type a.c induction motor.

(10 marks)

6. (a) State **three** types of d.c motors. (3 marks)

(b) A short shunt compound machine is connected to a 400 V d.c supply and runs as a motor drawing a current of 50 A. The armature resistance, series winding resistance and shunt winding resistance are $0.3\,\Omega$, $0.4\,\Omega$ and $195\,\Omega$ respectively.
Determine the:

(i) shunt field current;

(ii) back e.m.f of the motor;

(iii) torque developed if the speed is 20 revolutions per second.

(9 marks)

(c) Table 1 shows open circuit characteristics of a shunt excited d.c machine.

(i) Plot the characteristic curve;

(ii) Determine the field current when the terminal voltage is 100 V. (4 marks)

Table 1

Terminal voltage (V)	47	85	103	115	123	128	136	142
Field current (I_f)	0.2	0.4	0.6	0.8	1.0	1.2	1.6	2.0

(d) State the conditions that should be fulfilled for a d.c machine to generate voltage. (4 marks)

7. (a) Describe the construction of a 3 phase induction motor. (5 marks)

(b) With the aid of labelled diagrams, explain the operation of a manual star-delta starter for a 3 phase induction motor. (9 marks)

(c) A 3-phase, 8 pole induction motor is connected to a 50 Hz supply. It has a synchronous speed of 800 rpm. The motor absorbs 60 kW of power while the stator and rotor losses are 6 kW and 3 kW respectively.

Determine the :

(i) percentage slip;

(ii) torque produced.

(6 marks)

8. (a) Explain 'synchronizing' as used in 3-ϕ synchronous machines. (2 marks)

(b) With the aid of a labelled diagram, explain the working principle of a 'synchroscope' as used in the synchronization of synchronous machines. (8 marks)

(c) A 3-ϕ, 6600 V, 50 HZ star connected synchronous motor takes a current of 60A. The resistance and synchronous reactance per phase are 2 Ω and 21 Ω respectively. The power system has a p.f of 0.8 lagging. Determine the:

(i) power input;

(ii) line induced e.m.f;. (10 marks)

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