*The* UNIVERSITY *of* NORTH CAROLINA *at* CHAPEL HILL

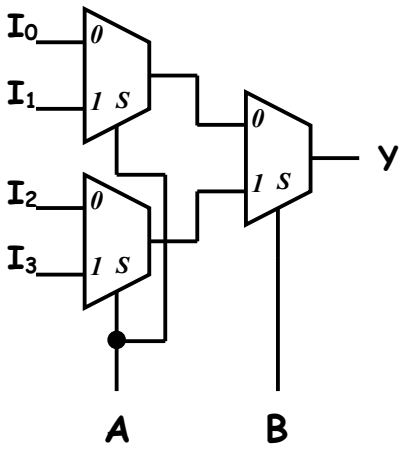
**Comp 411 Computer Organization**
Fall 2012

**Problem Set #3**
*Issued Monday, 10/29/12; Due Monday, 11/5/12*

Note: You may use additional sheets of paper, but please enter your answers in the space provided in this document.

**Problem 1. Mux Madness (16 points)**

Suppose you wanted to implement a Boolean function *Y* of two inputs *A* and *B* using multiplexers, as shown in the figure.




Give binary values for $I_0$, $I_1$, $I_2$, and $I_3$ that implement the following functions on the two inputs *A* and *B:*

a) Y = NAND(A,B)
b) Y = (A != B)
c) Y = (A < B)
d) Y = XOR(A,B)

| Function Y= | $I_0$ | $I_1$ | $I_2$ | $I_3$ |
|---|---|---|---|---|
| NAND(A, B) | | | | |
| A != B | | | | |
| A < B | | | | |
| XOR(A, B) | | | | |

**Problem 2. "Go Forth and Multiply" (52 points)**

a) [16 points] Complete the truth table below showing multiplication of two 2-bit unsigned integers $A_1A_0$ and $B_1B_0$, producing a 4-bit result $P_3P_2P_1P_0$. Please enter your answer directly in the table below.

| $A_1A_0B_1B_0$ | $P_3P_2P_1P_0$ |
|---|---|
| 0000 | |
| 0001 | |
| 0010 | |
| 0011 | |
| 0100 | |
| 0101 | |
| 0110 | |
| 0111 | |
| 1000 | |
| 1001 | |
| 1010 | |
| 1011 | |
| 1100 | |
| 1101 | |
| 1110 | |
| 1111 | |

b) [20 points] Suppose you wanted to compute the *fourth power* of a 2-bit number (i.e., $A^4$). Complete the truth table below in which the input column contains the 2-bit input ($A=A_1A_0$), and the output column is the 8-bit result.

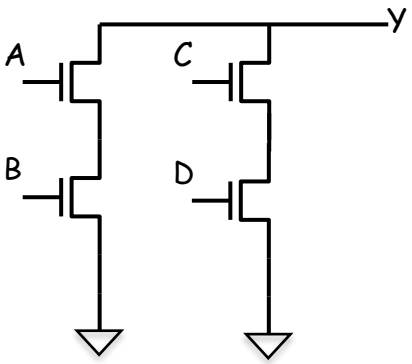
| $A_1A_0$ | $P_7P_6P_5P_4P_3P_2P_1P_0$ |
|---|---|
| 00 | |
| 01 | |
| 10 | |
| 11 | |

c) [16 points] For each of the 8 output bits from part (b), give the sum-of-products Boolean equation (circuit not needed):

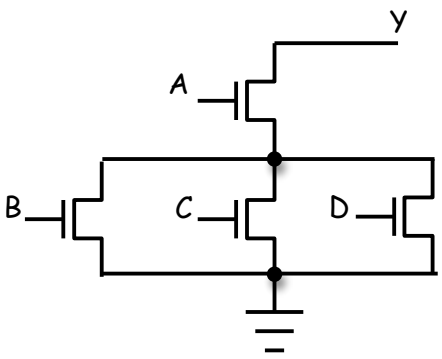
$P_0 =$
$P_1 =$
$P_2 =$
$P_3 =$
$P_4 =$
$P_5 =$
$P_6 =$
$P_7 =$

**Problem 3. "Fishing for Complements" (32 points).** Show the complementary set of p-channel or n-channel transistors that complete the following CMOS circuits:

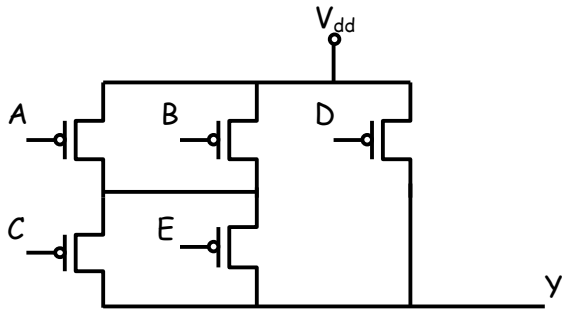
a)




b)



c)

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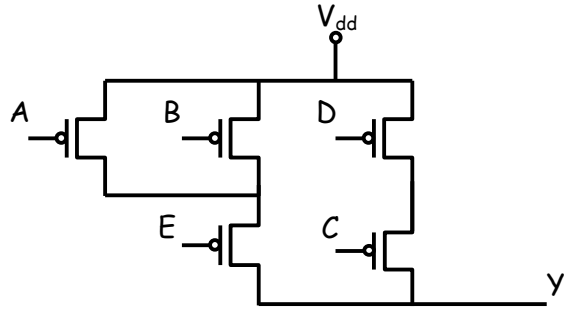
d)

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