MACHAKOS UNIVERSITY

University Examinations for 2020/2021

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: 11/8/2021 **TIME: 8:30 – 10:30 AM**

INSTRUCTIONS TO STUDENTS

1. *This paper contains 5 questions.*
2. *Attempt* ***Question One*** *and* ***Any Other Two questions***

QUESTION ONE(COMPULSORY)(30 MARKS)

a) Perform the following binary operation: $11.001_2 + 0.11011_2 + 111.111_2$ (2 marks)

b) Perform the following operation using 9's complement subtraction: $125.35_{10} - 94.7_{10}$ (3 marks)

c) Convert $D2763_{16}$ to decimal. (2 marks)

d) Simplify the logic function $f(A,B,C,D) = \sum_m (1,3,7,11,15) + d(0,2,5)$ using the Quine-McCluskey method. (7 marks)

e) Using the following truth table below,
   (i) Derive the Boolean expression representing the function Y using products of sum. (2 marks)
   (ii) Draw the simplest circuit possible (4 marks)

A	B	C	Y
0	0	0	1
0	0	1	1
0	1	0	0
0	1	1	1
1	0	0	0
1	0	1	0
1	1	0	1
1	1	1	1

where A, B and C are the inputs and Y is the output.

f) Perform the following binary subtraction using 1's compliment arithmetic $10111.1_2 - 10011.1_2$ (3 marks)

g) Perform the following operation in BCD: $89_{10} + 276_{10}$ (2 marks)

h) Prove the following identity: $AB + \overline{AC} + A\bar{B}C(AB + C) = 1$ (5 marks)

QUESTION TWO (20 MARKS)

a) With the aid of a well labelled diagram, explain the implementation of NAND gate using TTL logic family with a totem pole output. (7 marks)

b) Obtain the minimal POS expression for the Boolean function given below using a K-map and implement the minimum expression using logic gates. $f(A, B, C, D) = \prod(3, 4, 6, 7, 11, 12, 13, 14, 15)$ (8 marks)

c) With aid of a well labeled logic circuit and truth table, explain the operation of a clocked D flip-flop. (5 marks)

QUESTION THREE (20 MARKS)

a) Perform the following BCD subtraction using 10's complement: $75E_{16} - 87_{10}$. (3 marks)

b) Differentiate between synchronous and asynchronous sequential circuits. (2 marks)

c) Draw a circuit diagram and a truth table of a J-K flip-flop and explain its operation. (7 marks)

d) Simplify the following Boolean expressions: $AB + A\bar{B}C\left(\overline{B}\overline{C} + C\right) + \overline{AC}$. (5 marks)

e) Perform the following using binary multiplication: $11.11_2 \times 0.111_2$ (1½ marks)

f) Perform the following binary division: $10.01_2 \div 1.1_2$ (1½ marks)

QUESTION FOUR (20 MARKS)

a) A 4-bit binary number is applied to a circuit on four lines A, B, C, D. The circuit has a single output, F, which is true if the number is in the range three to twelve, inclusive.
   (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)

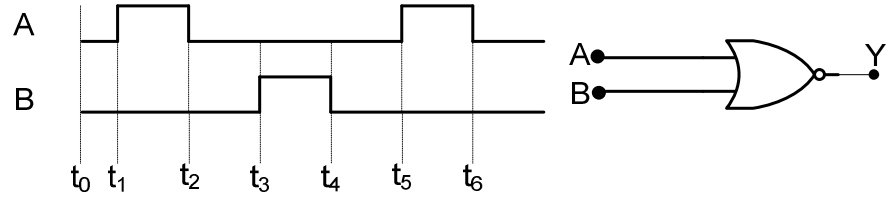
   (iii) Construct a circuit to implement the simplified expression in (ii) above using NAND gate only. (3 marks)

b) Briefly explain the following terms:-
   (i) Registers
   (ii) Shift-registers (4 marks)

c) With the aid of logic symbols and truth tables, explain the operation of the following two-input gates.
   (i) NOR
   (ii) XOR (6 marks)

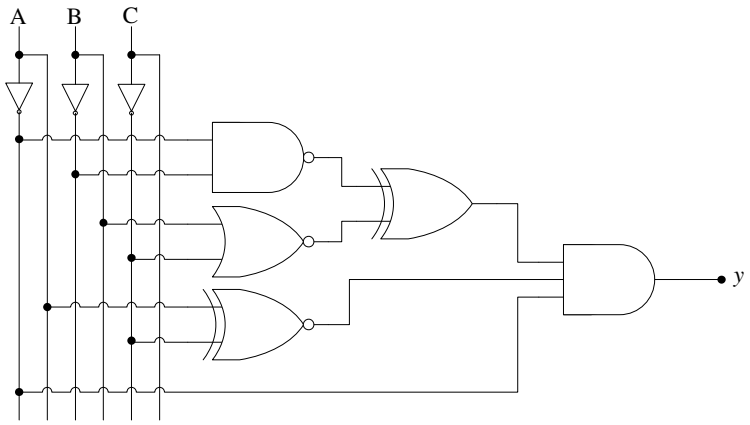
QUESTION FIVE (20 MARKS)

a) The figure below shows the two waveforms applied to the NOR gate. Determine the resulting output waveform. (4 marks)



b) Differentiate between combinational and sequential circuits. (5 marks)

c) Determine the Boolean expression and the truth table for the output of the logic circuit shown below. (4 marks)



d) Explain any four advantages of digital systems over analogue systems (4 marks)

e) Use 2's complement to subtract 1101_2 from 1010_2 (3 marks)