

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 20Ω is used for half-wave rectification. The applied voltage, $V = 50 \sin \omega t$ 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 15Ω and input resistance of $7 \text{ K}\Omega$. It is supplied from a signal source of e.m.f 10 mV with internal resistance of $3 \text{ K}\Omega$. The amplifier feeds a load of 35Ω .
- (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 $20 \mu A$ and $\beta = 50$.
- (i) Determine the quiescent (Q) point;
- (ii) draw the load line. (7 marks)

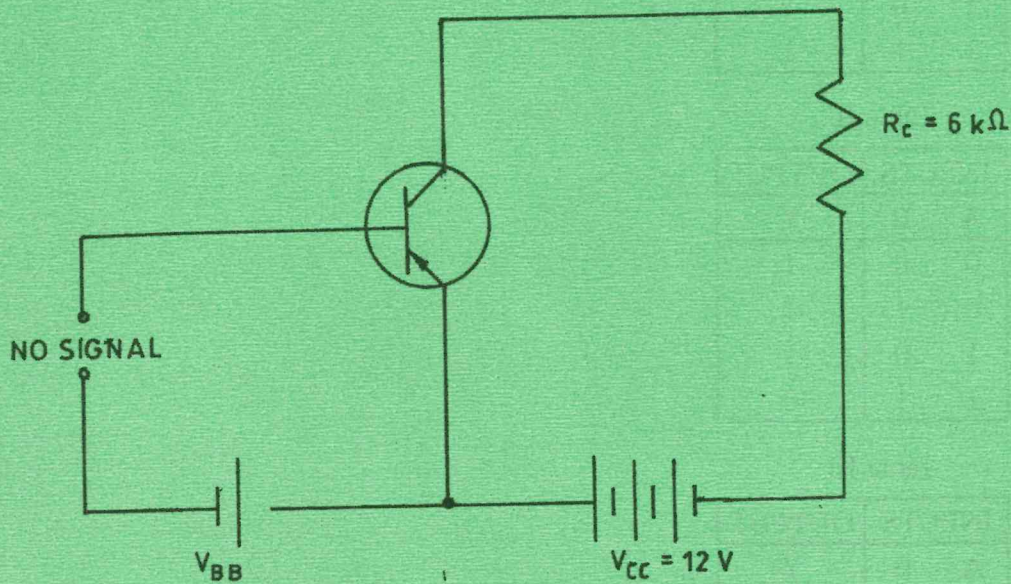


Fig.1

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) $4AF.9_{16}$ 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)

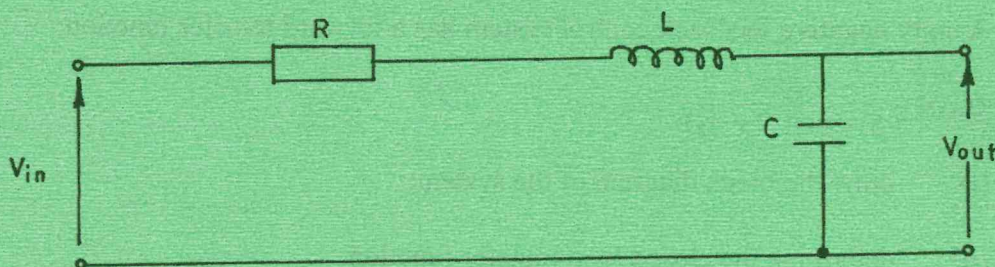


Fig. 2

- (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)

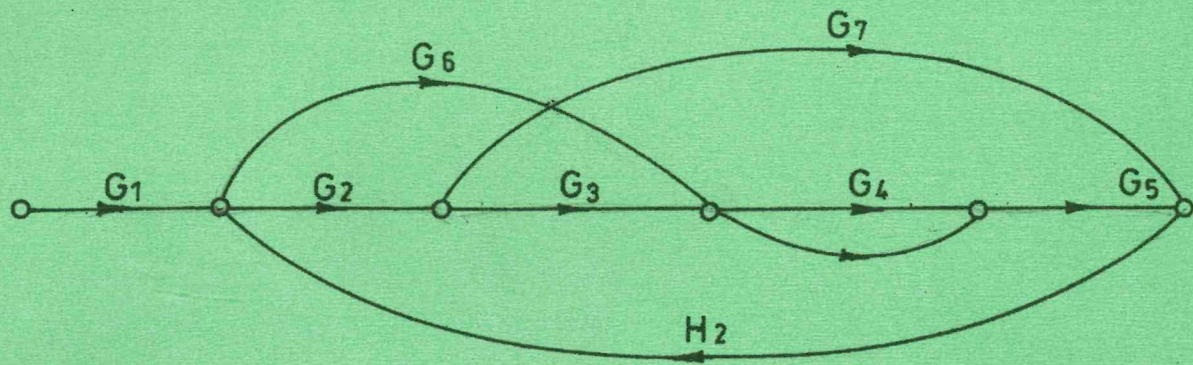


Fig.3

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

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