

ID:

ASSIGNMENT # 1 [EE-1005]

Assigned Number: \_\_\_\_\_

# DIGITAL LOGIC & DESIGN (EE-1005)

## ASSIGNMENT #3

ID: 241-2599NAME: Abdul HadiSECTION: AI-ARead the Instructions Carefully

❖ NOTE: Use Assigned number & Your Name

❖ (Same as Assignment 1)

❖ Your assigned number is given to you in excel sheet provided with assignment

❖ **FOR EXAMPLE:** Assigned Number if your assigned number is **0821**

	Assign Digit 0	Assign Digit 1	Assign Digit 2	Assign Digit 3
Short for Assigned Digit	A0	A1	A2	A3
Write Assigned Number Digit By Digit	6 7	9 8	2 2	3 1

FOR EXAMPLE: Name is HAMAZADAUD

- ❖ Use your name instead of HAMZA
- ❖ If your name starts with MUHAMMAD kindly use your second name
- ❖ Convert repeated character to small letter or to other symbols to make them unique (see example for A, a & @)

SIXTH CHARACTER OF YOUR NAME	FIFTH CHARACTER OF YOUR NAME	FOURTH CHARACTER OF YOUR NAME	THIRD CHARACTER OF YOUR NAME	SECOND CHARACTER OF YOUR NAME	FIRST CHARACTER OF YOUR NAME	ZERO CHARACTER OF YOUR NAME	
Short for CHARACTER	C0	C1	C2	C3	C4	C5	C6
YOUR NAME CHARACTER BY CHARACTER	# \$	\$ @	* a	I Z	O M	A A	H H

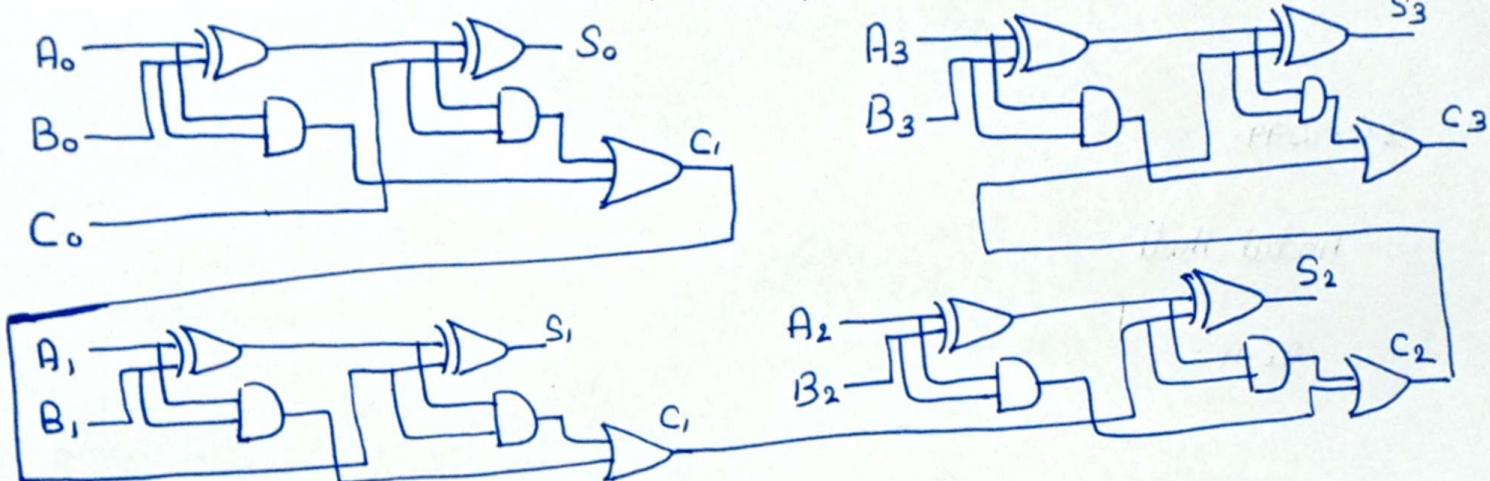
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[CLO 3: Design combinational and sequential logic circuits]

1. Design 4-bit adder using just Half adders? Only circuit is required?

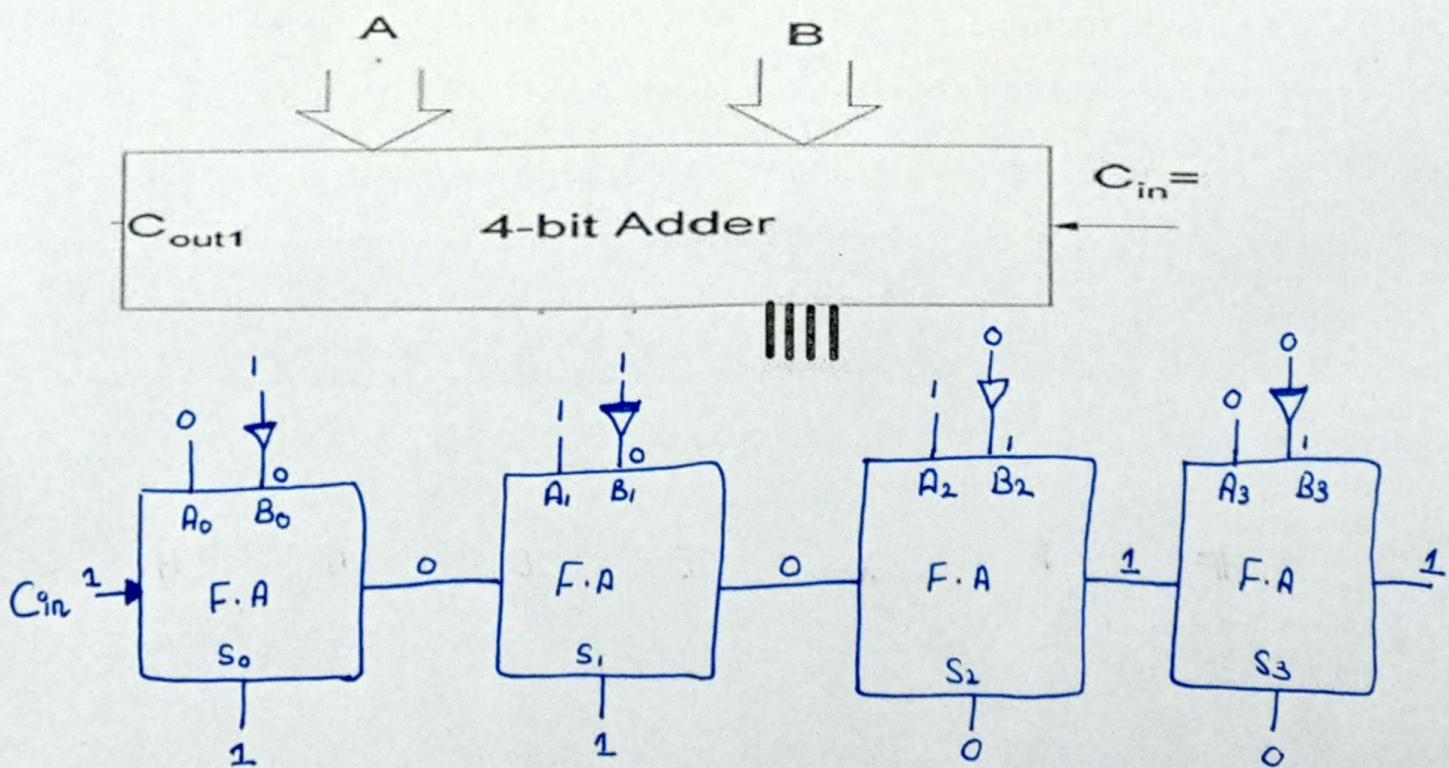


2. Convert following 4-bit adder to 4-bit subtractor circuit? So it could perform operation A-B? Use the circuit you have designed to subtract binary (A<sub>0</sub>-A<sub>3</sub>)

HINT: could use 2's complement

$$A_0 = 0110$$

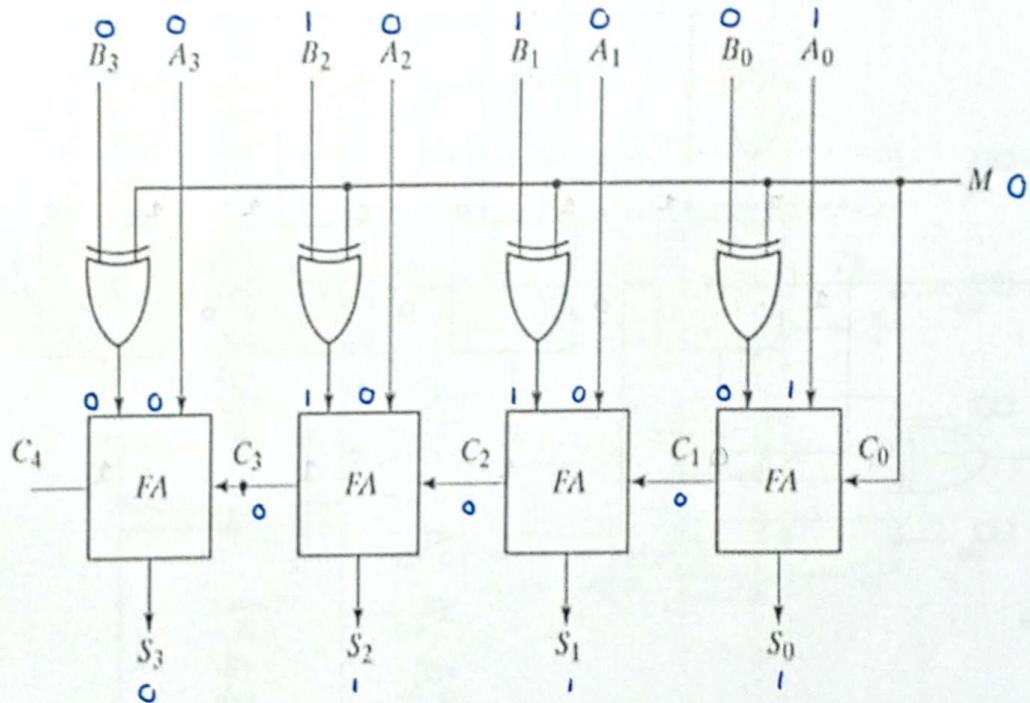
$$A_3 = 0011$$



$$Ans = 0011$$

3. Perform unsigned Addition  $A+B$  where  $A=1$  and  $B=(A0)_2$  using Following is 4-adder/subtractor circuit? Also write short explanation when  $A < B$

$$A = 0001 \quad B = 0110$$



Explanation

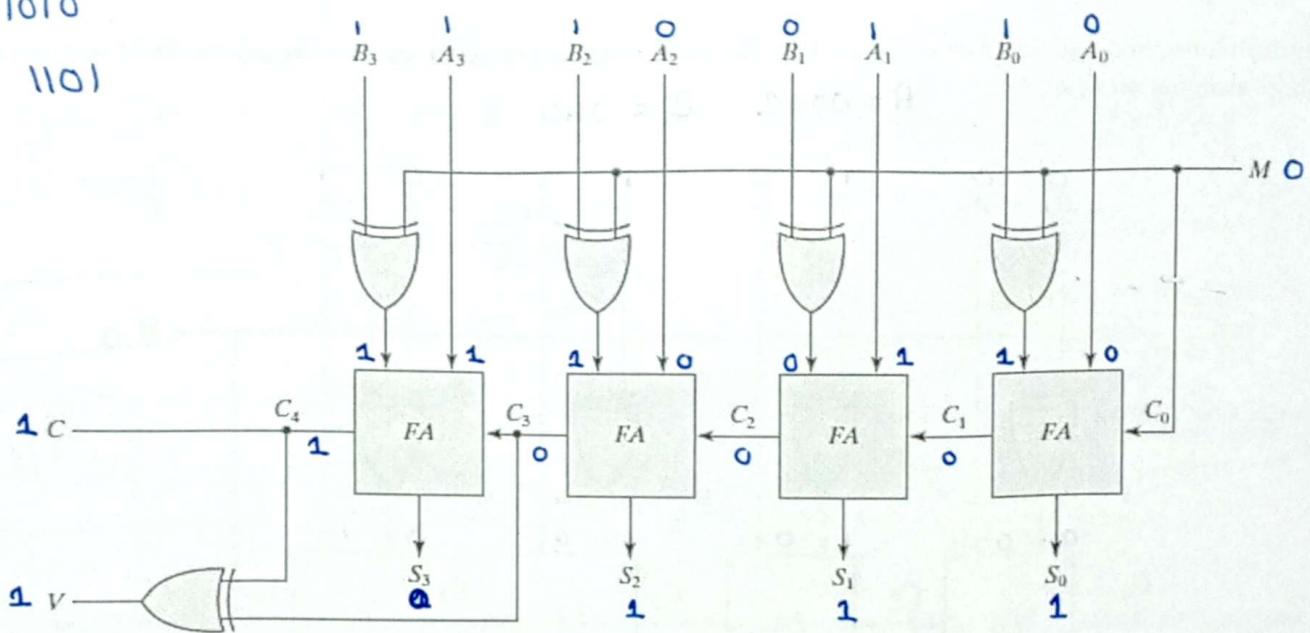
When we performed unsigned subtraction and  $B > A$  we get a bigger number as underflow occurs and the number wraps around.

6. Perform signed Addition  $A+B$  where  $A = 2$ 's complement of  $(A0)_2$  and  $B = 2$ 's complement of  $(A3)_2$  using Following is 4-adder/subtractor circuit? Also write short explanation on working of overflow flag(v)

NOTE: If  $A0 = 9$  which cannot be represented using 4-bit signed representation than considered it equal to 8, By taking 2's complement of  $A0$  and  $A1$  you are considering it as negative number

$$A = 1010$$

$$B = 1101$$



## Explanation

We performed signed addition using 9's complement of  $A \oplus B$ . The sum was  $(0111) + 7$  which is incorrect since  $-6 + (-3) = -9$ . This result lies outside the 4-bit signed range overflow and overflow flag ( $V = 1$ ) indicates a signed error.

7. Following is an 8-bit unsigned adder/subtractor circuit. Apply following numbers to the circuit and perform A-B  
 NOTE: where A = Binary of the first two digits of the assigned number

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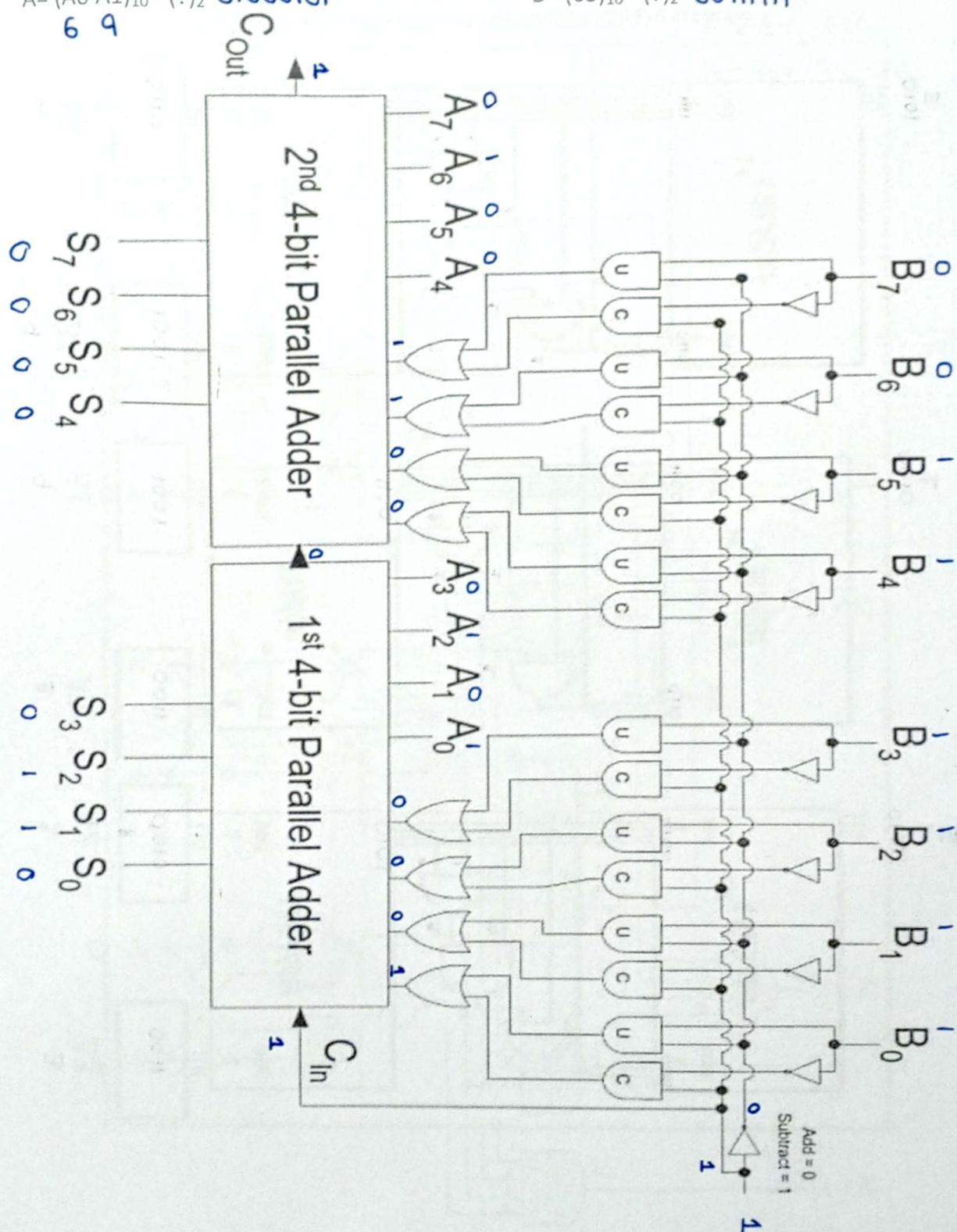
$$A = (A_0 A_1)_{10} = (?)_2$$

6 9

01000101

$$B = (63)_{10} = (?)_2$$

00111111



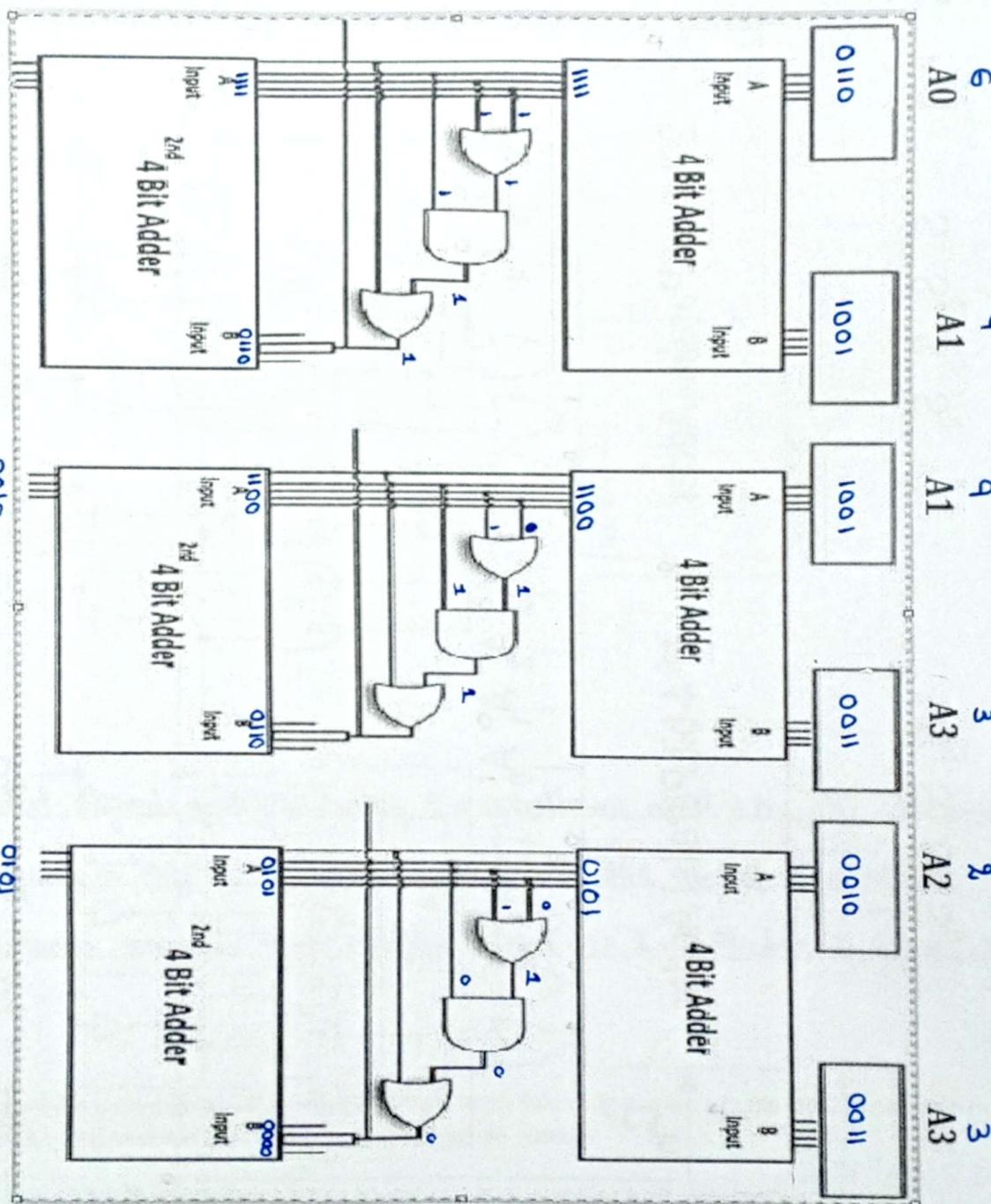
ANS = 6

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8. Perform three different **BCD Additions** using the following circuits? Convert **A0, A1, A2, A3** from your assigned numbers to **BCD numbers** and apply on the circuits given below



## ASSIGNMENT # 3 [EE-1005]

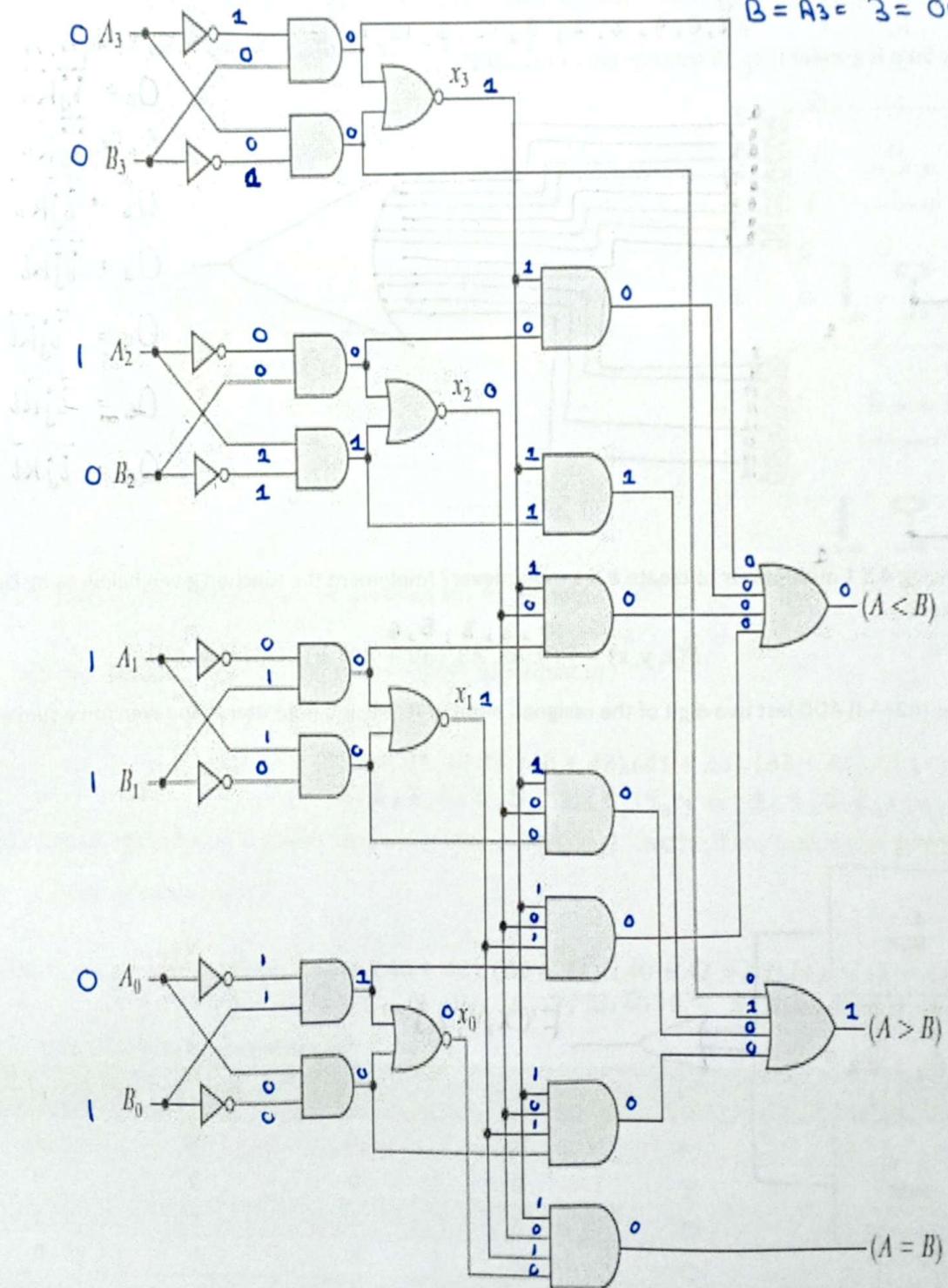
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9. Process given values of A and B on a comparator circuit give below? Where  $A = (A_0)_{10} = (?)_2$  and  $B = (A_3)_{10} = (?)_2$   
 NOTE: You are supposed to process each and every gate given below

$$A_0 = 6 = 0110$$

$$B = A_3 = 3 = 0011$$

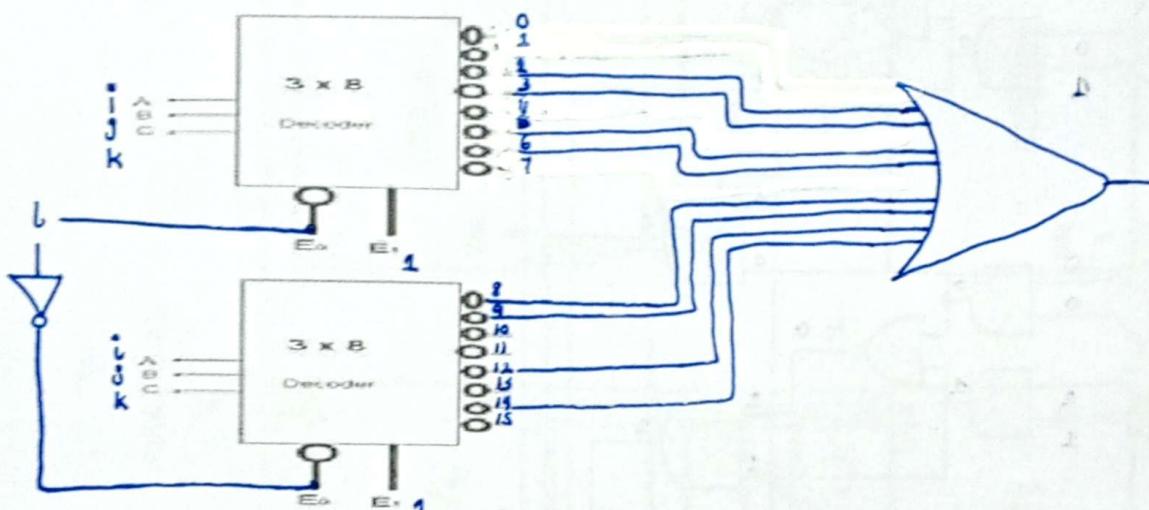


10. Implement the following function using two  $3 \times 8$  Decoder. Also write expressions for output  $O_0 - O_7$

$$(i, j, k, l) = \sum(2, A_0, A_1, A_2, A_3, (A_0 + A_2), (A_1 + A_3), (A_2 + A_3), 12, 14)$$

$$2, 6, 9, 2, 3, 8, 12, 5, 12, 14 = 2, 3, 5, 6, 8, 9, 12, 14$$

NOTE: If any Sum is greater than 15 considered sum equal 10



$$O_0 = \bar{i} \bar{j} k \bar{l}$$

$$O_1 = \bar{i} \bar{j} k l$$

$$O_2 = \bar{i} j k \bar{l}$$

$$O_3 = \bar{i} j k l$$

$$O_4 = \bar{i} j \bar{k} l$$

$$O_5 = \bar{i} j \bar{k} \bar{l}$$

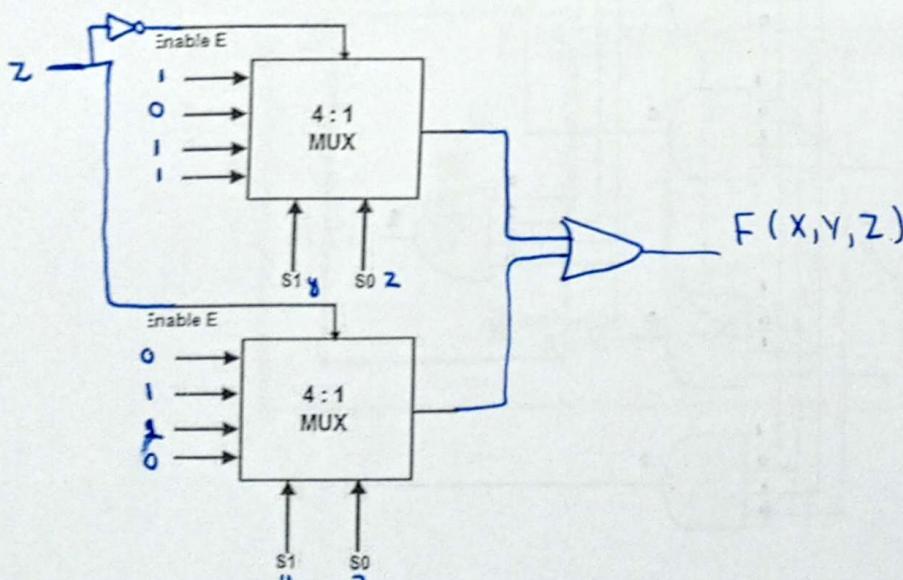
$$O_6 = \bar{i} j k \bar{l}$$

11. Use following  $4 \times 1$  multiplexer to create  $8 \times 1$  multiplexer? Implement the function given below using  $8 \times 1$  multiplexer?

$$0, 2, 3, 5, 6$$

$$F(x, y, z) = \sum(0, A_2, A_3, (A_2 + A_3), 6)$$

NOTE: To get  $(A_2 + A_3)$  ADD last two digit of the assigned number if the sum is greater than seven force sum equal result to 7



12. Implement the function given below using  $4 \times 1$  multiplexer?

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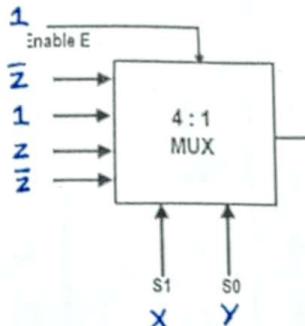
## ASSIGNMENT # 3 [EE-1005]

Assigned Number:

$$F(x, y, z) = \sum(0, A2, A3, (A2 + A3), 6)$$

0, 1, 3, 5, 6

NOTE: To get  $(A2 + A3)$  ADD last two digit of the assigned number if the sum is greater than seven force sum equal result to 7



X	Y	z	F
0	0	0	1
0	0	1	0
0	1	0	1
0	1	1	1
1	0	0	0
1	0	1	1
1	1	0	1
1	1	1	0

13. Implement the function given below using 8x1 multiplexer?

NOTE: If any Sum is greater than 15 considered sum equal 10

$$F(i, j, k, l) = \sum(2, A0, A1, A2, A3, (A0 + A2), (A1 + A3), (A2 + A3), 12, 14)$$

2, 6, 9, 2, 3, 8, 12, 5, 12, 14 = 2, 3, 5, 6, 8, 9, 12, 14

14. Implement the function given below using 16x1 multiplexer? NOTE: If any Sum is greater than 31 considered sum equal 31

$$F(a, b, c, d, e) = \sum(3, A0, A1, A2, A3, (A0 + A2), (A0 + A1), (A0 + A2 + A3), (A1 + A2 + A3), 17, 23, 27, 30)$$

3, 6, 9, 2, 3, 8, 15, 14, 14, 17, 23, 27, 30 = 2, 3, 6, 8, 9, 14, 15, 17, 23, 27, 30

15. Design 4X2 Low Priority Encoder?

INPUT				OUTPUT		
D <sub>0</sub>	D <sub>1</sub>	D <sub>2</sub>	D <sub>3</sub>	A	B	Valid
0	0	0	0	X	X	0
1	X	X	X	0	0	1
0	1	X	X	0	1	1
0	0	1	X	1	0	1
0	0	0	1	1	1	1

## SIMPLIFICATION AND EXPRESSIONS

$$\text{Valid} = D_0 + D_1 + D_2 + D_3$$

$$A = D_2 + D_3$$

$$B = D_1 + D_3$$

16. Design an 8 X 3 Low Priority Encoder? Priority Encoder you are designing **A2** and **A3** has the most priority respectively than the other input. Arrange other inputs in ascending order

TABLE

		INPUTS							OUTPUTS		
A2=4	A3=6	0	1	2	3	5	7	0 <sub>0</sub>	0 <sub>1</sub>	0 <sub>2</sub>	VALID
0	0	1	X	X	X	X	X	0	0	0	1
0	0	0	1	X	X	X	X	1	0	0	1
0	0	0	0	1	X	X	X	0	1	0	1
0	0	0	0	0	1	X	X	1	1	0	1
1	X	X	X	X	X	X	X	0	0	1	1
0	0	0	0	0	0	1	X	1	0	1	1
0	1	X	X	X	X	X	X	0	1	1	1
0	0	0	0	0	0	0	1	1	1	1	1

## SIMPLIFICATION AND EXPRESSION

$$\text{Valid} = 4 + 6 + 0 + 1 + 2 + 3 + 5 + 7$$

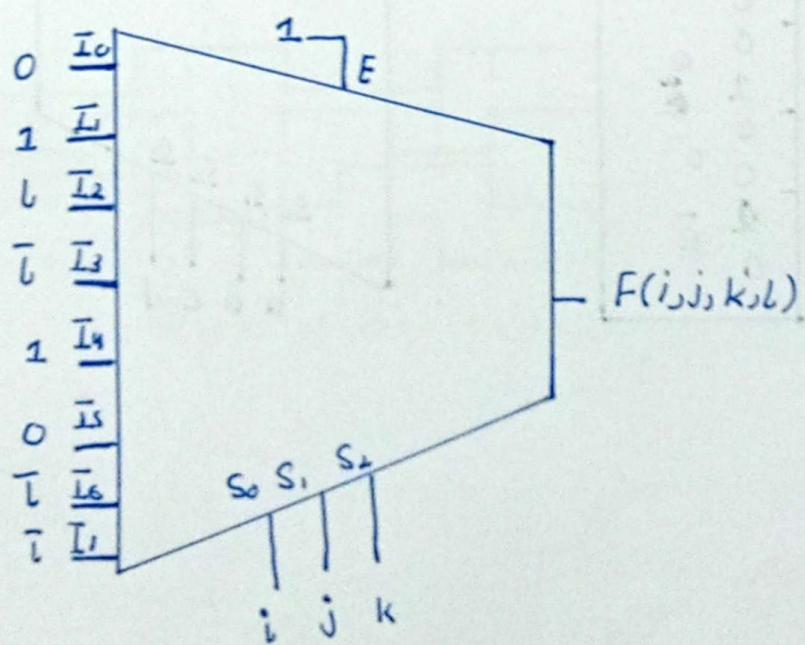
$$O_0 = 1 + 3 + 5 + 7$$

$$O_1 = 2 + 3 + 6 + 7$$

$$O_2 = 4 + 5 + 6 + 7$$

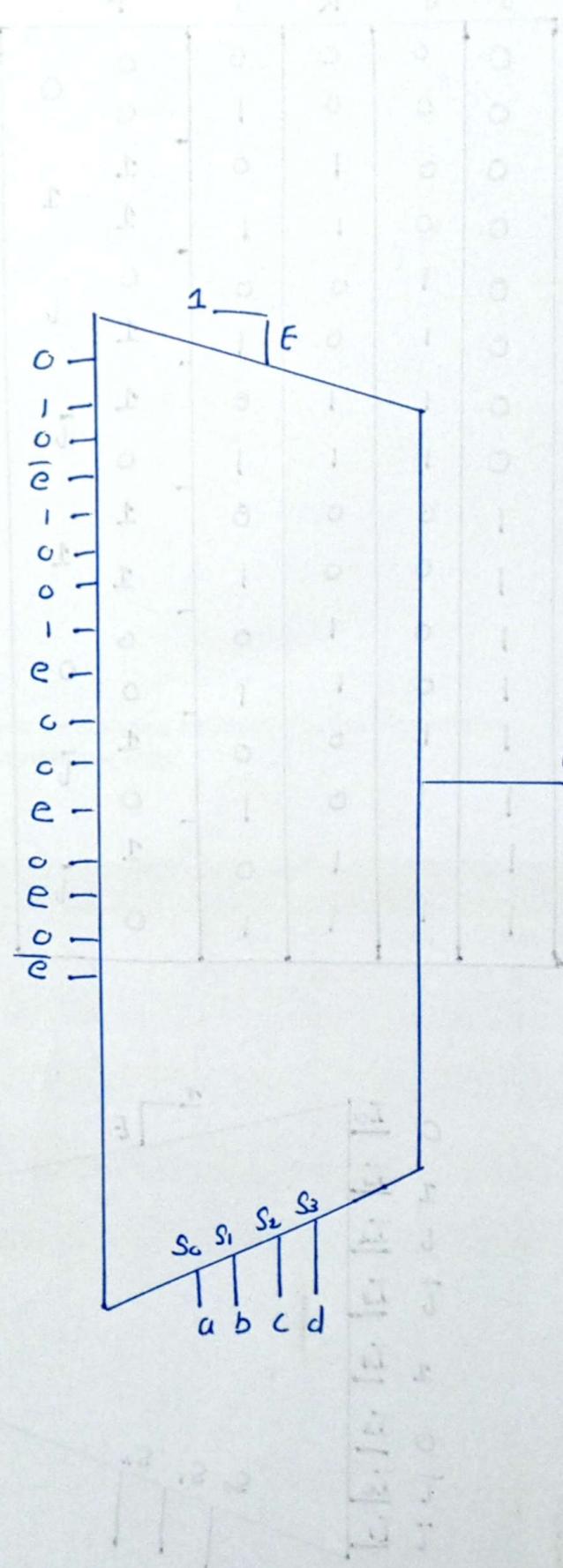
$$\text{Ques 13:- } F(i, j, k, l) = \sum (2, 3, 5, 6, 8, 9, 12, 14)$$

	$i$	$j$	$k$	$l$	$F$
0	0	0	0	0	0
1	0	0	0	1	0
2	0	0	1	0	1
3	0	0	1	1	1
4	0	1	0	0	0
5	0	1	0	1	1
6	0	1	1	0	1
7	0	1	1	1	0
8	1	0	0	0	1
9	1	0	0	1	1
10	1	0	1	0	0
11	1	0	1	1	0
12	1	1	0	0	1
13	1	1	0	1	0
14	1	1	1	0	1
15	1	1	1	1	0



Q No 14:-  $F(a, b, c, d, e) = \sum (2, 3, 6, 8, 9, 14, 15, 17, 23, 27, 30)$

	a	b	c	d	e	F
0	0	0	0	0	0	0
1	0	0	0	0	1	0
2	0	0	0	1	0	1
3	0	0	0	1	1	1
4	0	0	1	0	0	0
5	0	0	1	0	1	1
6	0	0	1	1	0	0
7	0	0	1	1	1	1
8	0	1	0	0	0	1
9	0	1	0	0	1	0
10	0	1	0	1	0	0
11	0	1	0	1	1	0
12	0	1	1	0	0	0
13	0	1	1	0	1	0
14	0	1	1	1	0	1
15	0	1	1	1	1	1
16	1	0	0	0	0	e
17	1	0	0	0	1	0
18	1	0	0	0	0	0
19	1	0	0	0	1	0
20	1	0	0	1	0	0
21	1	0	0	1	0	0
22	1	0	0	1	1	e
23	1	0	1	1	0	0
24	1	1	1	1	0	0
25	1	1	1	0	1	e
26	1	1	0	0	0	0
27	1	1	0	0	1	0
28	1	1	0	1	1	0
29	1	1	1	1	0	1
30	1	1	1	1	1	0
31	1	1	1	1	0	e



17. Design a single bit comparator from the following table? Write expression for  $A=B$ ,  $A>B$ ? Design circuit from expression using logic gates?

Input		Output		
A	B	$A < B$	$A > B$	$A = B$
0	0	0	0	1
0	1	1	0	0
1	0	0	1	0
1	1	0	0	1

Find Expressions:

$$A > B = A \cdot \bar{B}$$

$$A < B = \bar{A} \cdot B$$

$$A = B = A \oplus B$$

18. Write expression for 6-bit comparator?  $X_i = A_i \oplus B_i$

$$A > B = A_5 \bar{B}_5 + X_5 A_4 \bar{B}_4 + X_5 X_4 A_3 \bar{B}_3 + X_5 X_4 X_3 A_2 \bar{B}_2 + X_5 X_4 X_3 X_2 A_1 \bar{B}_1 + X_5 X_4 X_3 X_2 X_1 A_0 \bar{B}_0$$

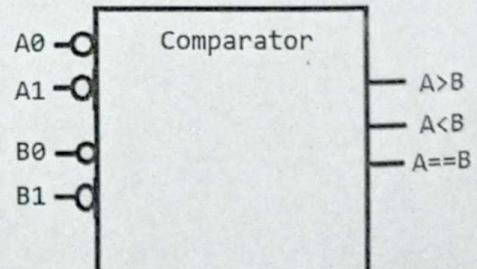
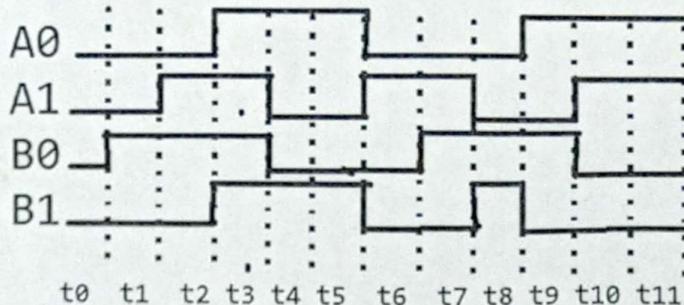
$$A < B = \bar{A}_5 B_5 + X_5 \bar{A}_4 B_4 + X_5 \bar{A}_4 \bar{B}_3 + X_5 \bar{A}_4 X_3 \bar{B}_2 + X_5 \bar{A}_4 X_3 X_2 \bar{B}_1 + X_5 \bar{A}_4 X_3 X_2 X_1 \bar{B}_0$$

$$A = B = X_5 X_4 X_3 X_2 X_1 X_0$$

19. Given the waveforms and circuit of a comparator. Draw the output waveform for each output. Note that the circuit is active low input.

$$A = A_1 A_0$$

$$B = B_1 B_0$$



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Waveforms:

$A > B =$

$A < B =$

$A == B =$

