2507/207
ELECTRIC CIRCUIT ANALYSIS
Oct./Nov. 2018
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 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) State the following laws with reference to single phase a.c. circuits:

(i) maximum power transfer theorem;

(ii) Thevenin's theorem.

(4 marks)

(b) Figure 1 shows an a.c. circuit. Using the admittance method, determine the values of the:

(i) conductance and susceptance of the parallel branch circuit;

(ii) total and branch currents and their respective power factors.

(13 marks)

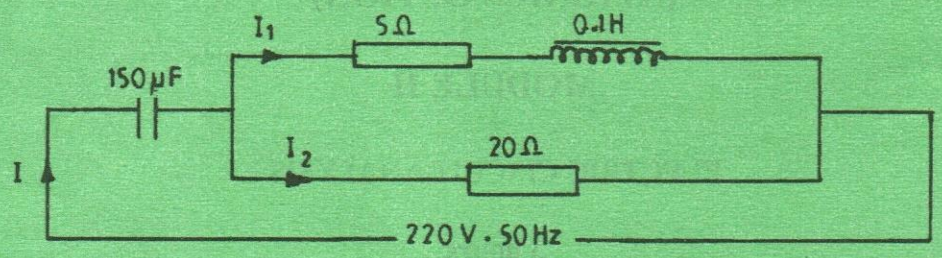


Fig 1

(c) A capacitor of 200 μF capacitance and a resistor of 10 Ω resistance are connected in series across 120 V 50 Hz single phase supply. Calculate the average power dissipated in the circuit. (3 marks)

2. (a) With reference to d.c. circuits define the following:

(i) transient;
(ii) time constant with reference to R-L circuit.

(4 marks)

(b) A d.c. voltage of 100 V is applied to a circuit consisting of a resistor of 80 Ω in series with an inductor of 20 H. Calculate the;.

(i) time constant of the circuit;
(ii) growth of current at the instant of switching on;
(iii) rate of rise of current when the current is 0.5 A;
(iv) steady state current flowing in the circuit;
(v) time taken for the current to reach 2 A.

(7 marks)

(c) Three amplifiers each having a gain of 20 are connected in cascade by means of transmission lines. If the ratio of output to input power loss of each of the line is 40;

(i) draw the block diagram of the circuit;
(ii) determine the:

(I) gains of the amplifiers and line losses in decibels.

(II) transmission losses and gains of the system in decibels.

(9 marks)

3. (a) Explain "phase sequence" and its importance in three phase power systems.

(4 marks)

(b) With the aid of a diagram, show that for a star connected three phase symmetrical system, the line voltage is given by:

$V_L = \sqrt{3} \times Vph$
Where V_L = line voltage
V_{ph} = phase voltage.

(6 marks)

(c) Draw a labelled circuit diagram for power measurement in a delta connected three phase load using the two wattmeters method. (4 marks)

(d) A three phase industrial load of 11.56 kW operates on full load at 85% efficiency and 0.45 power factor lagging. If two wattmeters are connected to measure the total input power to the load, determine the reading of each wattmeter. (6 marks)

4. (a) With reference to complex waveforms;

(i) State **three** methods of minimising generation of harmonics in a.c. circuits.

(ii) Define the following:

(I) form factor;
(II) selective resonance.

(7 marks)

(b) Figure 2 shows a network supplied by a complex voltage waveforms. If the selective resonance occurs at 3rd harmonic frequency, determine the values of the:

(i) fundamental frequency in hertz;

(ii) maximum peak currents;

(iii) r.m.s. value of current.

(10 marks)

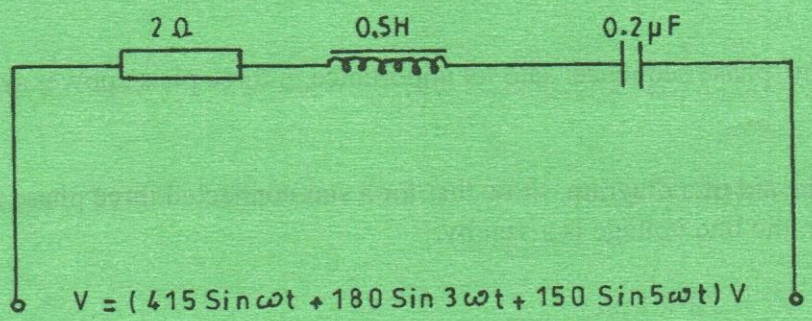


Fig. 2

(c) Explain the effects of harmonics in single phase transformers. (3 marks)

5. (a) With reference to transformers, state **two** types of:

(i) construction;

(ii) windings.

(4 marks)

(b) A 25 kVA, transformer has iron loss and copper loss on full load of 300 W and 500 W respectively. Determine at 0.8 power factor lagging the:

(i) full load percentage efficiency;

(ii) percentage efficiency at $\frac{3}{4}$ full load;

(iii) value of the load at maximum efficiency;

(iv) value of maximum efficiency.

(10 marks)

(c) A 3300/415 V 50 Hz delta-star, 3-phase transformer supplies a star-connected three phase load at 0.8 power factor lagging. If the primary line current is 26 A:

(i) draw the circuit diagram of the system;

(ii) determine the:

(I) phase currents flowing in the primary winding;

(II) secondary phase and line currents;

(III) output power of the transformer in kW.

(6 marks)

6. (a) Explain why a three phase synchronous motor is not self starting. (3 marks)

(b) State **four** conditions to be satisfied before a three phase synchronous machine is connected to an infinite bus bar. (4 marks)

(c) Draw a circuit diagram of synchronising a three phase synchronous machine to an infinite bus-bar using the synchroscope method. (5 marks)

(d) A 75 kW 415 V 50 Hz 3-phase, star connected synchronous motor operates at 92% efficiency on full load. With its excitation current adjusted to 6 A, it operates on full load at 0.85 power factor lagging. The synchronous reactance per phase is 0.8 Ω with negligible armature resistance.

(i) draw the phasor diagram of the system, and hence;

(ii) determine the excitation current required for the motor to operate at unity power factor.

(8 marks)

7. (a) Draw labelled construction diagrams for the following machines:

(i) single phase shaded pole motor;

(ii) variable reluctance stepper motor with rotor and stator poles of four and six respectively.

(6 marks)

(b) With the aid of a labelled circuit diagram, describe the principle of operation of metadyne generator. (6 marks)

(c) Explain how direction of rotation for a shaded-pole motor may be reversed.

(2 marks)

(d) (i) Sketch torque-speed characteristic curve of a repulsion induction motor.

(ii) State **two**:

(I) advantages of the motor in (d) (i);

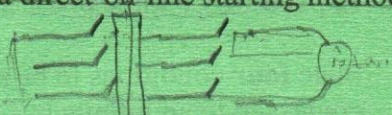
(II) disadvantages of the machine in (d) (i).

(6 marks)

8. (a) Explain why an ordinary induction motor does not run at synchronous speed.

(3 marks)

(b) Draw a labelled circuit connection diagram of a direct-on-line starting method for a three phase squirrel cage induction motor.



(5 marks)

(c) A 415 V 50Hz 6-pole three phase induction motor operating at full load speed of 960 revolutions per minute has stator losses amounting to 1.2 kW when its net output is 30.8 kW. If the friction and windage losses are 800 W, determine at full load the:

(i) mechanical power developed;

(ii) rotor copper loss;

(iii) percentage efficiency. $\frac{P_o}{P_i} \times 100$

(7 marks)

(d) (i) Explain the effects of armature reaction in d.c. machines.

(ii) State any **two** methods of reducing the effects of armature reactions in d.c. machines.

(5 marks)

THIS IS THE LAST PRINTED PAGE.