2521/203 2602/202
2601/202 2603/202
DIGITAL AND ANALOGUE ELECTRONICS II
June/July 2022
Time: 3 hours

THE KENYA NATIONAL EXAMINATIONS COUNCIL

DIPLOMA IN ELECTRICAL AND ELECTRONICS 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;
Mathematical tables/non-programmable scientific calculator;
*This paper consists of **EIGHT** questions in **TWO** sections, **A** and **B**.*
*Answer any **TWO** questions from section **A**, and any **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 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.

Turn over

SECTION A: ANALOGUE ELECTRONICS II

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

1. (a) With the aid of the V-I characteristic curves, describe the operation of a photodiode. (7 marks)

(b) Define the following terms with reference to silicon controlled rectifiers:

(i) latching current;
(ii) peak inverse voltage.

(4 marks)

(c) **Figure 1** shows a symbol of a semiconductor device.

Fig. 1

(i) name the device;
(ii) explain the operation of the device in (ii).

(5 marks)

(d) A unijuction transistor used to trigger the silicon controlled rectifier has $r_{B1} = 4\,k\Omega$ and $r_{B2} = 2.5\,k\Omega$. Determine the:

(i) value of intrinsic stand ratio;
(ii) peak point voltage if V_{BB} of 15 V was applied at a barrier potential of 0.7 V.

(4 marks)

2. (a) Explain the following as used in amplifiers:

(i) positive feedback;
(ii) negative feedback. (4 marks)

(b) With aid of a sketch, show from first principles that the voltage gain of an amplifier with negative feedback is given by the expression:

$$Av' = \frac{A_V}{1 + \beta A_V}.$$ (4 marks)

(c) An RC coupled amplifier has voltage gain of 1000, $f_1 = 50$ Hz, $f_2 = 200$ kHz and distortion of 5% without feedback. If negative feedback with feedback ratio 0.01 is applied, determine:

(i) gain with feedback;
(ii) f_1';
(iii) f_2';
(iv) distortion.

(8 marks)

(d) With the aid of block diagrams, differentiate between voltage series feedback and voltage shunt connection. (4 marks)

3. (a) **Figure 2** shows a common emitter transistor amplifier. The transistor parameters are $h_{ie} = 1100\,\Omega, h_{fe} = 50, h_{re} = h_{oe} = 0$.
Determine;

(i) voltage gain;
(ii) input resistance at the source terminals;
(iii) output resistance. (10 marks)

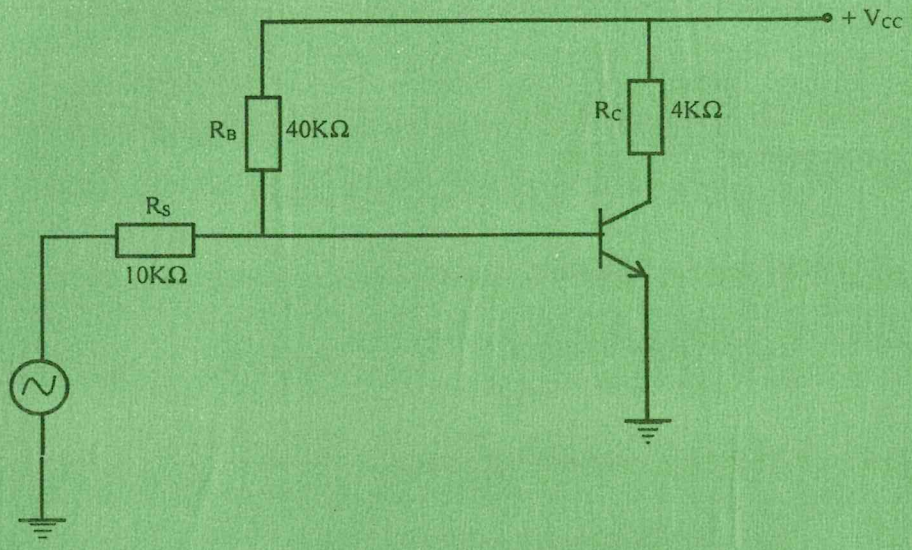

Fig. 2

(b) Explain the following terms as used in differential amplifiers:

(i) common mode gain;
(ii) common mode rejection ratio (CMRR). (4 marks)

(c) Derive the expression for the output voltage of a 3 input OP-Amp based summing amplifier. (6 marks)

SECTION B: DIGITAL ELECTRONICS

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

4. (a) (i) Use 1's complement method to solve $18_{10} - 25_{10}$.

(ii) Use 2's complement method to solve $1E_{16} - F_{16}$.

(8 marks)

(b) A circuit is required which will produce logic 1 when its two inputs are not identical.

(i) draw its truth table and hence derive its logic expression;
(ii) show how such a circuit can be constructed using NAND gates only.

(7 marks)

(c) With the aid of a circuit diagram, explain the working principle of dynamic random access memory (DRAM).

(5 marks)

5. (a) (i) Convert the following numbers:

(I) 71_8 to binary;
(II) $8A3_{16}$ to decimal.

(ii) Perform the following operations:

(I) add BCD numbers 17 and 15;
(II) convert gray code 1001011 to binary.

(10 marks)

(b) Differentiate between even and odd parity as used in error detection codes. (4 marks)

(c) Using K-map, simplify the Boolean expression:

$f(A, B, C, D) = \sum(0,1,2,3,4,5,6,7,8,9,12,13)$ (6 marks)

6. (a) Explain the following terms as used in digital systems:

(i) reflective code;
(ii) weighted code.

(4 marks)

(b) Draw the truth table of a full adder circuit and hence implement it using;

(i) OR gates only for the sum;
(ii) NAND gates only for the carry output.

(10 marks)

(c) A 4 bit counter has a propagation delay time (tpd) of 50 ns for each flip flop and a propagation delay time (tpd) of 20 ns for each AND gate used.

(i) Determine the maximum frequency (f_{max}) when the counter is connected as:

(I) synchronous counter;
(II) ripple counter.

(ii) Compare the results in c (i).

(6 marks)

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

(I) fan in;
(II) speed of operation.

(ii) **Figure 3** shows a circuit diagram of a CMOS logic gate. Explain its operation and deduce the logic function it performs. (7 marks)

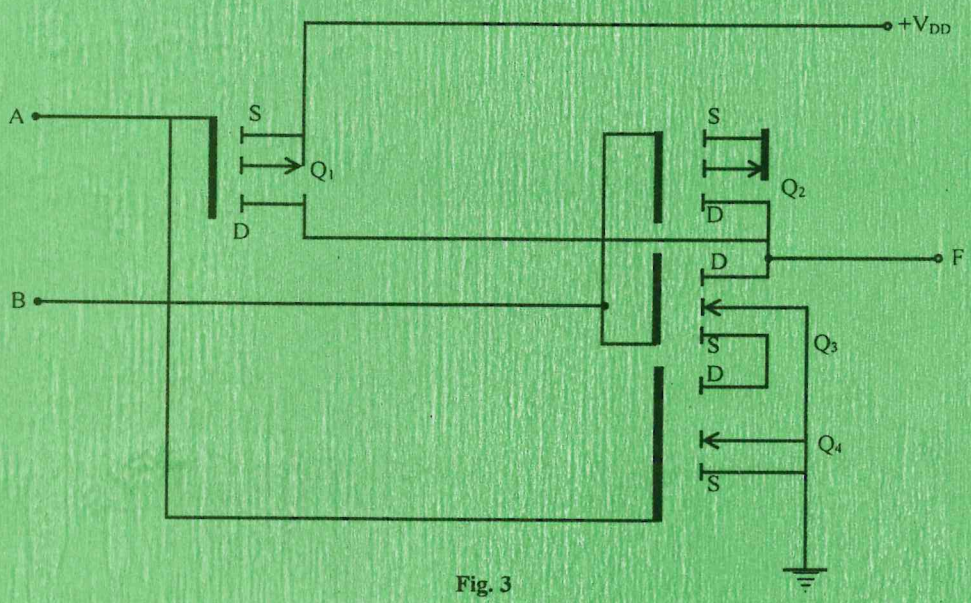

Fig. 3

(b) **Figure 4** shows a block diagram of 4-to-1 multiplexer:

(i) draw its truth table;
(ii) obtain the Boolean expression for the output Y from the truth table in b (i);
(iii) implement the expression in b (i) using logic gates.

(6 marks)

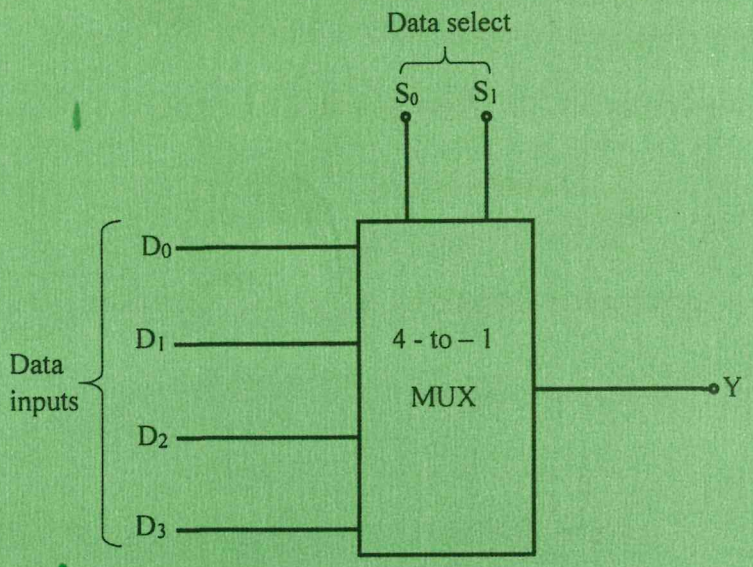

Fig. 4

(c) (i) State **two** methods used in overcoming the switching difficulties associated with strobed operation of flip flops.

(ii) **Figure 5** shows a logic circuit diagram of a binary counter. Assuming the flip flops are initially reset:

(I) draw the timing diagrams for Q_A, Q_B and Q_C due to application of clock pulses.

(II) determine the counting sequence of the counter.

(7 marks)

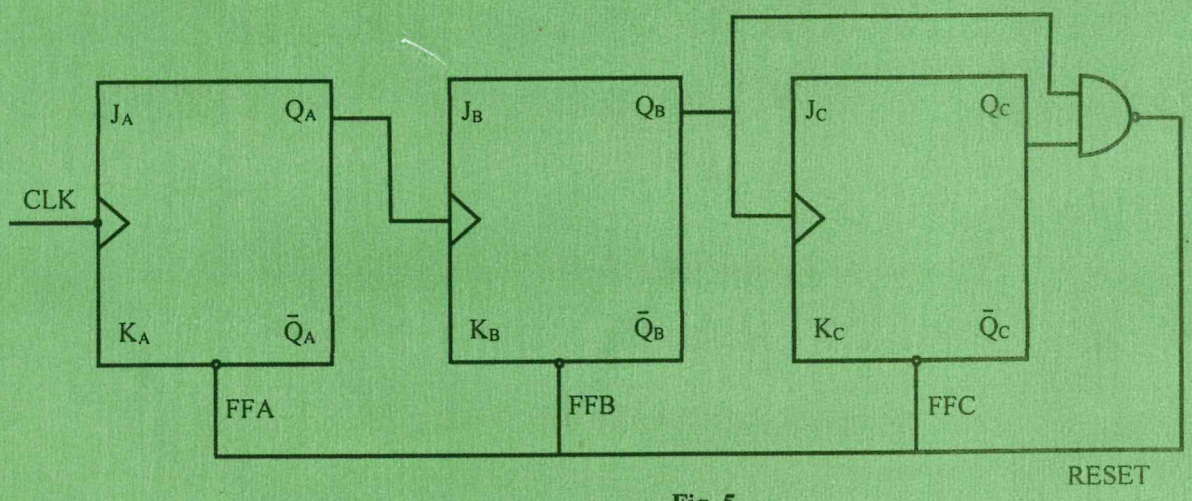

Fig. 5

8. (a) Differentiate between volatile and non-volatile memory. (4 marks)

(b) An office electronic equipment has a memory capacity of $16K \times 8$. Calculate:

(i) the number of words in this memory;
(ii) number of bits in each word (word length);
(iii) total number of memory cells in the memory.

(6 marks)

(c) A data handling company intends to purchase digital to analog converters (DAC) for field use. If you were consulted to advice on the best converters, state four performance characteristics you would consider. (4 marks)

(d) A computer is used to control motor speed. A DAC is used to vary the speed from 0 to 1,000 r.p.m. The computer has a resolution of 1 r.p.m. Determine the:

(i) number of bits of the computer;
(ii) number of digital counts (steps) for a motor speed of 900 r.p.m.

(6 marks)

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