2507/207
ELECTRIC CIRCUIT ANALYSIS
June/July 2019
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 7 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 the following with reference to two-port networks:

(i) characteristic impedance;
(ii) iterative impedance;
(iii) insertion loss.

(3 marks)

(b) Figure 1 shows an equivalent circuit diagram of a symmetrical T-network for an attenuator pad circuit, in which $R_1 = R_2 = 312\ \Omega$ and $R_3 = 423\ \Omega$. If the attenuator feeds a matched load, determine the:

(i) characteristic impedance in ohms;

(ii) insertion loss in decibels.

(6 marks)

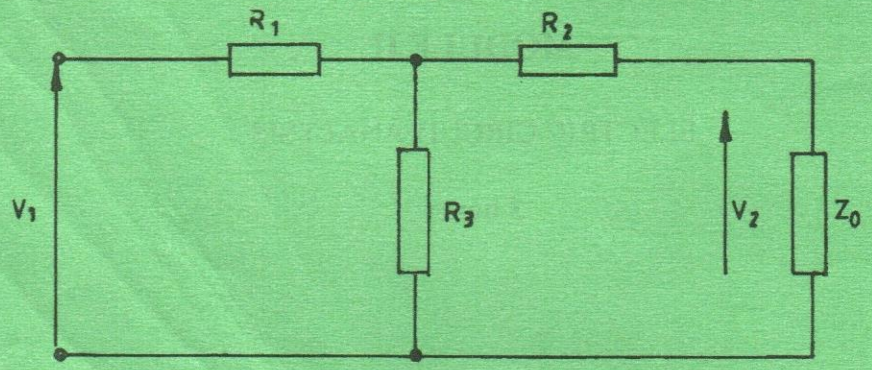

Fig.1

(c) Figure 2 shows ABCD constants for an a.c. symmetrical two-port network having the following constants:

$A = D = 1.2 < 30°\Omega$, $B = 120 < 60°\Omega$, $C = 5 \times 10^{-3} < 90°S$. If the input voltage and the load impedance are $220 < 0°V$ and $150 < 0°\Omega$ respectively. Determine the:

(i) characteristic impedance;
(ii) output current and its power factor;
(iii) output voltage;
(iv) output power.

(11 marks)

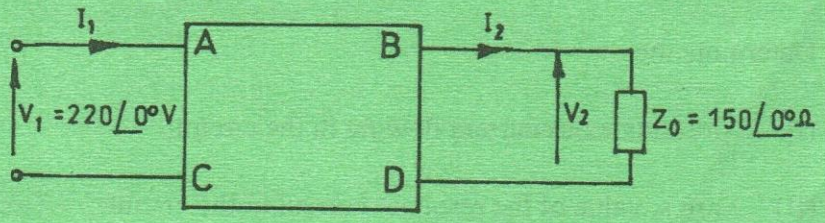

Fig. 2

2. (a) (i) Draw an equivalent circuit diagram of an R-L-C series a.c. circuit.

(ii) Explain the effects of varying frequency to the circuit in (a) (i).

(iii) Sketch the characteristic curves for (a) (i).

(8 marks)

(b) A coil having a resistance and an inductance of 10 Ω and 100 μH respectively is connected in parallel with a variable capacitor C. The combination of the circuit is connected in series with a resistance of 5 kΩ across a 120 V 1 MHz single phase supply system.

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

(ii) Determine at resonance the:

(I) value of the capacitance, C;

(II) current flowing in the circuit;

(III) dynamic impedance of the circuit;

(IV) Q-factor of the circuit.

(12 marks)

3. (a) With reference to complex waveform:

(i) State **two** sources of harmonics generation in a.c. circuits;

(ii) Explain **two** effects of harmonics in three phase transformers.

(6 marks)

(b) A complex voltage $V = (350 \sin \omega t + 150 \sin 3\omega t + 80 \sin 5 \omega t)$ volts is applied to a series circuit comprising a coil of 10 Ω resistance and inductance of 6.36 mH. If the supply voltage is maintained constant, with a fundamental frequency of 50 Hz.

(i) Draw the circuit diagram of the system;

(ii) Determine the:

(I) instantaneous current flowing in the circuit;

(II) r.m.s. value of the resultant current in the circuit;

(III) power dissipated in the circuit;

(IV) overall power factor of the circuit.

(10 marks)

(c) The time constant of an inductive coil is found to be 2.5 mSec. When a resistor of 80 Ω is added in series with the coil, the new time constant is found to be 0.5 mSec. If a constant d.c. voltage of 100 V is applied to the coil without the additional resistor in the circuit, determine the:

(i) resistance of the coil in ohms;

(ii) inductance of the coil;

(iii) maximum value of current flowing in the circuit.

(4 marks)

4. (a) Differentiate operating characteristics between star and delta connected three phase loads when supplied at the same terminal voltage and frequency. (3 marks)

(b) State **three** advantages of three phase over single phase supply systems. (3 marks)

(c) A balanced delta connected load having a resistance and inductance per phase of 33 Ω and 79.5 mH respectively is supplied by a symmetrical 415 V 50 Hz system. If the phase sequence is positive, using the Red-Yellow line voltage as the reference;

(i) Draw the circuit connection diagram;

(ii) Determine the:

(I) phase currents and their respective phase angles;

(II) line currents and their respective angles;

(III) input power in kW;

(IV) KVAr rating of the load.

(14 marks)

5. (a) Sketch labelled:

(i) Circuit diagrams of the following d.c. machines:

(I) short shunt compound generator;

(II) long shunt compound motor.

(ii) Speed-load torque characteristics curve on the same axis for the following d.c. motors:

(I) series;
(II) separately excited.

(5 marks)

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

(c) With the aid of labelled diagrams, explain the process of commutation in a d.c. generator. (5 marks)

(d) Draw a labelled schematic circuit diagram of a face plate starter for a d.c. shunt motor and state the functions of each component. (7 marks)

6. (a) Explain why transformers are rated in kVA. (2 marks)

(b) State **three** objectives of performing open circuit and short circuit tests on transformers. (3 marks)

(c) A 11,000/3300 V star/star connected three phase distribution transformer supplies a three phase delta connected load through a delta/star connected three phase transformer of 3300/415 V line voltage. If the load takes a line current of 800 A at 0.8 power factor lagging:

(i) Draw the circuit diagram of the system;

(ii) Determine the values of the:

(I) line and phase voltages in each part of the circuit;

(II) line and phase currents at all the stages of the circuit;

(III) input and output power in kW.

(11 marks)

(d) With the aid of a circuit diagram, explain how to perform open circuit test on a delta-star connected three phase transformer. (4 marks)

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

(b) Draw the circuit connection diagrams of the following machines:

(i) capacitor start single phase induction motor;

(ii) capacitor start, capacitor run single phase induction motor;

(iii) amplidyne generator.

(9 marks)

(c) Explain how direction of rotation may be reversed in the following motors:

(i) single phase a.c. series motor;

(ii) capacitor start single phase a.c. induction motor.

(2 marks)

(d) State any **two** suitable applications of the following:

(i) amplidyne generator;

(ii) stepper motors;

(iii) linear induction motors.

(6 marks)

8. (a) State **three**:

(i) operating characteristics of a three phase synchronous motor;

(ii) advantages of providing a rotating field winding and stationary armature winding for large three phase synchronous machine.

(6 marks)

(b) With the aid of a circuit diagram, describe the dark lamps method of synchronizing a three phase synchronous machine to live bus bars. (7 marks)

(c) A 415 V 50 Hz 3 phase, star connected load takes a line current of 30 A at 0.8 power factor lagging. A 7.46 kW 415 V 50 Hz three phase synchronous motor operating at 90% efficiency is connected in parallel with the load to raise the overall power factor to unity. Calculate the:

(i) kVAr rating of the synchronous motor required;

(ii) kVA rating of the motor;

(iii) operating power factor of the motor;

(iv) current taken by the motor.

(7 marks)

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