2506/202
2507/202
ELECTRONICS AND CONTROL
SYSTEMS
June/July 2019
Time: 3 hours

THE KENYA NATIONAL EXAMINATIONS COUNCIL

DIPLOMA IN AERONAUTICAL ENGINEERING (AIRFRAMES AND ENGINES OPTION) (AVIONICS OPTION)

MODULE II

ELECTRONICS AND CONTROL SYSTEMS

3 hours

INSTRUCTIONS TO CANDIDATES

*This paper consists of **EIGHT** questions in **TWO** sections, **A** and **B**.*
*Answer **THREE** questions from section **A** and **TWO** questions from section **B** 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.

SECTION A: ELECTRONICS TECHNOLOGY

*Answer **THREE** questions from this section.*

1. (a) Distinguish between forward biasing and reverse biasing with respect to semi conductor diodes. (2 marks)

(b) (i) State **two** advantages of full-wave bridge rectifiers over centre-tapped full-wave rectifiers.

(ii) With the aid of a diagram, describe the operation of a centre-tapped full-wave rectifier. (10 marks)

(c) A P-N junction diode having internal resistance (r) of 20 Ω is used for half-wave rectification. The applied voltage, V = 50 sin ωt and load resistance $R_L = 800\,\Omega$. Determine the:

(i) maximum current (I_m);

(ii) direct current I_{dc};

(iii) root mean square current (I_{rms});

(iv) d.c output voltage. (8 marks)

2. (a) List **two** applications of Light Emitting Diodes (LEDs). (2 marks)

(b) Draw the symbols of the following devices:

(i) silicon controlled rectifier;

(ii) LED;

(iii) varactor diode. (6 marks)

(c) State **two** classes of power amplifiers with respect to their mode of operation. (2 marks)

(d) An amplifier has an open circuit voltage gain of 1,000, an output resistance of 15 Ω and input resistance of 7 KΩ. It is supplied from a signal source of e.m.f 10 mV with internal resistance of 3 KΩ. The amplifier feeds a load of 35 Ω.

(i) sketch the equivalent circuit for the amplifier;

(ii) Determine the:

I. magnitude of the input voltage;
II. magnitude of the output voltage. (10 marks)

3. (a) State **three** merits of sinusoidal oscillators. (3 marks)

(b) With the aid of a diagram, describe the construction of a colpitt's oscillator. (7 marks)

(c) State **three** merits of common emitter configuration with respect to bipolar junction transistors (BJTs). (3 marks)

(d) Figure 1 shows a PNP transistor. The zero signal base current is 20 μA and $\beta = 50$.

(i) Determine the quiescent (Q) point;

(ii) draw the load line. (7 marks)

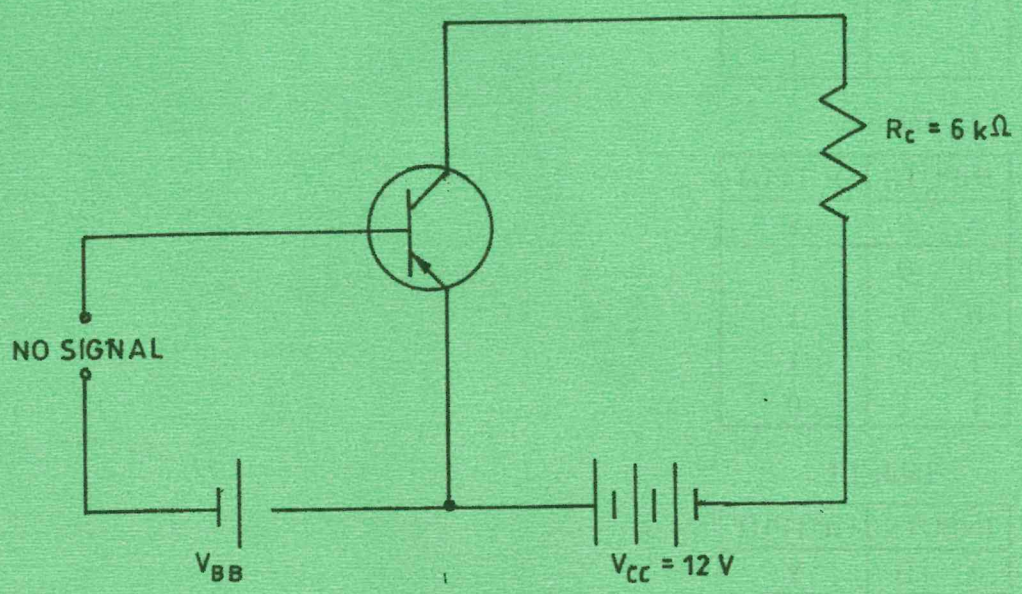


Fig.1

4. (a) Define the following with respect to memories:

(i) access time;

(ii) memory cell. (2 marks)

(b) Tables I, II and III show truth tables for different logic gates:

(i) identify the logic gates;

(ii) draw the symbols in (i);

(iii) write the Boolean expressions for the gates in (i). (9 marks)

Table I

INPUTS		OUTPUT
A	B	Y
0	0	0
0	1	1
1	0	1
1	1	1

Table II

INPUTS		OUTPUT
A	B	Y
0	0	1
0	1	1
1	0	1
1	1	0

Table III

INPUTS		OUTPUT
A	B	Y
0	0	0
0	1	1
1	0	1
1	1	0

(c) With the aid of a logic circuit diagram, describe the operation of a clocked J - K flip-flop. (9 marks)

5. (a) Convert the following:

(i) 27.25_{10} into binary;

(ii) 64.075_{10} into octal;

(iii) $4\,AF.9_{16}$ into octal. (9 marks)

(b) Write the Boolean equivalence of the following:

(i) A.1 = ;

(ii) A + 1 =;

(iii) A + AB = (3 marks)

(c) Add 37_{10} *and* 49_{10} in excess 3 code. (4 marks)

(d) Draw a logic circuit of a 2 to 4 decoder. (4 marks)

SECTION B: CONTROL SYSTEMS

*Answer **TWO** questions from this section*

6. (a) Define the following:

(i) settling time;

(ii) delay time;

(iii) peak time. (3 marks)

(b) Draw a 2nd order systems response curve showing the following:

(i) overshoot;

(ii) rise time;

(iii) peak time. (7 marks)

(c) A unity negative feedback control system has a forward transfer function:

$$G_{(s)} = \frac{K}{(S+a_1)(S+a_2)}$$

(i) draw the block diagram of the system;

(ii) determine the closed loop transfer function. (6 marks)

(d) draw a three-input summer operational amplifier circuit. (4 marks)

7. (a) State Routh's stability criterion. (2 marks)

(b) The open loop transfer function of a control system is given by:

$$G_{(s)} = \frac{K}{S(S^2+S+1)(S+4)}$$

The system has a unity feedback. Determine the characteristic equation. (4 marks)

(c) A second order system is describe by the differential equation:

$$3\frac{d^2\theta_0}{dt^2} + 6\frac{d\theta_0}{dt} = 12\,E. \text{ Where } E = (\theta_i - \theta_0).$$

Determine the:

(i) undamped natural frequency;

(ii) damping factor;

(iii) percentage overshoot;

(iv) time taken to reach the overshoot. (8 marks)

(d) With the aid of a diagram, describe components of a servo system. (6 marks)

8. (a) State **three** advantages of the bode plots over polar plots. (3 marks)

(b) Figure 2 shows an RLC circuit having a 150 Ω resistance, 0.06 H inductor and a 67 μF capacitor.

Determine the:

(i) transfer function;

(ii) resonant frequency. (6 marks)

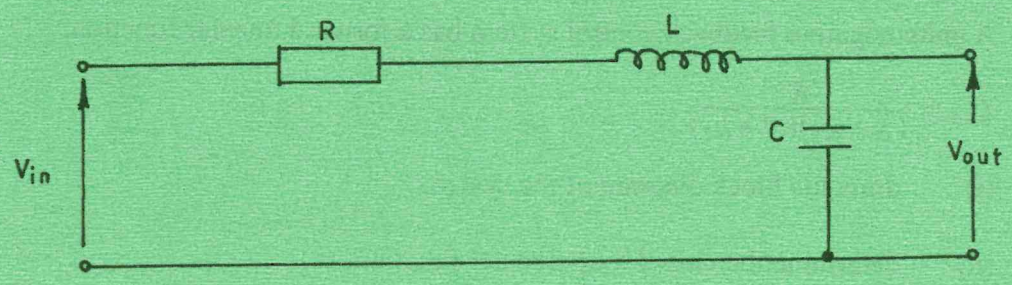
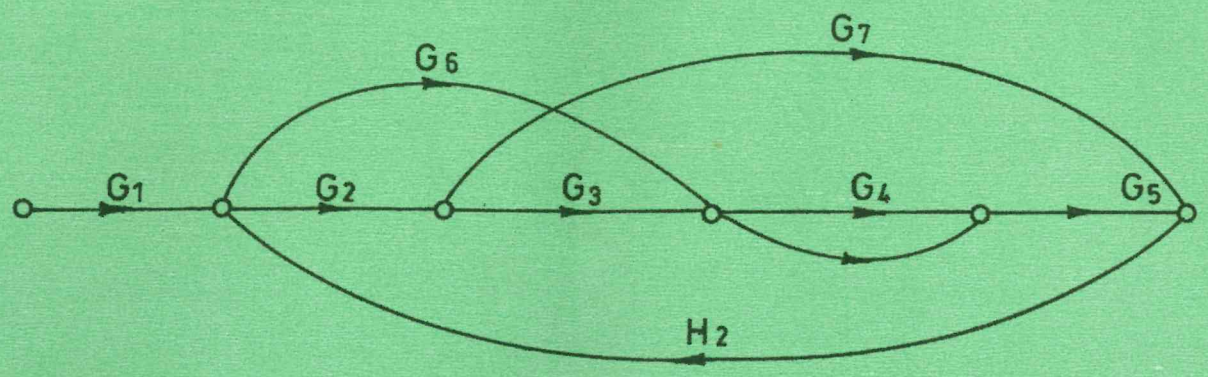


Fig. 2

(c) Figure 3 shows a signal flow graph of a control system. Using Mason's gain formula determine the closed loop transfer function. (8 marks)



$TF = \frac{T_1\Delta_1 + T_2\Delta_2}{\Delta}$

Fig.3

(d) Highlight **three** characteristics of an ideal operational amplifier (OP - AMP). (3 marks)

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