Solution

جامعة بيرزيت

BIRZEIT UNIVERSITY
Electrical and Computer Engineering Department
Digital Systems – ENCS234
Midterm Exam
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Student Name: ______________________________ **ID:** ____________________

Question 1

A. 5 points] Convert $(154.125)_8$ to **Base-16** format

$$(154.125)_8 \longrightarrow (\underbrace{0110}\underbrace{1100}.\underbrace{0010}\underbrace{1010}\underbrace{1000})_2 = (6C.2A8)_{16}$$

B. 9 points] Perform the following subtraction using signed 2's complement 8 bit representation (-74 – 66) and determine the overflow ?

$74 \longrightarrow 01001010$

$-74 \xrightarrow{2's\,comp} 10110110$

$66 \longrightarrow 01000010$

$-66 \xrightarrow{2's\,comp} 10111110$

```
 [1 0] 1 1 1 1 1
       1 0 1 1 0 1 1 0
       1 0 1 1 1 1 1 0
       ---------------
 [1]   0 1 1 1 0 1 0 0
```

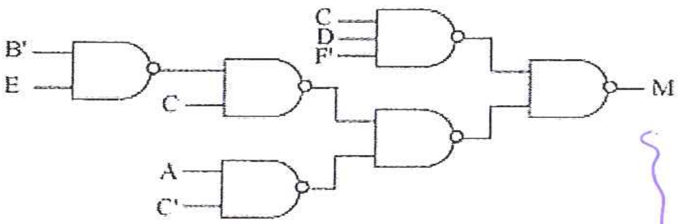
overflow

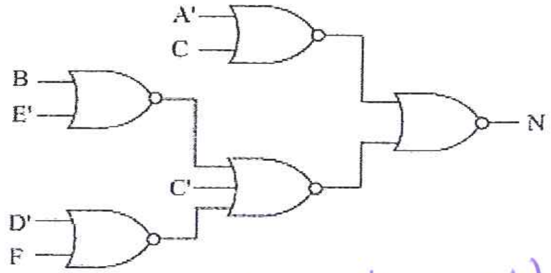
C. 6 points] Perform the following addition using BCD representation (874 + 236)

```
          0010    0011    0110
          1000    0111    0100
          ----    ----    ----
          1010    1010    1010
           110     110     110
          ----    ----    ----
  0001    0001    0001    0000
  ----    ----    ----    ----
     1       1       1       0
```

D. 10 points] A certain ENCS234 student claims (أدعى) that the two circuits below implement the same Combinational logic function. Prove or disprove his claim. Show your derivation.

Prove





$(A'+C)(B'E+C')+CDF'$

$A'B'E+A'C'+B'CE+CDF'$

$= A'C'+B'CE+CDF'$

More explaination

$A'B'E+A'C'+B'CE+CDF'$

$A'B'E(C+C')+A'C'+B'CE+CDF'$

$B'CE(A'+1)+A'C'(B'E+1)+CDF'$

$= B'CE+A'C+CDF'$

$(A'+C)(B'E+C'+DF')$

$= A'B'E+A'C'+A'DF'+B'CE+CDF'$

$= A'B'E+A'C'+B'CE+CDF'$

$= A'C'+B'CE+CDF'$

More explaination

$A'B'E+A'C'+A'DF'+B'CE+CDF'$

$= A'B'E(C+C')+A'C'+A'DF'(C+C')+B'CE+CDF'$

$= B'CE+A'C+CDF'$

Same function

or you need to build the truth table

Question 2

A. 22 points] Simplify using QM Tabulation method the following function

$F(A,B,C,D,E) = \sum(0, 1, 2, 9, 11, 12, 13, 27, 28, 29)$

List 1

	minterm	ABCDE
✓	0	00000
✓	1	00001
✓	2	00010
✓	9	01001
✓	12	01100
✓	11	01011
✓	13	01101
✓	28	11100
✓	27	11101
✓	29	11101

list 2

minterm	ABCDE	
0,1	0000-	PI2
0,2	000-0	PI3
1,9	0-001	PI4
9,11	010-1	PI6
9,13	01-01	PI5
12,13	0110-	✓
12,28	-1100	✓
11,27	-1011	PI7
13,29	-1101	
28,29	1110-	

list 3

minterm	ABCDE	
12,13,28,29	-110-	PI1

	0	1	2	9	11	12	13	27	28	29
PI1 *						x	x		x	x
PI2	x	x								
PI3 *	x		x							
PI4		x		x			x			
PI5				x						
PI6				x	x			x		
PI7 *					x					

	1	9
PI2	x	
PI4	x	x
PI5		x
PI6		x

$f(A,B,C,D,E) = PI_1 + PI_3 + PI_4 + PI_7$

$= BCD' + A'B'C'E' + A'C'D'E + BC'DE$

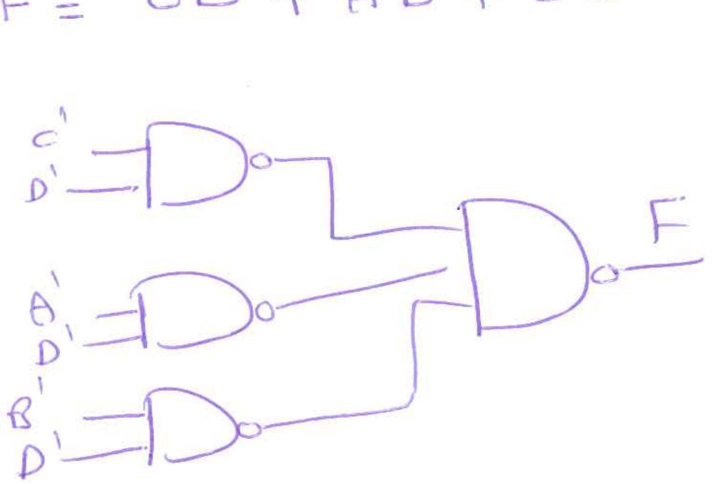
B. 10 points] Implement the following function using together with the don't care using NAND-NAND

$F(A,B,C,D) = \prod(1, 3, 5, 7, 11, 14, 15)$

$D(A,B,C,D) = \prod(0, 8, 9, 13)$

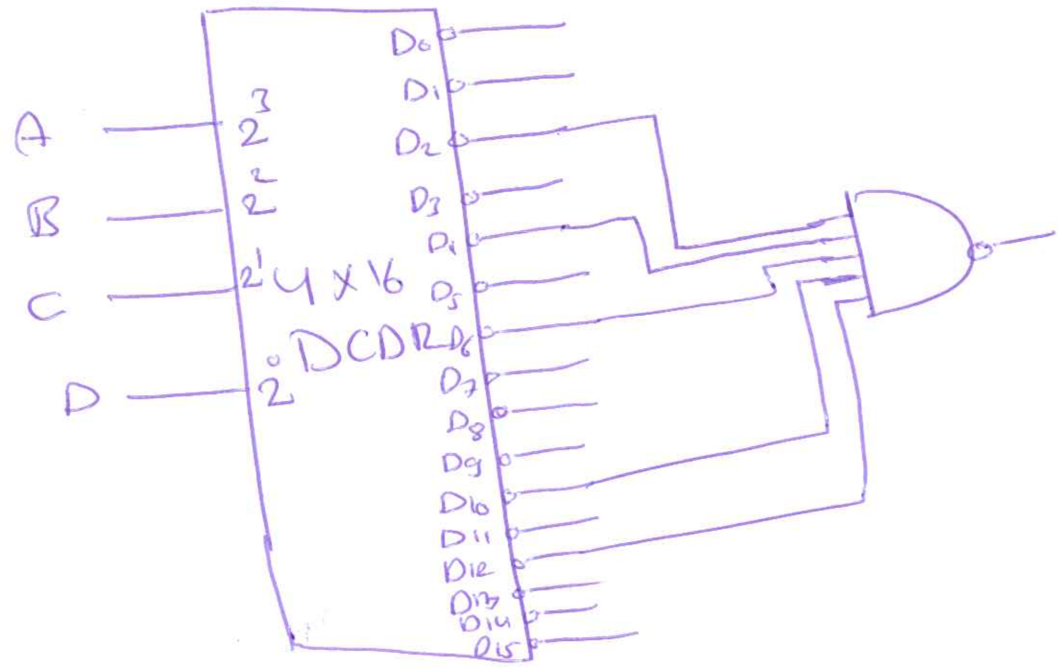
AB \ CD	00	01	11	10
00	X	0	0	1
01	1	0	0	1
11	1	X	0	0
10	X	X	0	1

$F = C'D' + A'D' + BD'$



C. 8 points] Implement the same function in part B using active low 4-to-16 decoder

OR you can use AND gate with Π



Question 3

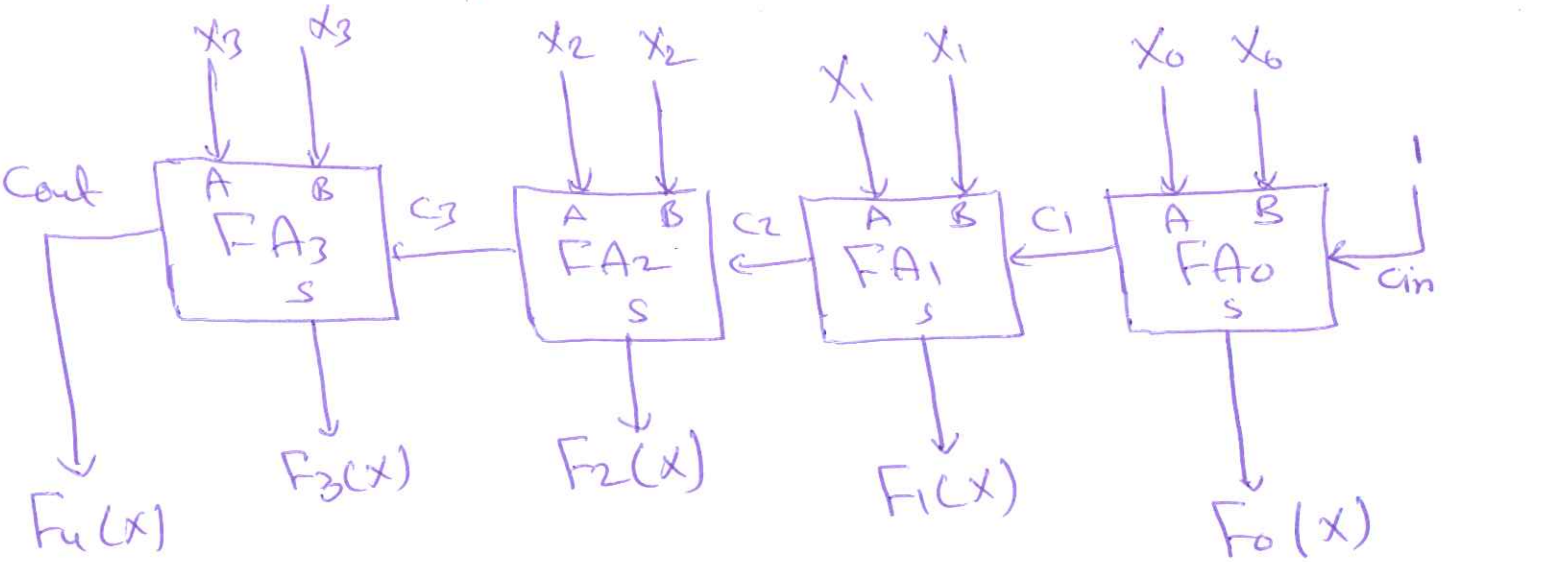
A. 10 points] Design a digital circuit to realize the following function

F(X) = 2*X + 1

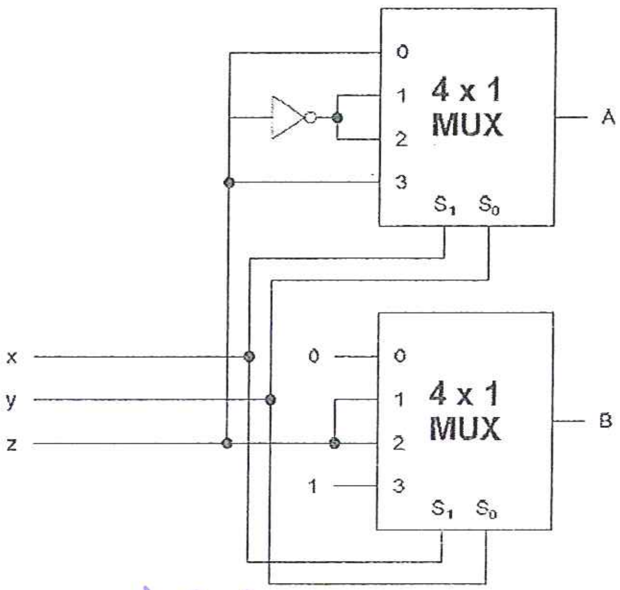
Where X is a 4-bit unsigned binary number (e.g, $X=X_3X_2X_1X_0$)

Hint: Use adders as block diagram

2X + 1 = + $X_4 X_3 X_2 X_0$
$X_4 X_3 X_2 X_0$
+ 1



B. 10 points] Determine the outputs functions A and B as sums of minterms.



input output

x	y	z	A	B
0	0	0	0	0
0	0	1	1	0
0	1	0	1	0
0	1	1	0	1
1	0	0	1	0
1	0	1	0	1
1	1	0	0	1
1	1	1	1	1

$A = \sum(1,2,4,7)$

$B = \sum(3,5,6,7)$

Question 4

10 points] Show a truth table of a 4-input combinational circuit whose output is equal to **1 if the input variables have more 1's than 0's or number of 1's equal number of 0's.**

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