2507/207
ELECTRIC CIRCUIT ANALYSIS
Oct./Nov. 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) (i) Define a 'Two-Port Network'.

(ii) List **one** example of each of the following types of two-port network:

(I) Active network;
(II) Passive network. (4 marks)

(b) (i) Transmission -line parameters in a two -port network are given as

$$V_1 = AV_2 - BI_2$$
$$I_1 = CV_2 - DI_2$$

Express the equations in matrix form.

(ii) Using the equations in b(i) determine the:

(I) short circuit transfer admittance;
(II) open circuit transfer impedance. (6 marks)

(c) (i) Explain the following terms:

(I) complex wave;
(II) harmonics.

(ii) A complex wave of rms value of 240 V has 22 % third harmonic and 5% fifth harmonic contents.
Determine the rms value of the:

(I) fundamental waveform;
(II) 3rd and 5th harmonic contents. (10 marks)

2. (a) (i) With aid of a labelled phasor diagram, derive the relationship between the line voltage ($V_L$) and phase voltage ($V_p$)in a three phase star connected balanced system.
(ii) Write an expression for electric power delivered in the system. (9 marks)

(b) Draw the two-wattmeter method of power measurement in a three phase three wire star connected distribution system. (4 marks)

(c) The input power to a three phase load is measured by a two wattmeter method and the readings obtained are 6.8 kW and –3.6 kW. The line voltage is 415 V.

Determine the:

(i) total active power;
(ii) power factor. (7 marks)

3. (a) (i) Explain why the stator core of a three phase induction motor is made of sheet steel.

(ii) Draw a labelled construction diagram of a wound rotor of a three phase induction motor.

(iii) State **one** advantage of the of the rotor in (ii) over the squirrel cage rotor.

(7 marks)

(b) A three phase, 6 pole 50 Hz induction motor has ship of 1% at no-load and a slip of 3% at full-load.
Determine the:

(i) synchronous speed;
(ii) no-load speed;
(iii) full-load speed;
(iv) frequency of rotor current at standstill. (8 marks)

(c) (i) Illustrate each of the following methods of transformer winding connections:

(I) Delta-Delta;
(II) Delta-Star.

(ii) List **one** method of transformer cooling. (5 marks)

4. (a) Draw a labelled construction diagram of a d.c machine. (4 marks)

(b) (i) Illustrate each of the following types of armature windings:

(I) lap winding;
(II) wave winding.

(ii) A 8-pole lap wound d.c. machine has 960 conductors and a flux of 40 mWb per pole. If the machine rotates at 400 rpm, determine the emf induced.

(7 marks)

(c) (i) Explain the need for starters in d.c. motors.

(ii) Figure 1 shows a d.c motor face-plate starter:

(I) Name the parts labelled 1 – 5.
(II) Explain the functions of the parts labelled 2 and 3 respectively.

(9 marks)

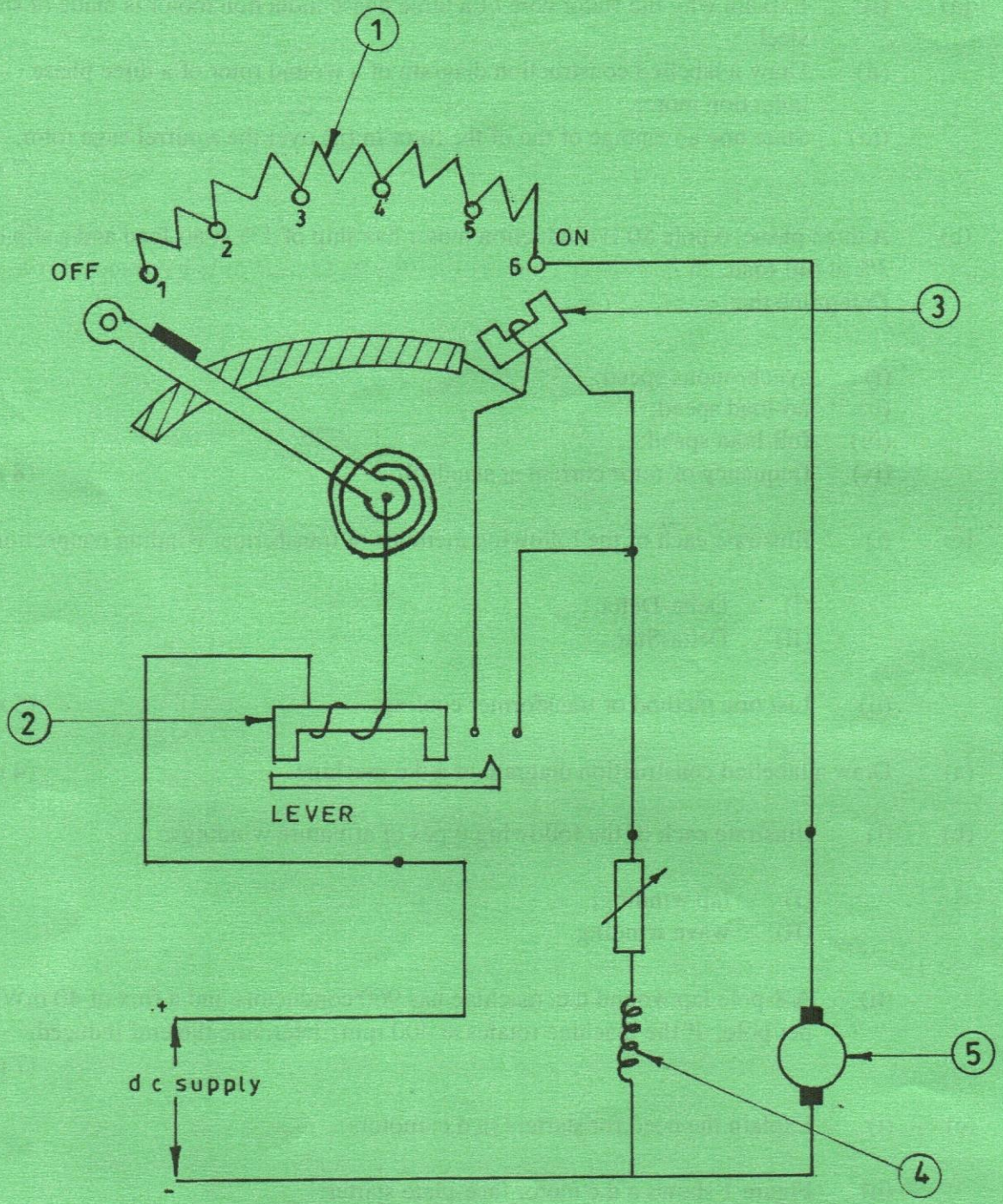


Fig. 1

5. (a) Define the following terms with reference to transients:

(i) transient period;
(ii) steady state period. (4 marks)

(b) With the aid of a circuit diagram, explain the growth of current in a d.c. R - L circuit. (6 marks)

(c) A 10 $\mu$F capacitor is connected in series with a 50 $\Omega$ resistor to a d.c supply of E volts. After 0.7 seconds, the voltage across the resistor is 20 V. Determine the value of:

(i) supply voltage E;

(ii) charging current 1.4 seconds after power supply is switched on. (6 marks)

(d) Figure 2 shows a capacitor discharge circuit, show that $Vc + RC\frac{dVc}{dt} = 0$ where Vc is capacitor voltage. (4 marks)

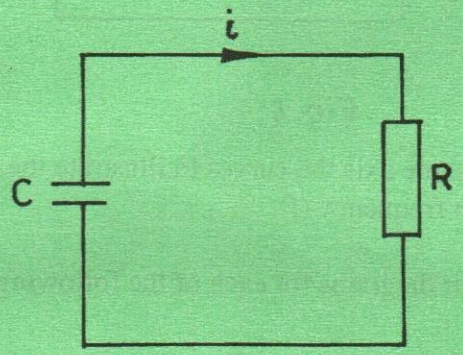


Fig. 2

6. (a) State the maximum power transfer theorem. (2 marks)

(b) Figure 3 shows a bridge circuit with $R_a = 20\Omega$ $R_b = 30\Omega$, $R_c = 50\Omega$, $R_e = 5\Omega$ and $R_d = 24\ \Omega$.

(i) Transform the delta formed by the resistances $R_a$, $R_b$ and $R_c$ into star equivalent.
(ii) Draw the equivalent circuit diagram in b(i) and determine the current supplied by the battery. (14 marks)

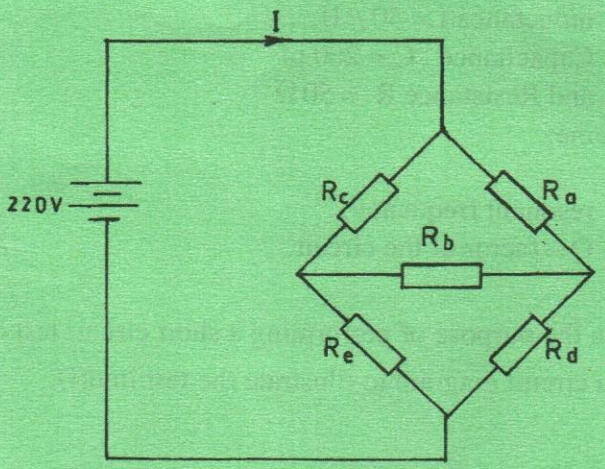


Fig. 3

(c) (i) Figure 4 shows R – L – C series a.c. circuit. Write the expression for the circuit current I.

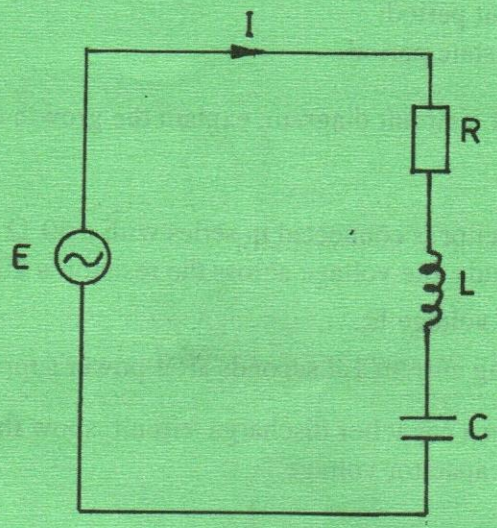


Fig. 4

(ii) Sketch on the same axis the curves to illustrate the variation of the reactances $X_L$ and $X_C$ with frequency (f). (4 marks)

7. (a) Draw equivalent circuit diagrams for each of the following types of d.c. machines:

(i) long compounded motor;
(ii) separately excited d.c. generator. (4 marks)

(b) Sketch, on the same axis the torque versus armature current characteristic curves for:

(i) d.c. shunt motor;
(ii) d.c. series motor. (4 marks)

(c) (i) Define 'Q-factor as applied in ac series R–L–C circuits.
(ii) An a.c. series R–L–C circuit has
inductance L= 50 $\mu$H,
Capacitance , C = 200 pF
and Resistance R = 50 $\Omega$
Determine;

(I) resonant frequency;
(II) Q – factor of the circuit. (7 marks)

(d) (i) Explain the purpose of performing a short circuit test on a transformer.
(ii) Draw a circuit diagram to illustrate the test in d(i). (5 marks)

8. (a) Define each of the following terms as use in d.c. machines:

(i) commutation;
(ii) armature reaction. (4 marks)

(b) Sketch the open circuit characteristic curve for a d.c. shunt generator. (3 marks)

(c) With the aid of a labelled cross-sectional diagram, explain the operation of a single phase shaded pole induction motor. (8 marks)

(d) (i) Define synchronization as applied in synchronous machines.
(ii) State **three** conditions to be satisfied before a three phase synchronous motor is connected to an existing three phase supply. (5 marks)

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