MACHAKOS UNIVERSITY

University Examinations for 2022/2023 Academic Year

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

THIRD YEAR .....SEMESTER EXAMINATION FOR

BACHELOR OF SCIENCE (TELECOMMUNICATION AND INFORMATION TECHNOLOGY)

SPH307 DIGITAL ELECTRONICS

DATE: **TIME:**

INSTRUCTIONS

ANSWER QUESTION ONE AND ANY OTHER TWO QUESTIONS

QUESTION ONE (COMPULSORY) (30 MARKS)

a) Find the decimal equivalent of binary number, 1 1 0 1 1 0 0 1. 0 101 0 (3marks)

b) Convert the following numbers from binary to hexadecimal
100100011
1111000000001101 (4 marks)

c) Represent the decimal number 5,137 in (i)BCD, (ii) excess -3 code (2 marks)

d) 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)

e) 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)

e) Express the complement of the following function ns in sum-of-min-terms form:
i) $F(A, B, C, D)=\sum(3,5,9,1,15)$ ii) $F(x, y, z] =\Pi(2.\ 4,\ 5.\ 7)$ (2 marks)

f) Draw the multi-level NAND circuit for the given expression (4 marks)

$$w(x + y + z) + xyz$$

QUESTION TWO (20MARKS)

a) Convert the following numbers with the indicated bases to decimal (8 marks)

i) $(4310)_5$ ii) $(198)_{12}$ iii) $(735)_8$ iv) $(525)_6$

b) Demonstrate the validity of the following identities by means of truth tables (12 marks)
i. DeMorgan's theorem for three variables $(x + y + z)' = x'y'z'$ and $(xyz)' = .x' + y' + z'$
ii. The distributive law $x + yz' = (x + y)(x + z)$
iii. The associative law $x + (y + z) = (x + y) + Z$

QUESTION THREE (20 MARKS)

a) Draw a NAND logic diagram that implements the complement of the given function.
$F(A, B, C, D)= \sum(0,1,2,3,4,8,9,12)$ (10 marks)

b) Design a combinational circuit with three inputs and one output (10 marks)
i) The output is 1 when the binary of the input is less than 3. The output is 0 otherwise
ii) The output is 1 when the binary value of the input is an odd number.

QUESTION FOUR [20MARKS]

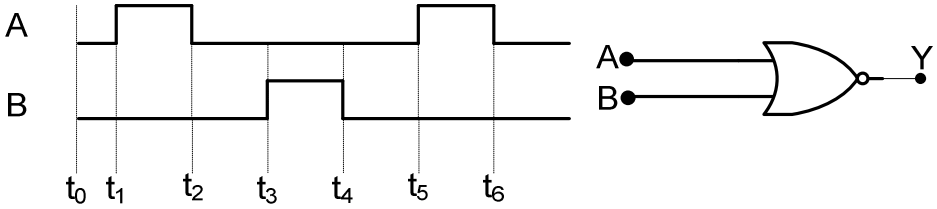
a) A majority circuit s a combinational circuit whose output is equal to 1 if the input variable has more 1's than 0's. The output is 0 otherwise. Design a three-input majority circuit by finding the circuit truth tab, Boolean equation and a logic diagram (10 marks)

b) Proof the following Boolean identity
$(A+B)(A+\bar{B})(\bar{A}+C)=AC$ (4 marks)

c) With the aid of logic symbols and truth tables, explain the operation of the following two-input gates.
(i) NAND
(ii) XOR (6 marks)

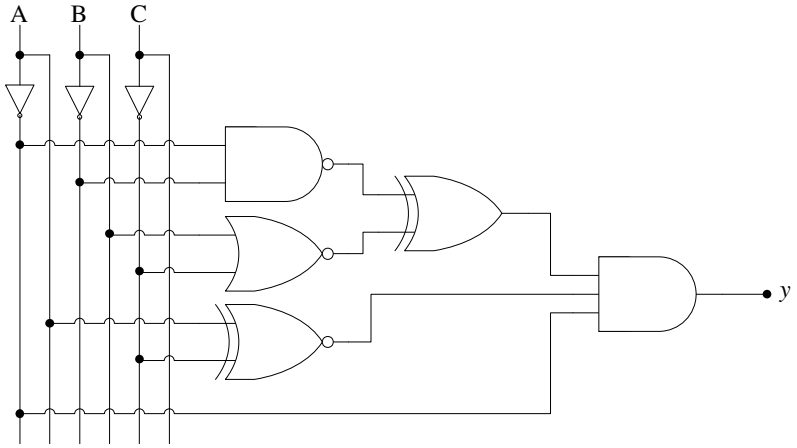
QUESTION FIVE (20MARKS)

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) Simplify the following Boolean expression to a minimum number of literal hence implement the logic gate

e) $AB\bar{C} + \bar{A}BC + ABC + \bar{A}B\bar{C}$ (4 marks)

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