

2506/202

2507/202

ELECTRONICS AND CONTROL SYSTEMS

Oct. /Nov. 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

You should have the following for this examination:

answer booklet;

non-programmable scientific calculator;

Log-linear graph paper.

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 and 1 insert.

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

Answer **THREE** questions from this section.

1. (a) Differentiate between intrinsic and extrinsic semiconductors. (2 marks)
- (b) With the aid of a V-I characteristic curve explain the operation of a zener-diode. (7 marks)
- (c) Figure 1 shows a common-emitter silicon transistor amplifier circuit diagram using a fixed-bias.

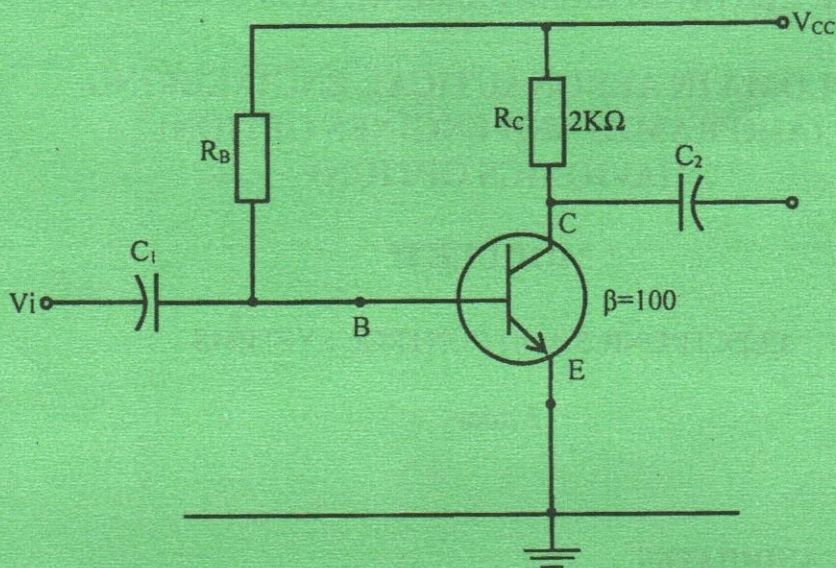


Fig. 1

The transistor is operated at $I_C = 1 \text{ mA}$, $V_{CE} = 4 \text{ V}$.
Determine the:

- (i) supply voltage, V_{CC} ;
- (ii) value of base resistor, R_B . (7 marks)
- (d) A two-stage common-emitter RC - coupled amplifier uses two similar, transistors whose h-parameter and internal capacitances are $h_{fe} = 600$, $h_{ie} = 10 \text{ k}\Omega$, $C_{bc} = 2.5 \text{ pF}$ and $C_{be} = 9 \text{ PF}$. The coupling capacitor is $0.5 \mu\text{F}$ and the load resistance is $10 \text{ k}\Omega$.
Determine the:
- (i) mid-frequency gain of the first stage;
- (ii) lower cut-off frequency. (4 marks)

2. (a) (i) With the aid of a circuit diagram, describe the operation of a half-bridge controlled inverter.
- (ii) State **two** areas of application of inverters.
- (8 marks)

(b) Figure 2 shows a circuit diagram of a Colpitt's oscillator.

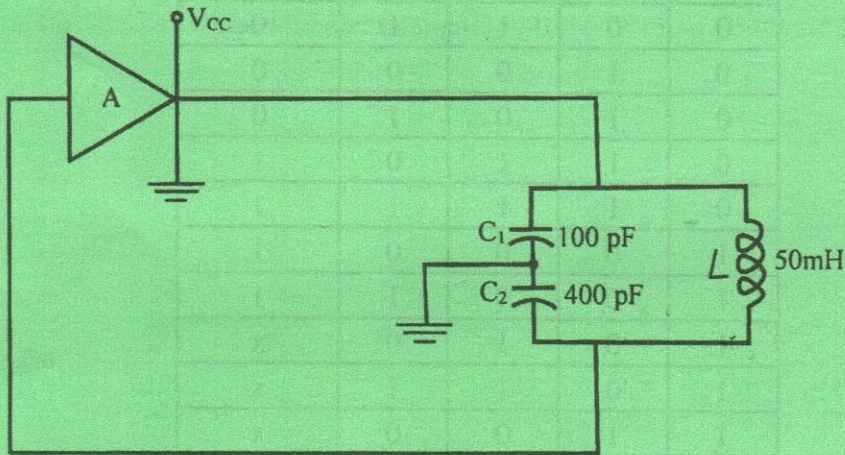


Fig. 2

Determine the:

- (i) frequency of oscillation;
- (ii) feedback factor;
- (iii) minimum gain.
- (8 marks)

- (c) (i) Distinguish between monostable and bistable multivibrators.
- (ii) State **two** merits of using LEDs as displays.
- (4 marks)

3. (a) Convert the decimal number 43 into:
- (i) octal;
- (ii) excess - 3 code;
- (iii) binary.
- (6 marks)

- (b) Prove the following identity using Boolean algebra:
 $A \oplus B \oplus AB = A + B$
- (6 marks)

(c) Table 1 shows the truth table for a logic circuit.

Table 1

Inputs				Output
A	B	C	D	Y
0	0	0	0	0
0	0	0	1	0
0	0	1	0	0
0	0	1	1	0
0	1	0	0	0
0	1	0	1	0
0	1	1	0	1
0	1	1	1	1
1	0	0	0	1
1	0	0	1	1
1	0	1	0	x
1	0	1	1	x
1	1	0	0	x
1	1	0	1	x
1	1	1	0	x
1	1	1	1	x

(i) Using a K-map, derive the minimum logic expression for Y.

(ii) Implement Y using NAND gates only.

(8 marks)

4. (a) Define each of the following with respect to logic gates:

(i) fan-out;

(ii) power dissipation.

(2 marks)

(b) State two merits of Emitter-Coupled logic (ECL) gates.

(2 marks)

(c) An asynchronous counter counts from 0 to 12.

(i) Determine the number of flip-flops required to implement it;

(ii) Draw the logic circuit diagram of the counter, using JK flip-flop.

(7 marks)

(d) (i) Draw a circuit diagram of a CMOS NAND gate and describe its operation.

(ii) State **three** advantages of CMOS gates over TTL gates.

(9 marks)

5. (a) (i) Draw a truth table of a binary full-adder.

(ii) Realise the full adder circuit using:

(I) 3 to 8 decoder and OR-gates;

(II) 4 x 1 multiplexers.

(10 marks)

(b) Define each of the following with respect to computer memories:

(i) cache;

(ii) access time.

(2 marks)

(c) (i) A microcomputer requires 32k X 8 RAM memory. This is implemented using 8k X 8 RAM chips. Determine the:

(I) number of chips required;

(II) number of address lines for each 8k X 8 chips.

(ii) Draw a schematic block diagram for the implementation of the memory in c(i).

(8 marks)

SECTION B: CONTROL SYSTEMS

Answer TWO questions from this section.

6. (a) Define each for the following with respect to control systems:

(i) control action;

(ii) feedback;

(iii) disturbance.

(3 marks)

(b) Figure 3 shows a block diagram of a control system.

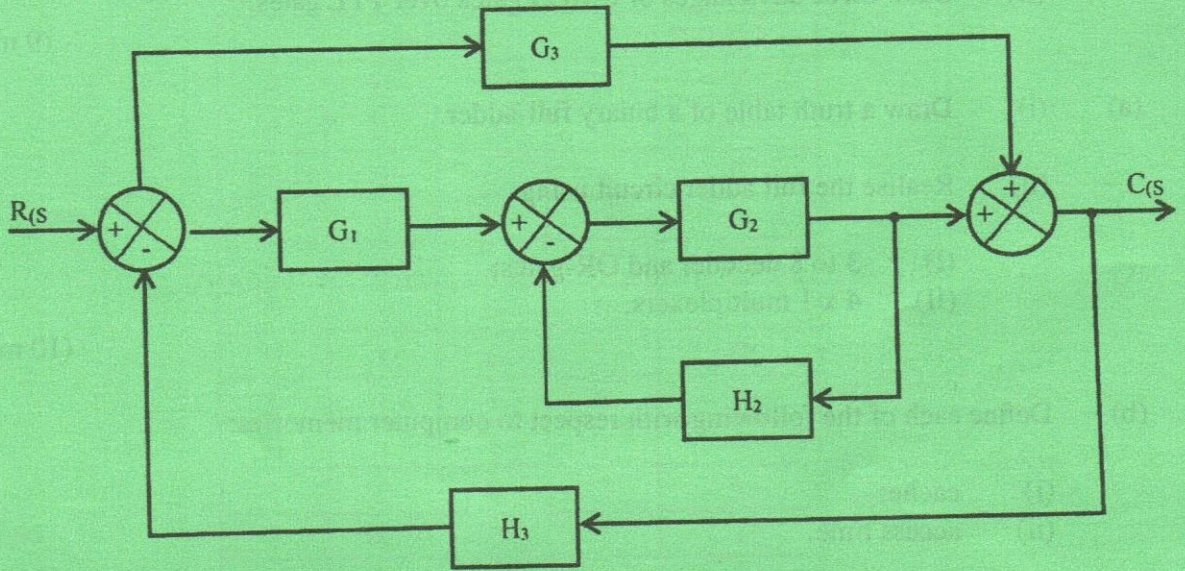


Fig. 3

(i) Draw a signal flow graph for the block diagram.

(ii) Use Mason's gain formula to determine the transfer function.

(14 marks)

(c) State **three** effects of a phase-lead compensation control network on a system.

(3 marks)

7. (a) State **three** reasons why Bode plots are preferred in system analysis to Nyquist plots.

(3 marks)

(b) Outline the procedure for obtaining the Bode plot of a given transfer function.

(5 marks)

(c) (i) Using asymptotic approximations, plot the Bode diagram for the following transfer function:

$$G(S) = \frac{10}{S(1+0.4S)(1+0.1S)}$$

(ii) From the Bode plot in c(i), obtain the:

- (I) gain margin;
- (II) phase margin.

(12 marks)

8. (a) State the Routh-Hurwitz stability criterion. (2 marks)

(b) The open-loop transfer function of a unity feedback system is given by:

$$G(s) = \frac{0.382k}{s(1 + 0.1s)(1 + 0.06s)}$$

Using the Routh array, determine the limiting value of K for the system to be stable. (6 marks)

(c) (i) Draw analogue computing symbols for each of the following:

(I) integrator;

(II) summer.

(ii) State two merits of analogue computer simulation in control system design. (4 marks)

(d) A unity feedback control system has an open loop transfer function given by:

$$G(s) = \frac{1}{s(s+1)(s+2)}$$

Draw an analogue computer simulation diagram for the closed-loop system. (8 marks)

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Semi-log Graph Paper

