LINCOLN UNIVERSITY COLLEGE

ASSIGNMENT (15%)

Faculty : **ENGINEERING**

Course : **DIPLOMA ELECTRICAL AND ELECTRONICS ENGINEERING (ODL)**

Module Title : **DIGITAL ELECTRONICS**

Date : **2nd MAY 2024**

Instruction to candidates

1. Answer ALL the questions.

CO	Descriptions	Domain
CLO 2	Use DeMorgans Theorem to simplify a negated expression. (C3, PLO2)	C3
CLO 3	Formulate and employ a Karnaugh Map to reduce Boolean expressions and logic circuits to their simplest forms. (C2, PLO6)	C2

Do not open this question paper until instructed.

QUESTION 1

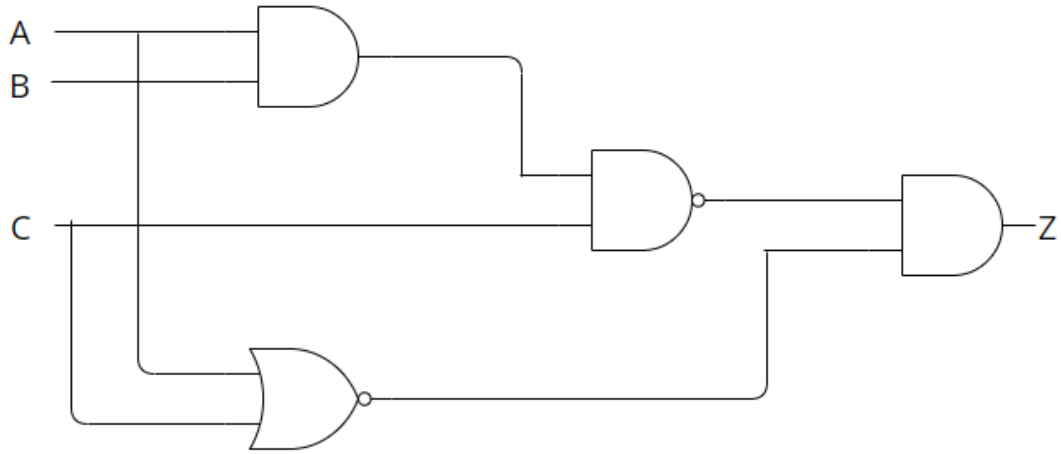


Figure 1

a. List the types of gates used in the circuit shown in Figure 1. (3 Marks)

b. Determine the number of input and output variables in the circuit (Figure 1). (4 Marks)

c. Write the Boolean expression for Z in terms of A, B and C. (3 Marks)

d. Convert the Boolean expression in (c) into Sum-of-products (SOP) form. (4 Marks)

e. Construct the Truth Table for this circuit. (6 Marks)

f. Simplify the Boolean expression in (c) using the K – Map technique. (6 Marks)

g. Sketch the simplified circuit based on question (f). (4 Marks)

(Total = 30 Marks)

QUESTION 2

a. Answer the question based on Figure 2.

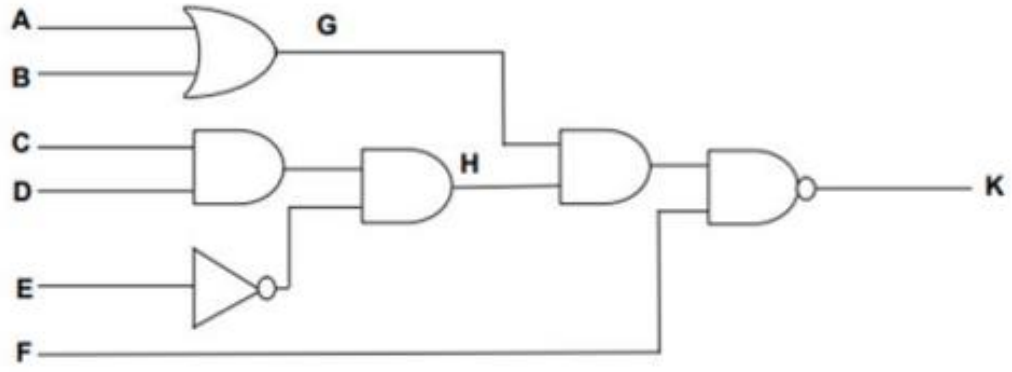


Figure 2

Complete the truth table for the inputs that have been given. (6 Marks)

Inputs								
A	B	C	D	E	F	G	H	K
0	0	1	1	0	0			
0	1	1	1	0	1			
1	0	1	1	1	0			
1	1	1	1	1	1			

b. Figure 3 below shows a logic circuit.

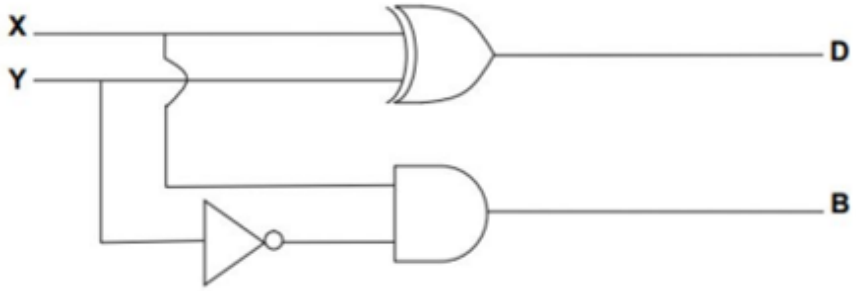


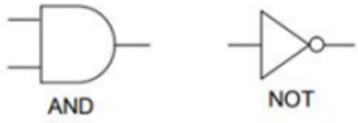
Figure 3

Based on Figure 3, write a Boolean expression for D and B. (4 Marks)

(Total = 10 Marks)

QUESTION 3

a. Represent the Boolean expression $Q = \overline{\bar{A}.\bar{B}}$ as a logic circuit by drawing a diagram in the space below using only the following symbols: (4 Marks)



b. Use the following truth tables to demonstrate that $A + B = \overline{\bar{A}.\bar{B}}$ (10 Marks)

A	B	A + B
0	0	
0	1	
1	0	
1	1	

A	B	$\bar{A}$	$\bar{B}$	$\bar{A}.B$	$\overline{\bar{A}.\bar{B}}$
0	0				
0	1				
1	0				
1	1				

c. Simplify the following Boolean expressions:

i. $x = AB + A(B + C) + B(B + C)$ (3 Marks)

ii. $x = \overline{(A + \bar{B}).(\bar{C} + D)}$ (3 Marks)

(Total = 20 Marks)

QUESTION 4

a. Complete the Boolean function that corresponds to the following truth table.

INPUT			OUTPUT
A	B	C	X
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	1
1	0	0	0
1	0	1	0
1	1	0	1
1	1	1	1

$X = \bar{A}.B.C +$ _____ (4 Marks)

The part to the right of the equal sign is known as the sum-of-product.

b. For the truth table above complete the Karnaugh Map (K-map) (4 Marks)

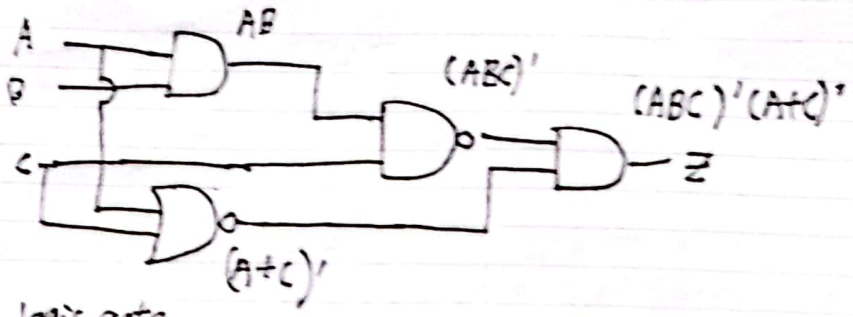
		AB			
		00	01	11	10
C	0				
	1				

c. Simplify the Boolean expression by group(s) of 1's to produce an optimal SOP and write the simplified SOP Boolean expression. (6 Marks)

(Total = 14 Marks)

---- END OF PAPER ----

Question 1 Digital Electronics



a) List logic gate

AND gate, NAND gate and NOR gate

b) Determine the input & output variable.

Input variable : A, B and C
Output variable : Z

c) Write the boolean expression for Z in terms of A, B and C

$Z = (ABC)'(A+C)'$

☆ d) Convert boolean expression in (c) to SOP form

$Z = (ABC)'(A+C)'$
$= (A'+B'+C')(A'C')$ ↳ De Morgan Law
$= A'A'C' + A'B'C' + A'C'C'$
$= A'C' + A'B'C' + A'C'$
$= A'C'(1 + B')$
$= A'C'$

☆ e) ~~K-map technique~~ Construct the truth table for the circuit

	A	B	C	AB	ABC	(ABC)'	A+C	(A+C)'	Z=(ABC)'(A+C)'	
①	0	0	0	0	0	1	0	1	1	A'B'C'
②	0	0	1	0	0	1	1	0	0	
③	0	1	0	0	0	1	0	1	1	A'B C'
④	1	0	0	0	0	1	1	0	0	
⑤	1	0	1	0	0	1	1	0	0	
⑥	1	1	0	1	0	1	1	0	0	
⑦	1	1	1	1	1	0	1	0	0	
⑧	0	1	1	0	0	1	1	0	0	

f)

C \ AB	00	01	11	10
0	1	1	0	0
1	0	0	0	0

$Z = A'C'$

$Z = A'B'C' + A'BC'$

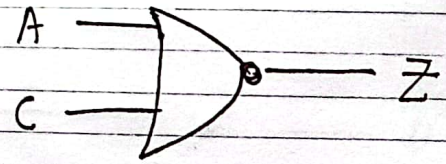
$= A'C'(B' + B)$

$= A'C'$

proved they're same.

g) Sketch the simplified circuit based on question (f)

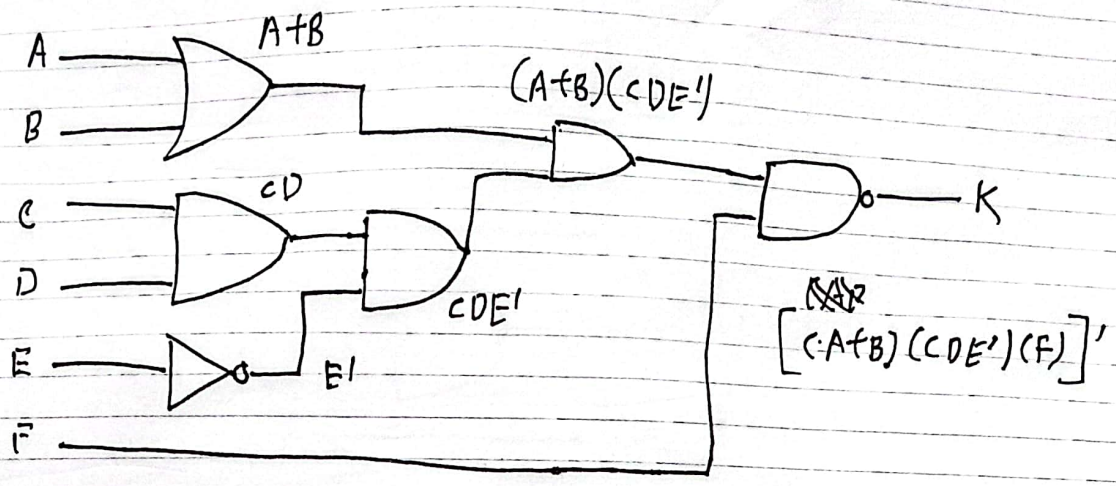
- NOR gate



Truth table		
A	C	NOR, Z
0	0	1
0	1	0
1	0	0
1	1	0

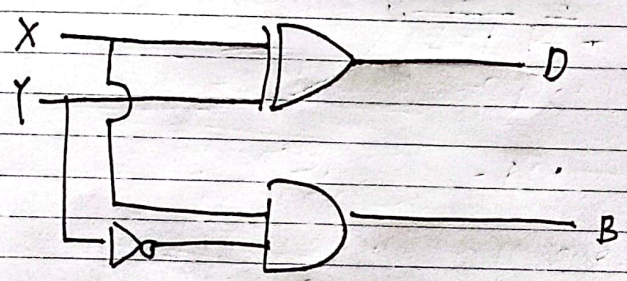
Question 2

a)



Inputs						A+B	CDE'	[(G+H)F]'
A	B	C	D	E	F	G	H	K
0	0	1	1	0	0	0	1	1
0	1	1	1	0	1	1	0	0
1	0	1	1	1	0	1	0	1
1	1	1	1	1	1	1	0	1

b)



$D = X'Y + XY'$

$B = XY'$

Question 3

a)

$Q = (A'B')'$

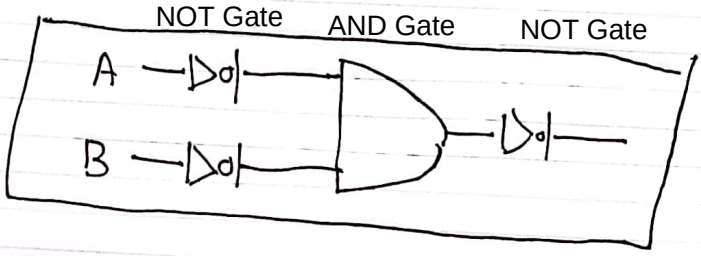
$= A'' + B''$

$= A + B$

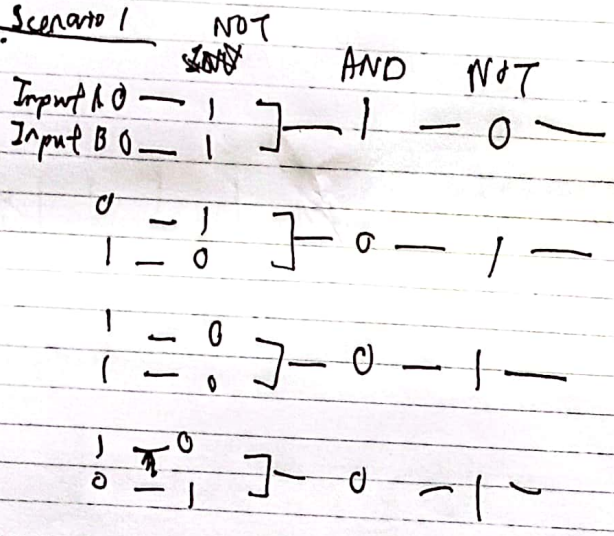
OR gate

A	B	$\overline{A}$	$\overline{B}$	$\overline{A}\overline{B}$	$\overline{\overline{A}\overline{B}}$
0	0	1	1	1	0
0	1	1	0	0	1
1	0	0	1	0	1
1	1	0	0	0	1

answer :



Test Scenario 1



All fulfilling ~~table~~ truth table with OR gate characteristics.

Question 3

a) $Q = (A'B')'$

or

$Q = A'' + B''$

$= A + B$

A	B	$\bar{A}$	$\bar{B}$	$\overline{AB}$	$\overline{\bar{A}\bar{B}}$
0	0	1	1	1	0
0	1	1	0	0	1
1	0	0	1	0	1
1	1	0	0	0	1

OR gate.

b) $A+B = \overline{\bar{A}\bar{B}}$

A	B	A+B
0	0	0
0	1	1
1	0	1
1	1	1

A	B	$\bar{A}$	$\bar{B}$	$\bar{A}\bar{B}$	$\overline{\bar{A}\bar{B}}$
0	0	1	1	1	0
0	1	1	0	0	1
1	0	0	1	0	1
1	1	0	0	0	1

c) Simplify the following boolean expression

i) $X = AB + A(B+C) + B(B+C)$

$= \underline{AB} + \underline{AB} + AC + \underline{BB} + BC$

$= AB + AC + B + BC$

$= AB + AC + B(1+C)$

$= AB + AC + B$

$= AB + B + AC$

$= B(A+1) + AC$

$= B + AC$

ii) $X = \left((A+B')(C'+D)\right)'$

$= (A+B')' + (C'+D)'$

$= A'B + CD$

Question 4

a)

Input			Output
A	B	C	X
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	1
1	0	0	0
1	0	1	0
1	1	0	1
1	1	1	1

$A'BC$

ABC'

ABC

$X = A'BC + ABC' + ABC$

b & c)

C \ AB	00	01	11	10
0	0	0	1	0
1	0	1	1	0

$X = BC + AB$

from (a)

$X = A'BC + ABC' + ABC$

$= A'BC + AB(C' + C)$

$= A'BC + AB$

$= B(A + A'C)$

(Apply $A + A'B = A + B$)

$= B(A + C)$

$= BC + AB$

$X = BC + AB$