Section B

WRITTEN QUESTIONS

Question 1

[4]

(a) Use the XOR operator on the bit patterns 100110101 and 101010011. (Determine 100110101 XOR 101010011.)

(b) Determine 1101101 + 1000110 in binary.

(c) A 6-bit digital counter can be made up of _____ T flip-flops. At the start the counter represents _____.

Question 2 **[4]**

Draw the logic circuit for the following Boolean expression (do not simplify the expression):

$F(x, y, w) = [(x' + y + w) + xy]' \oplus w'$

(The circuit should include one OR gate, one AND gate, one NOR gate, one XOR gate and two inverters. Draw all the gates clearly.)

Question 3

[8]

Use only Boolean algebra to simplify the Boolean expression F. (First determine F_1 and F_2, then simplify $F_1 + F_2$, showing all the steps. You need not provide the names of the Boolean rules that you apply.)

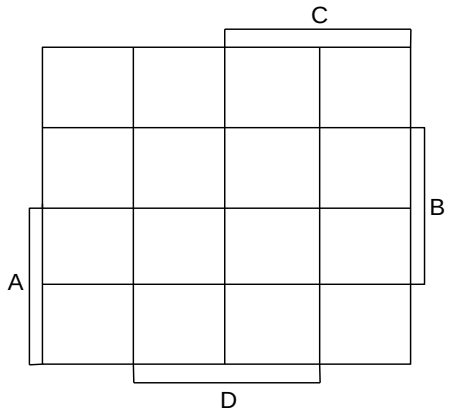
$F_1 = x'(wy')' + x'wy'$
$F_2 = (xw + w')'$
$F(w, x, y) = F_1 + F_2$.

Question 4 **[5]**

Use a Karnaugh map to find the simplest form of
$H(A, B, C, D) = m_0 + m_1 + m_2 + m_3 + m_5 + m_6 + m_8 + m_9 + m_{13}$.

Derive the terms of H directly from the Karnaugh map without making use of algebraic manipulations or truth tables. Show the groupings clearly.

Use exactly the same order for the variables as given in the following diagram:



Question 5 **[9]**

Four types of packages (A, B, C and D) containing chemicals are supplied to research laboratories. Each package contains unique types of chemicals:

Package A contains three different types of chemicals.
Package B contains six different types of chemicals.
Package C contains five different types of chemicals.
Package D contains two different types of chemicals.

Suppose the input variables A, B, C and D in a truth table take on the value 1 whenever a laboratory receives a package containing chemicals. For example, if A = 0, B = 1, C = 0 and D = 1, it means that a laboratory receives packages B and D.

Construct a truth table (use the same order for the variables as given in the table below) to determine the Boolean function F(A, B, C, D), which gives a 1 whenever a laboratory receives more than 11 different types of chemicals.

Give F as a sum-of-minterms in m-notation.

A	B	C	D	F	minterms
0	0	0	0		
0	0	0	1		
0	0	1	0		
0	0	1	1		
0	1	0	0		
0	1	0	1		
0	1	1	0		
0	1	1	1		
1	0	0	0		
1	0	0	1		
1	0	1	0		
1	0	1	1		
1	1	0	0		
1	1	0	1		
1	1	1	0		
1	1	1	1		

MULTIPLE-CHOICE QUESTIONS

Question 6

Which logic gate has an output of 1 only if it has two inputs that are not equal?

A. OR
B. XNOR
C. NAND
D. XOR

Question 7

How many adjacent minterms must be grouped together in a four-variable Karnaugh map if we want to derive a simplified term consisting of three variables?

A. 8
B. 4
C. 2

D. 1

Question 8

In which category of logic circuits does a flip-flop fall?

A. Combinational circuits
B. Sequential circuits
C. Adders
D. Multiplexers

Question 9

A three-bit digital counter counts from 0 to …

A. 16.
B. 15.
C. 8.
D. 7.

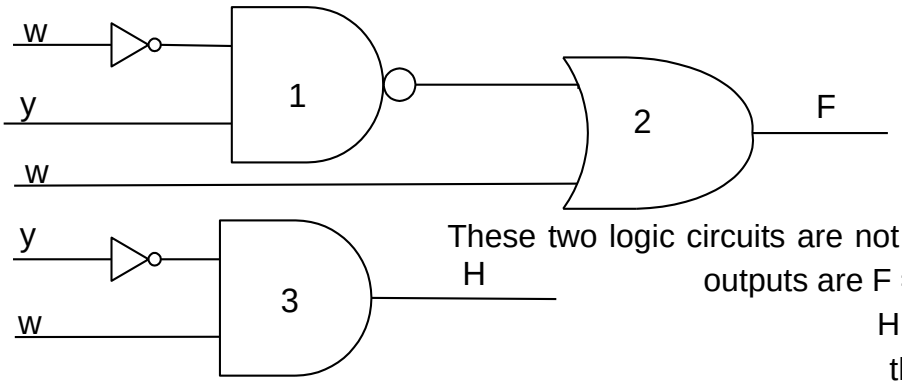
Question 10

Which one of the following options best describes a multiplexer?

A. A combinational circuit that has *n* inputs and *n* outputs
B. A combinational circuit that has *n* inputs and only 1 output
C. A sequential circuit that has *n* inputs and *n* outputs
D. A sequential circuit that has *n* inputs and $n - 1$ outputs

Question 11

Consider the following two logic circuits:



These two logic circuits are not equivalent. The outputs are F = (w'·y)' + w and H = y'·w. One of the four gates must be changed in order for the circuits to become equivalent. Which gate must be changed and what kind of gate must it become?

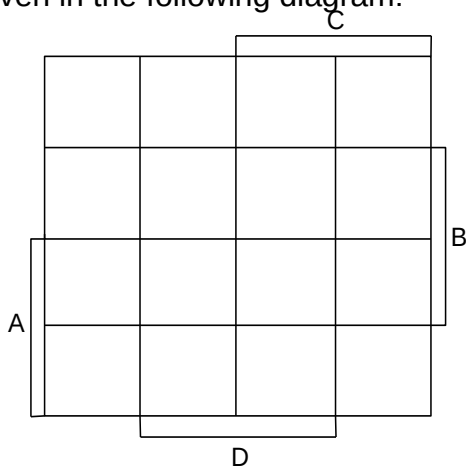
A. Gate 1 must change to a NOR gate.
B. Gate 1 must change to an OR gate.
C. Gate 3 must change to a NAND gate.
D. Gate 3 must change to an OR gate.

Question 12

Use a Karnaugh map to find the simplest form of the following sum-of-minterm expression:

$$F(A, B, C, D) = m_1 + m_6 + m_7 + m_9 + m_{10} + m_{14} + m_{15}$$

Derive the terms of F directly from the Karnaugh map without making use of algebraic manipulations or truth tables. Use exactly the same order for the variables as given in the following diagram:

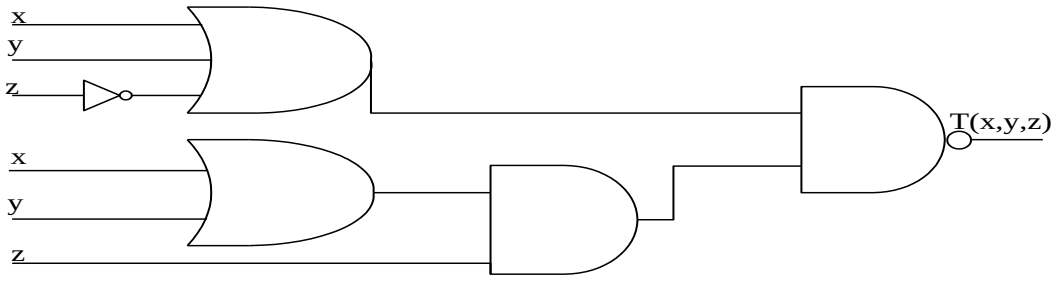


What is the simplified expression of F, derived directly from the Karnaugh map?

A. F = AB'CD' + B'C'D + BC
B. F = B'C'D + ACD' + BC
C. F = B'C'D + BCD + CD'
D. F = AB'C'D' + A'B'C'D' + ACD' + BC

Question 13

Consider the following logic circuit:



What is the final output T(x, y, z) of the given logic circuit?

A. T = (x + y + z')' + ((x + y)· z)'
B. T = [(x· y· z') **+** ((x· y) **+** z)]'
C. T = (x + y + z')' · ((x + y)· z)'
D. T = [(x + y + z') · ((x + y)· z)]'

Question 14

Consider the expression F = (xy')' ·**[**x'z**]** + (x'' + y').
If x = 1, y = 0 and z = 1, what are the values of (xy')'; **[**x'z**]**; (x'' + y') and F?

A. (xy')' = 0; **[**x'z**] = [**0**]**; (x'' + y') = (1) and F = 1
B. (xy')' = 0; **[**x'z**] = [**1**]**; (x'' + y') = (0) and F = 0
C. (xy')' = 1; **[**x'z**] = [**0**]**; (x'' + y') = (1) and F = 1
D. (xy')' = 1; **[**x'z**] = [**1**]**; (x'' + y') = (0) and F = 0

Question 15

Use only Boolean algebra to simplify the following Boolean expression: F(v, w, x) = vxw' + (vxw')'

What is the simplest form of F?

A. vxw' + v' + x' + w'
B. w'(vx + (vx)')
C. 0
D. 1