2521/203 2602/202
2601/202 2603/202
DIGITAL AND ANALOGUE ELECTRONICS II
June/July 2021
Time: 3 hours

THE KENYA NATIONAL EXAMINATIONS COUNCIL

DIPLOMA IN ELECTRICAL AND ELECTRONIC ENGINEERING
(POWER OPTION)
(TELECOMMUNICATION OPTION)
(INSTRUMENTATION OPTION)

MODULE II

DIGITAL AND ANALOGUE ELECTRONICS II

3 hours

INSTRUCTIONS TO CANDIDATES

You should have the following for this examination:
- *Answer booklet;*
- *Non-programmable scientific calculator;*
- *Drawing instruments.*

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

SECTION A: ANALOGUE ELECTRONICS II

*Answer any **TWO** questions from this section.*

1. (a) Figure 1 shows an equivalent diagram of a special semi-conductor device.

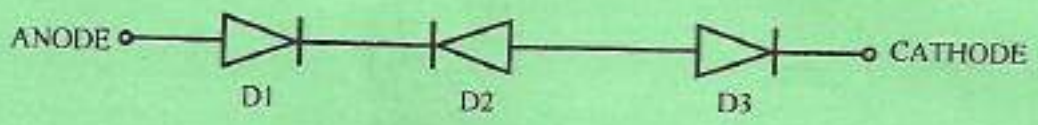

Fig. 1

(i) Identify the device.
(ii) Describe its operation.

(6 marks)

(b) (i) State **four** properties of an ideal operational amplifier (OP-AMP).

(ii) Define each of the following terms with respect to OP-AMPS:

I. slew rate;
II. common mode rejection ratio.

(6 marks)

(c) Figure 2 shows a multi-stage OP-AMP circuit with an input voltage of 80 μV.

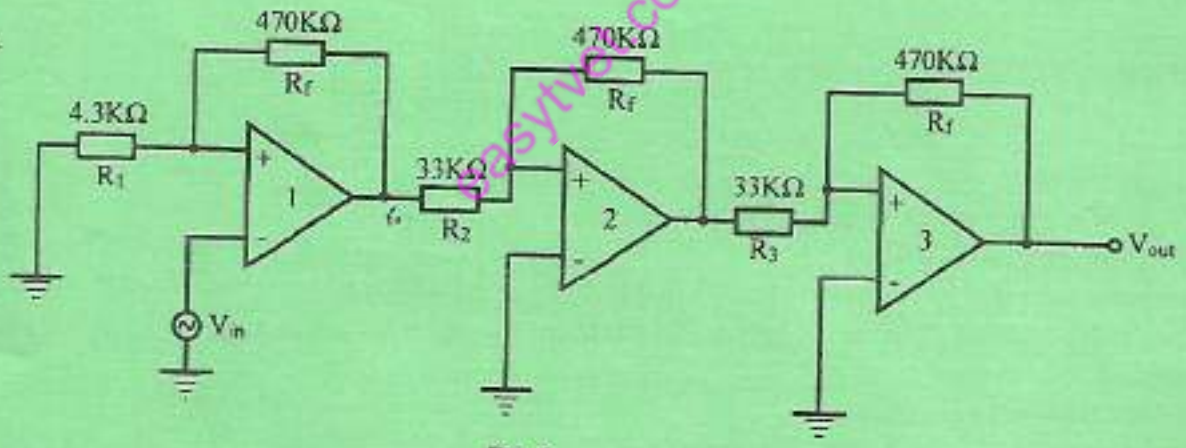

Fig. 2

Determine the:

(i) voltage gain of the first stage;
(ii) voltage gain of the second stage;
(iii) voltage gain of the third stage;
(iv) overall voltage gain.

(8 marks)

2. (a) Describe each of the following terms as used in transistor oscillators:

(i) tank circuit;
(ii) transistor amplifier;
(iii) feedback circuit.

(6 marks)

(b) (i) State **three** merits of the Wien Bridge oscillator.

(ii) Figure 3 shows the L-C tank circuit of a Hartley oscillator. The mutual inductance between the two coils is 20 μH.

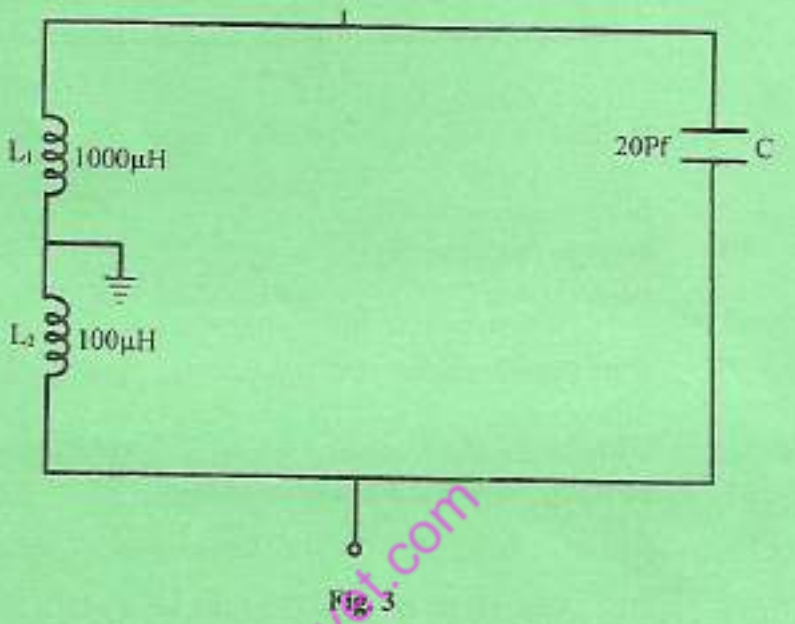

Fig. 3

Determine the:

I. total inductance;
II. operating frequency;
III. feedback fraction.

(9 marks)

(c) With the aid of a labelled circuit diagram, describe the operation of a Triac.

(5 marks)

3. (a) Define each of the following expressions as used in silicon controlled rectifiers (SCRS):

(i) break over voltage;
(ii) peak reverse voltage;
(iii) forward current rating.

(3 marks)

(b) Figure 4 shows in SCR half-wave rectifier circuit. The SCR has a forward breakdown voltage of 150 V when a current of 1 mA flows in the gate.

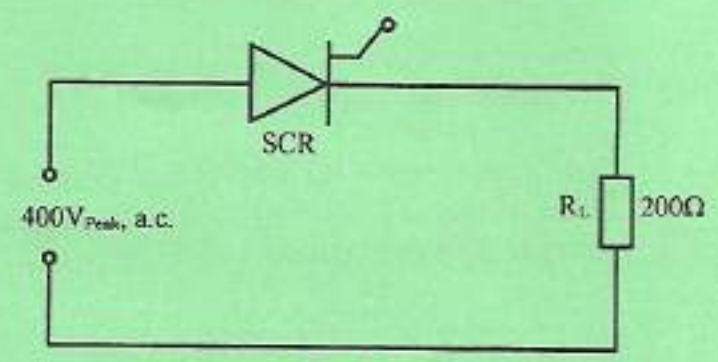

Fig. 4

Determine the:

(i) firing angle;
(ii) average output voltage;
(iii) output power. (9 marks)

(c) (i) State **three** merits of R-C coupled transistor amplifiers.

(ii) With the aid of a frequency response curve, describe the relationship between gain and frequency for R-C amplifiers. (8 marks)

SECTION B: DIGITAL ELECTRONICS

Answer any THREE questions from this section.

4 (a) State **three** advantages of digital systems over analogue systems. (3 marks)

(b) Perform each of the following arithmetic operations:

(i) $(8C4.37)_{16} + (27B.5D)_{16}$

(ii) $(1101101.01)_2 - (1011101.11)_2$

(iii) $(1101)_2 \times (1010)_2$

(9 marks)

(c) Add $(01100100)_2 + (10010010)_2$ in:

(i) BCD;
(ii) X − cess 3. (6 marks)

(d) Convert $(110101101)_2$ to Gray code. (2 marks)

5. (a) State De-Morgan's theorems. (2 marks)

(b) (i) Draw a logic circuit diagram of an S-R flip-flop using NOR gates only.
(ii) Draw the truth table for the flip flop in (b)(i). (7 marks)

(c) Tables I, II and III show truth tables for different logic gates.

Table I

INPUTS		OUTPUT
A	B	F
0	0	1
0	1	1
1	0	1
1	1	0

Table II

INPUTS		OUTPUT
A	B	F
0	0	1
0	1	0
1	0	0
1	1	0

Table III

INPUTS		OUTPUT
A	B	F
0	0	1
0	1	0
1	0	0
1	1	1

For each truth table:

(i) Identify the logic gate;
(ii) Draw its symbol;
(iii) Write its Boolean expression. (9 marks)

(d) Distinguish between Fan-In and Fan-Out as used in logic families. (2 marks)

6. (a) (i) With the aid a schematic block diagrams, describe the operation of a counter based Analogue to Digital Converter (ADC).

(ii) State **two** merits of the ADC in (a)(i). (9 marks)

(b) A 6-bit successive approximation ADC is used to convert an analogue signal. Determine the:

(i) percentage resolution;
(ii) time to convert a half-scale analogue signal, if its clock frequency is 1 μHz.

(5 marks)

(c) Illustrate implementation of 16-to-1 multiplexer using 4-to-1 multiplexers. (6 marks)

7. (a) Simplify each of the following expressions using Boolean rules:

(i) $Q = A\overline{B}\,\overline{C} + A\overline{B}C + AB\overline{C} + ABC$;

(ii) $Z = \overline{A}\,\overline{B} + \overline{A}B + A\overline{B}$.

(7 marks)

(b) A security alarm system uses four sensors to monitor the four corners of a building. The alarm is triggered when at least two sensors are activated.

(i) Draw the truth table for the system.
(ii) Using a K-Map simplify the Boolean expression in (b)(i). (10 marks)

(c) Draw a logic circuit diagram of an OR gate implemented using NAND gates only. (3 marks)

8. (a) Distinguish between volatile and non-volatile memory devices. (2 marks)

(b) A microcomputer has 32 K × 8 ROM memory. The available memory chips are 8K × 8 ROM. Determine the:

(i) word size;
(ii) address lines for the entire system;
(iii) number of chips required for the entire system;
(iv) draw the system memory map given that the address starts at 0000H.

(9 marks)

(c) (i) With the aid of a diagram, describe the operation of a Dynamic RAM memory cell.

(ii) State **two** merits of the RAM in (c)(i). (9 marks)

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