Universidad Carlos III de Madrid

Digital Electronics. 1st partial exam. March, 2013

Groups 65,69,79,95.

Surname, Name:	**Group:**

Time: 1h. 15'

Question 1 (1.5 pts). Answer this question here (remember to write your name and group)

Complete the table with the representation of the proposed number in the other systems or codes.

Hexadecimal	60H
Decimal system	96_{10}
Binary system	1100000_{2}
Octal system	140_{8}
BCD	10010110_{BCD}
Gray's code	1010000_{Gray}
2s-complement	01100000_{2C}

Question 2 (1.5 pts). Answer this question here

Consider the operation A-B, with A and B represented in 2s complement:

A= 01111_{2C}

B= 10110_{2C}

a) Write the equivalent representation of both operands in decimal system:

+15	-10

b) Write the representation of (-B) in 2s-complement and decimal system:

01010_{2C}

c) Perform the operation A + (-B) and write the result using 5 bits and the equivalent representation in decimal:

11001_{2C}	-7

d) Is there overflow? Explain why and if there is overflow, point out how to solve it and write the correct result of the operation, both in 2s-complement and decimal

Yes, there is overflow. The signs of both operands are positive and the one of the result is negative. It means that the result cannot be represented with just five bits. It can be solved by extending the operation to 6 bits. In that case the result is:

011001_{2C}	+25

Question 3 (4 pts)

Given the following boolean function:

$$F(d,c,b,a) = \sum_{4}(0,3,5,10,13) + \bigwedge(2,7,8,15)$$

a) Find a simplified expression for F as a product of sums.
b) Find a simplified expression for F as a sum of products.
c) Find an expression with only NAND operations for the simplified expression found in a). It is not required to show the graphical representation of the circuit.
d) Simplify F as much as possible (multi-level expression using all possible known gates, as XOR, XNOR, etc)
e) Implement F with a 4:16 decoder with active-low outputs and only an additional NAND logic gate.
f) Implement F with a MUX2 (multiplexer with 4 data inputs) and additional logic if needed (only one MUX2).
Important note: In the correction it will be considered if the solutions have the minimum possible number of components.

Solution:

a) $F = (\bar{c} + a)(\bar{d} + c + \bar{a})(c + b + \bar{a})$

b) $F = ac + \bar{a}\bar{c} + ab\bar{d}$

c) $F = \overline{\overline{(c\bar{a})}\ \overline{(d\bar{c}a)}\ \overline{(\bar{c}\bar{b}a)}}$

d) $F = a \overline{\oplus}\, c + ab\bar{d}$

e)

f)

QUESTION 3

2 a)

	d	c	b	a	F
0	0	0	0	0	1
1	0	0	0	1	0
2	0	0	1	0	X
3	0	0	1	1	1
4	0	1	0	0	0
5	0	1	0	1	1
6	0	1	1	0	0
7	0	1	1	1	X
8	1	0	0	0	X
9	1	0	0	1	0
10	1	0	1	0	1
11	1	0	1	1	0
12	1	1	0	0	0
13	1	1	0	1	1
14	1	1	1	0	0
15	1	1	1	1	X

a) 2

dc\ba	00	01	11	10
00	1	0	1	X
01	0	1	X	0
11	0	1	X	0
10	X	0	0	1

$F = (\bar{c}+a)(c+b+\bar{c})(\bar{d}+\bar{b}+\bar{a})$

b) 2

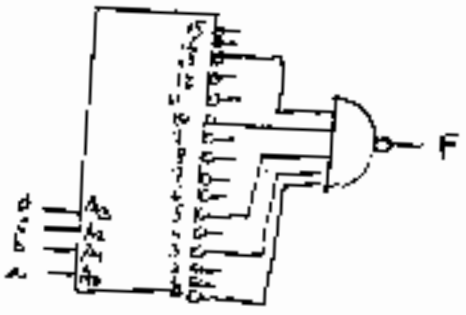
dc\ba	00	01	11	10
00	1	0	1	X
01	0	1	X	0
11	0	1	X	0
10	X	0	0	1

$F = \bar{c}\bar{a} + ca + \bar{d}ba$

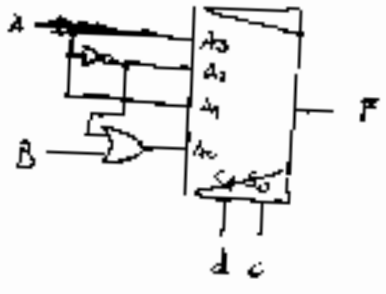
1 c) $F = \overline{(\bar{c}+a)(c+b+\bar{c})(\bar{d}+\bar{b}+\bar{a})} = \overline{\overline{c\bar{a}}\ \overline{\bar{c}ba}\ \overline{d\,ba}}$

1 d) From b) $\Rightarrow$ $F = (c \bar{\odot} a) + \bar{d}ba$

2 e)



2 f)



$A_3 = A$

$A_2 = \bar{A}$

$A_1 = A$

$A_0 = \bar{A} + B$

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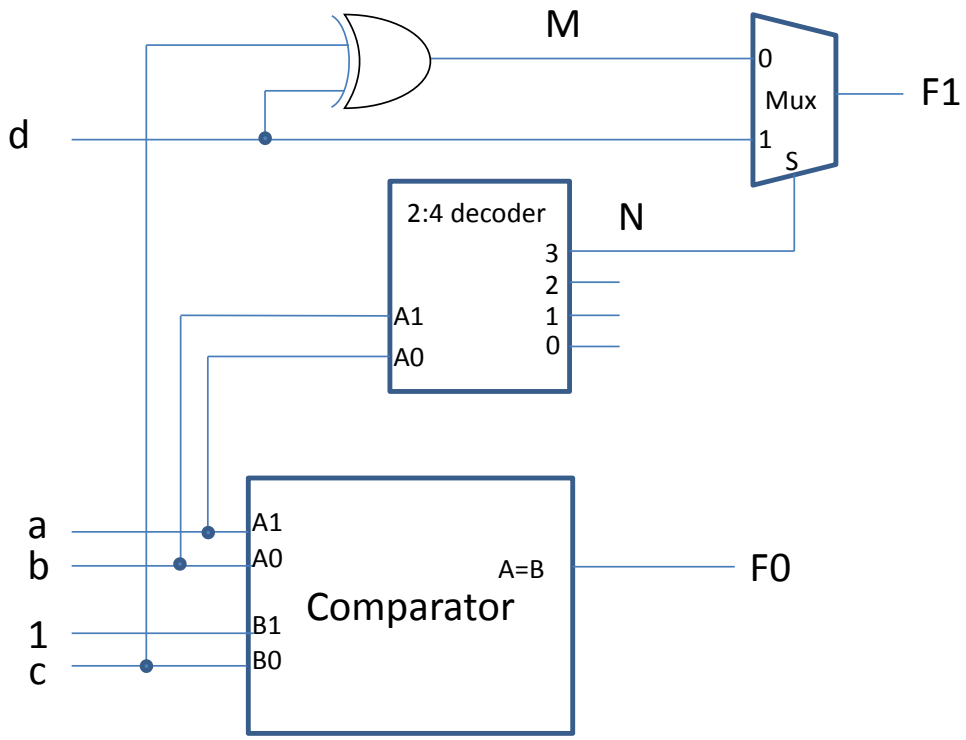
Question 3 (3 pts). Answer this question here (remember to write your name and group)

Write the truth table for the following circuit with inputs d,c,b,a and outputs F1 and F1:



a	b	c	d	M	N	F1	F0
0	0	0	0	**0**	**0**	**0**	**0**
0	0	0	1	**1**	**0**	**1**	**0**
0	0	1	0	**1**	**0**	**1**	**0**
0	0	1	1	**0**	**0**	**0**	**0**
0	1	0	0	**0**	**0**	**0**	**0**
0	1	0	1	**1**	**0**	**1**	**0**
0	1	1	0	**1**	**0**	**1**	**0**
0	1	1	1	**0**	**0**	**0**	**0**
1	0	0	0	**0**	**0**	**0**	**1**
1	0	0	1	**1**	**0**	**1**	**1**
1	0	1	0	**1**	**0**	**1**	**0**
1	0	1	1	**0**	**0**	**0**	**0**
1	1	0	0	**0**	**1**	**0**	**0**
1	1	0	1	**1**	**1**	**1**	**0**
1	1	1	0	**1**	**1**	**0**	**1**
1	1	1	1	**0**	**1**	**1**	**1**