ECE2030A Fall 2008
Introduction to Computer Engineering
Exam #1

50 min in-class exam.
Close books, close notes.
NO calculator.

This exam is given under the Georgia Tech Honor Code System. You must observe and sign the Honor Pledge: "I have neither given nor received aid on this exam." Your print name and signature below signifies your compliance with this honor code.

Name (Print): _____**SOLUTION**_____

Signature: _____

1. _____ (15 pts)
2. _____ (15 pts)
3. _____ (30 pts)
4. _____ (10 pts)
5. _____ (30 pts)

Total (100 pts) _____

1. (15%) Number representation. Please fill in the question marks assuming a "**signed** number system" using 2's complement. Please derive your results step by step.

1.1. $(21)_{10} = (\ ?\ )_2 = (\ ?\ )_{16}$

$= 16 + 4 + 1 = (0001\ 0101)_2 = (15)_{16}$

1.2. $(EC)_{16} = (\ ?\ )_2 = (\ ?\ )_{10}$

$= (1110\ 1100)_2$

MSB =1, thus it is negative. To find out the decimal positive counterpart, we perform 2's complement

$= (0001\ 0100) = 16 + 4 = 20$

Therefore, $(EC)_{16} = (1110\ 1100)_2 = (-20)_{10}$

1.3. What is the Hamming distance between the following two Hex numbers X and Y?

X = D201

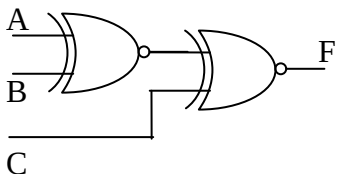
Y = E62C

The Hamming distance is the minimum number of substitutions required to change one into the other

1101 0010 0000 0001
1110 0110 0010 1100

0011 0100 0010 1101 → **7 is the Hamming distance.**

2. (15%) Fill in the truth table of the following Boolean logic ($F = A \oplus B \oplus C$)



2.1. (8%) Fill in the outout of the truth table below.

A	**B**	**C**	**F**
0	0	0	**0**
0	0	1	**1**
0	1	0	**1**
0	1	1	**0**
1	0	0	**1**
1	0	1	**0**
1	1	0	**0**
1	**1**	**1**	**1**

2.2. (7%) What do you think this function is used for?

Even/odd detection. The output indicates the even/odd number of a given 3-bit input

3. (30%) Draw the CMOS implementation of the following Boolean expressions.

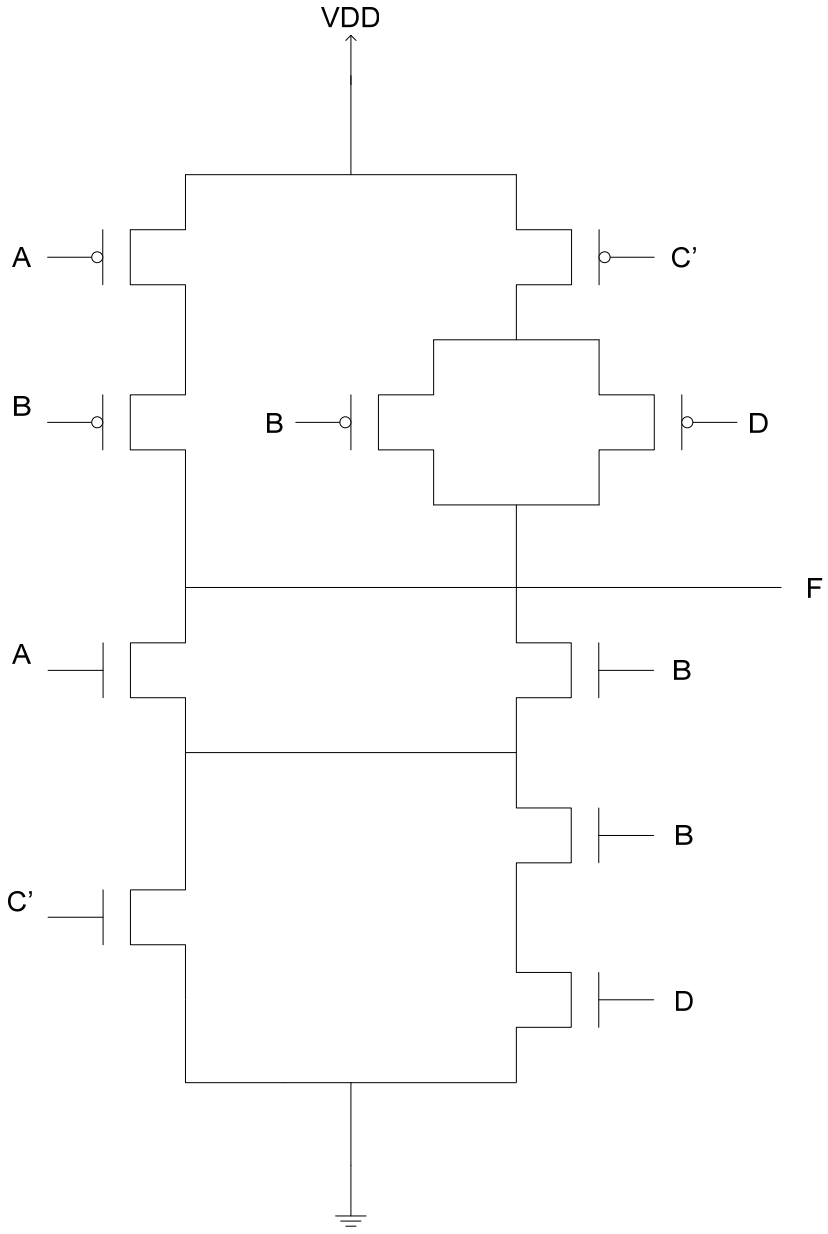
$$F = \overline{A + B} + C \cdot (\overline{B \cdot D})$$

Preferred route: PUN: $F = \overline{A} \cdot \overline{B} + C \cdot (\overline{B} + \overline{D})$

The other route: PDN: $\overline{F} = \overline{\overline{A + B} + C \cdot (\overline{B \cdot D})}$

$$\overline{F} = \overline{\overline{(A + B)}} \cdot \overline{C \cdot (\overline{B \cdot D})}$$

$$\overline{F} = (A + B) \cdot (\overline{C} + (B \cdot D))$$



4. (10%) Given a Boolean equation below. Convert this equation into a canonical Product-Of-Sum form. (You can use any method you like.)

$$F = \overline{A} + A \cdot \overline{B} \cdot C$$

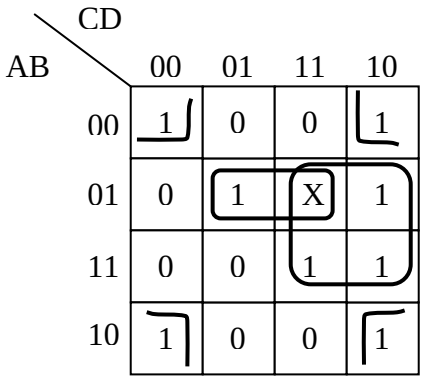
$$\begin{aligned}
F &= \overline{A} + A\overline{B}C \\
&= (\overline{A} + A)(\overline{A} + \overline{B}C) \\
&= \overline{A} + \overline{B}C \\
&= (\overline{A} + \overline{B})(\overline{A} + C) \\
&= (\overline{A} + \overline{B} + C\overline{C})(\overline{A} + B\overline{B} + C) \\
&= (\overline{A} + \overline{B} + C)(\overline{A} + \overline{B} + \overline{C})(\overline{A} + B + C)(\overline{A} + \overline{B} + C) \\
&= (\overline{A} + \overline{B} + C)(\overline{A} + \overline{B} + \overline{C})(\overline{A} + B + C) \\
\therefore \quad F &= \prod M(4, 6, 7)
\end{aligned}$$

5. (30%) Given the following canonical SOP form (with don't care component) in $\mathcal{B}^4$.

$$F(A, B, C, D) = \sum m(0, 2, 5, 6, 8, 10, 14, 15) + d(7)$$

5.1. (15%) Construct the corresponding Karnaugh map based on F. Identify the "essential prime implicants" by circling the 1's.

Find the essential PI's.



5.2. (15%) what is the minimized SOP Boolean expression?

$$F = \overline{B} \cdot \overline{D} + \overline{A} \cdot B \cdot D + B \cdot C$$