MACHAKOS UNIVERSITY

University Examinations for 2023/2024 Academic Year

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

THIRD YEAR FIRST SEMESTER EXAMINATION FOR

BACHELOR OF SCIENCE IN ELECTRICAL AND ELECTRONICS ENGINEERING

EEE 305: DIGITAL ELECTRONICS I

DATE: **TIME:**

INSTRUCTIONS

1. This paper contains 5 questions.
2. Attempt **Question One** and **Any Other Two questions**
3. Show calculations where applicable
4. **Mobile Phone** is **NOT ALLOWED** in the examination room

QUESTION ONE (30 MARKS) (COMPULSORY)

a) A circuit has four inputs D, C, B, A encoded in 8421 natural binary form. The inputs in the range $0000_2 = 0$ to $1011_2 = 11$ represent the months of the year from January (0) and December (11). Inputs in the range 1100 to 1111 (i.e. 12 to 15) cannot occur. The output of the circuit is a logic one if the month represented by the input has 31 days. Otherwise the output is false. The output for inputs in the range 1100 to 1111 is undefined.

i. Draw a truth table to represent the problem. **[3 marks]**

ii. Use the K-map to obtain a simplified expression for the function **[4 marks]**

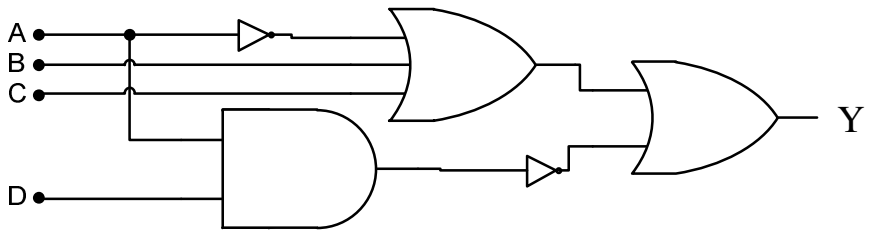
iii. Construct a circuit to implement the function using AND, OR and NOT gates **[3 marks]**

iv. Construct a circuit to implement the function using NOR gate only. **[3 marks]**

b) Simplify the following expression using Boolean algebra laws and rules and implement the simplified expression using logic gates.

$$F = xy + xyz + xy\bar{z} + \bar{x}yz$$ **[5 marks]**

c) Write the Boolean expression for output Y for logic circuit shown in the figure below and draw its truth table. **[5 marks]**



d) Perform $52_{10} - 89_{10}$ using 9's complement. **[3 marks]**

e) Subtract 101_2 from 111_2 using 1's complement. **[2 marks]**

f) Convert the fractional decimal 0.3125 to its equivalent binary fraction. **[2 marks]**

QUESTION TWO [20 MARKS]

a) Using a truth table, K-map and logic expressions, design a full adder. **[9 marks]**

b) Simplify the following Boolean expression and implement the simplified expression using EX-NOR and AND gates only.

$$Y = \overline{A}\overline{B}\overline{C}D + A\overline{B}\overline{C}\overline{D} + ABCD + \overline{A}\overline{B}CD$$ **[5 marks]**

c) Find the minterms or standard sum of products (SOP) and maxterms or standard product of sums (POS) forms for the function:

$f(A,B,C,D) = AC$ **[6 marks]**

QUESTION THREE [20 MARKS]

a) Minimize the following expression using Quine-McCluskey method:

$f(A,B,C,D) = \sum_m (0,1,2,3,5,7,8,9,11,14)$ **[10 marks]**

b) Explain four functions of codes. **[4 marks]**

c) Perform $22_{10} - 54_{10}$ using 10's complement method. **[3 marks]**

d) Add 83_{10} to 34_{10} in BCD. **[3 marks]**

QUESTION FOUR [20 MARKS]

a) Explain the following terms as used in digital electronics
   i. Multiplexing
   ii. Combinational circuit
   iii. Decoder **[3 marks]**

b) Explain any four advantages of using Multiplexer in designing logic circuits. **[4 marks]**

c) With the aid of logic circuits, explain the operation of a J-K Master-Slave flip-flip. **[9 marks]**

d) Prove the following identity using Boolean algebra and De Morgan's theorems: **[4 marks]**

$AB + \overline{A}\overline{C} + A\overline{B}C(AB + C) = 1$

QUESTION FIVE [20 MARKS]

a) Show that the EXCLUSIVE OR, EX-OR, operator is associative such that
$A \oplus (B \oplus C) = (A \oplus B) \oplus C$ **[7 marks]**

b) Minimize the multiple-output Boolean function given below, using a K-map and implement the minimum expression using only NAND gates.

$$f(A,B,C,D) = \sum(1,\ 2,6,7,8,13,14,15) + \sum_{x}(3,5,12)$$

where the min-terms with x are don't care conditions. **[8 marks]**

c) Draw a four-stage shift-right register using D-flip flops and explain its operation. **[5 marks]**