2507/207
ELECTRIC CIRCUIT ANALYSIS
June/July 2020
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.
*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 4 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 the following with reference to single phase a.c. circuits:

(i) Thevenin's theorem;
(ii) Norton's theorem. (4 marks)

(b) **Figure 1** shows a parallel circuit supplied by an a.c. voltage of 150 V 500 Hz. Determine the values of the:

(i) branch currents;
(ii) total current and its power factor. (8 marks)

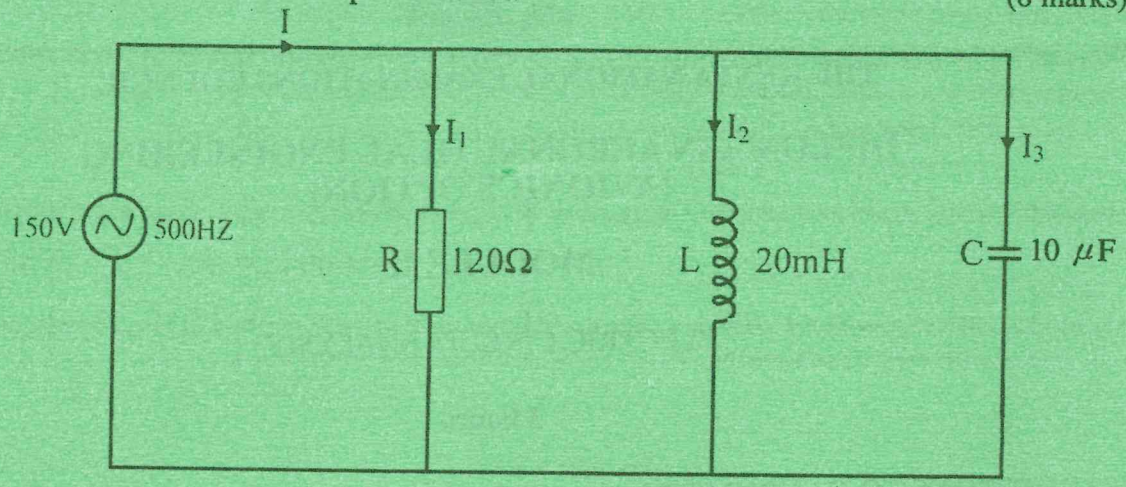

Fig. 1

(c) An a.c. single phase symmetrical two-port network has the following constants: $A = D = 1.2\angle 30°$, $B = 120\angle 60°\ \Omega$, $C = 5 \times 10^{-3}\angle 90°\ S$. The supply voltage and the load resistance are $220\angle 0°V$ and $150\angle 0°\ \Omega$ respectively. Draw the two port network and determine:

(i) characteristic impedance;
(ii) output current. (8 marks)

2. (a) (i) State **three** applications of amplidyne generators.
(ii) With the aid of a labelled diagram, explain the principle of operation of a three phase linear induction motor. (12 marks)

(b) Explain the need for a face-plate starters for medium size d.c. motors. (3 marks)

(c) A six pole d.c. generator has 840 armature conductors and 20 mWb flux per pole. The machine is driven at a constant speed of 1200 revs/minute. Determine the generated e.m.f in the armature when the armature conductors are wound in:

(i) lap;
(ii) wave. (5 marks)

3. (a) (i) With reference to complex waveforms, explain the term harmonic.

(ii) An electric circuit has a capacitor of 3.18 μF and a 1,000 Ω resistor connected in parallel. The combination of the parallel circuit is connected in series with a resistor of 1000 Ω. A complex voltage of $V=350 \sin \omega t + 150 \sin(3\omega t + 30°)$ V is applied to the circuit. Determine the values of the currents flowing in the circuit due to the:

(I) fundamental frequency;

(II) harmonic voltages, take $\omega = 314$ rads/sec. (12 marks)

(b) (i) Define the term transient.

(ii) A coil having an inductance of 0.04 H and a resistance of 10 Ω respectively is connected to a d.c. supply of 120 V. Determine the:

I. final steady value of the current;

II. time constant of the circuit.

III. value of current 5 ms after the circuit is connected to the supply. (8 marks)

4. (a) (i) With the aid of a labelled circuit diagram, explain the ONE wattmeter method of measuring power in a three phase load supplied with a three phase, three wire system when there is no neutral conductor, and the load is connected in star.

(ii) State the limitation of the method in (a) (i). (7 marks)

(b) A balanced delta connected three phase load of 33.3 Ω resistance and 76 mH inductance connected in series in each phase, is supplied by a 415 V.500 Hz three phase supply.

(i) Draw the equivalent circuit connection of the system.

(ii) Determine the:

I. phase currents

II. line currents. (13 marks)

5. (a) (i) Draw a labelled circuit diagram of a capacitor start, capacitor run, single phase induction motor

(ii) Sketch on the same axes the torque-speed characteristics of the following single phase induction motors:

(I) Capacitor start, capacitor run;

(II) Shaded pole. (8 marks)

(b) With the aid of a construction diagram, describe the operation of a single phase, shaded pole induction motor. (7 marks)

(c) A single phase universal series motor has armature winding circuit resistance and reactance of 30 Ω and 0.5 H respectively. When the motor is connected to a 240 V d.c. supply, it takes a current of 0.8A and runs at a speed of 2000 r.p.m. on full load. If the motor is connected to a 240 V 50 Hz a.c. supply and takes the same current at 0.8 p.f. lagging, determine the motor's new full load speed. (5 marks)

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

(i) characteristics of three phase synchronous motors.
(ii) Applications of three phase synchronous motors. (4 marks)

(b) Explain the main reasons for having stationary armature and rotating field systems in the construction of three phase synchronous machines. (4 marks)

(c) Describe with the aid of a diagram, the synchroscope method of synchronising a three phase synchronous machine to a three phase bus-bar system. (6 marks)

(d) A factory has load of 600 kVA operating at 0.75 power factor lagging. A synchronous motor having an input power of 175 kW is used to raise the overall power factor of the combined system of the factory to 0.95 lagging. Determine the required kVAr rating of the synchronous motor. (6 marks)

7. (a) (i) State **three** objectives of performing the open circuit and short circuit tests on transformers;
(ii) With the aid of a circuit diagram, explain how to perform a short circuit test on a three phase transformer. (10 marks)

(b) Describe the construction methods adopted in order to reduce leakage fluxes in transformers. (4 marks)

(c) A 3300/415V.50Hz delta/star connected 3-phase transformer supplies a star-connected load of 0.8 power factor lagging. If the primary line current is 15A. Determine, using an equivalent circuit diagram the:

(i) primary and secondary phase currents.
(ii) power output of the transformer. (6 marks)

8. (a) State **three** advantages of wound rotor slip-ring induction motors over squirrel cage induction motors of the same capacities. (3 marks)

(b) With the aid of a torque-speed characteristics curve, explain the effect of varying the rotor circuit resistance on induction motor performance. (6 marks)

(c) Draw a labelled circuit diagram of an auto-transformer starter for a three phase induction motor. (5 marks)

(d) The input power of a three-phase induction motor when operating at a slip of 5% on full load is 55 kW. If he stator losses on full load are 1500 W determine the:

(i) mechanical power developed;
(ii) output power developed when the windage and frictional losses are 800 W;
(iii) percentage full load efficiency. (6 marks)

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