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

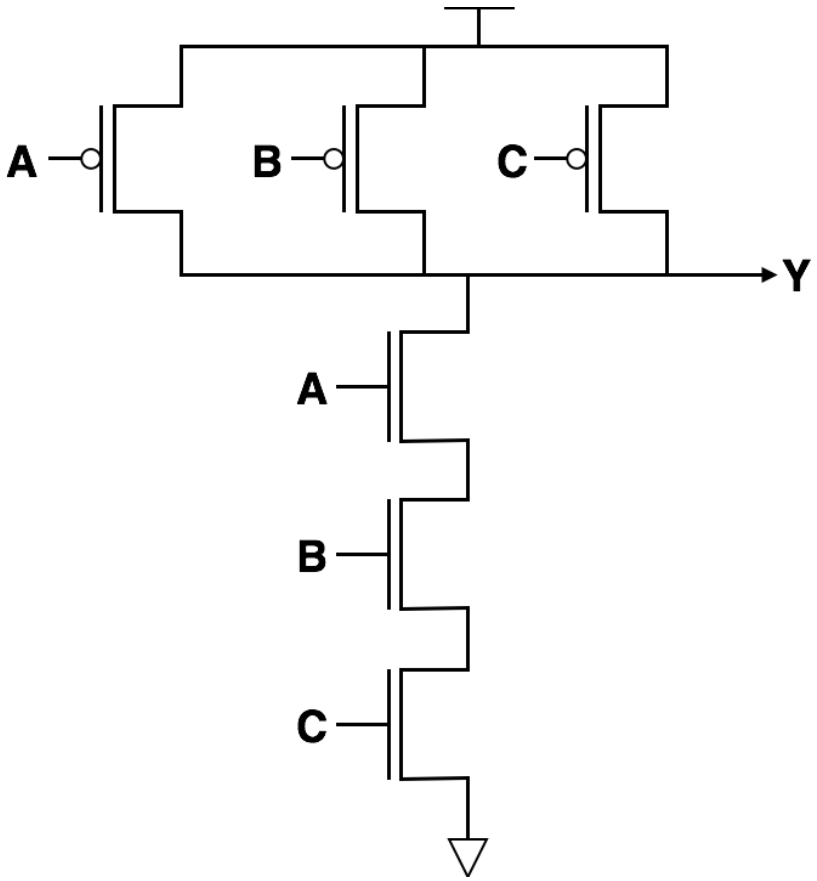
Comp 411 Computer Organization
Spring 2014

Problem Set #4
Issued Thursday, 3/13/13; Due Tuesday, 3/25/13
(hand in your work at start of the lab hour)

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

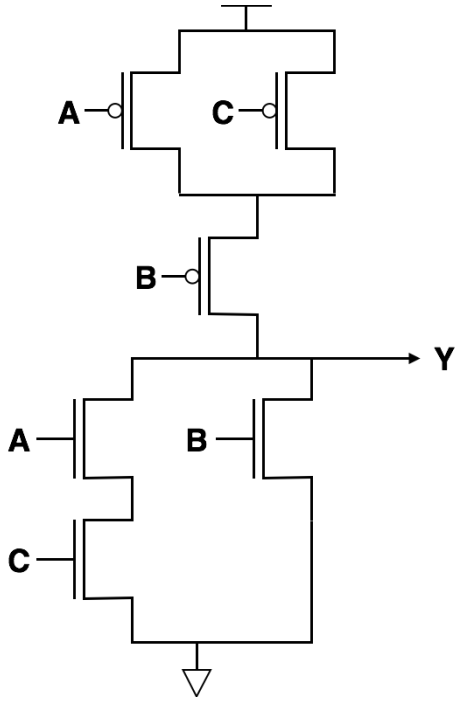
Problem 1. CMOS Transistors (54 points). In each of the parts below, a complete CMOS circuit consisting of 6-8 transistors is shown. Recall that p-type transistors have the little circle and are on the top half of the circuit, while n-type transistors do not have the little circle and are found on the bottom half. Create a truth table that corresponds to each of these circuits.

a) [6 points]



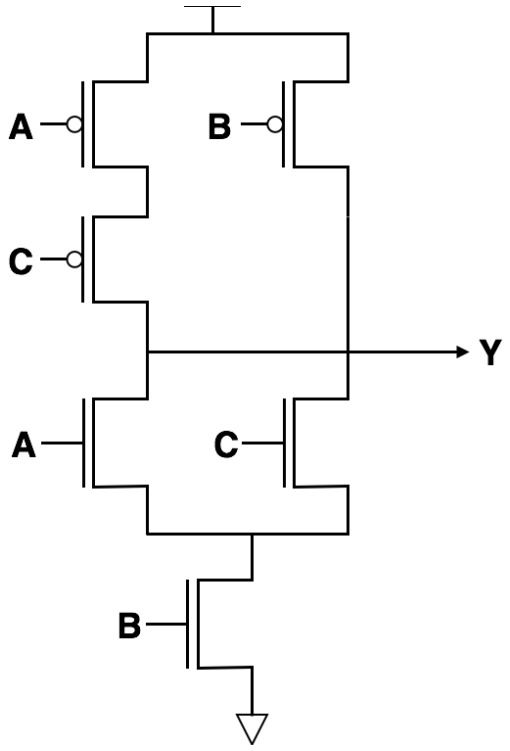
A	B	C	out
0	0	0	1
0	0	1	1
0	1	0	1
0	1	1	1
1	0	0	1
1	0	1	1
1	1	0	1
1	1	1	0

b) [8 points]



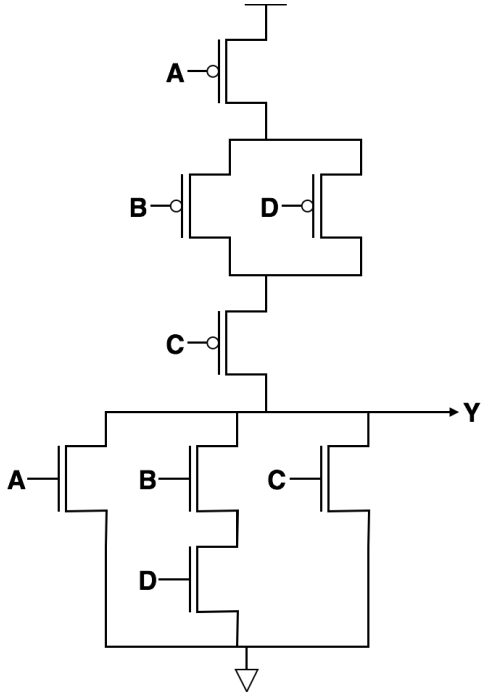
A	B	C	out
0	0	0	1
0	0	1	1
0	1	0	0
0	1	1	0
1	0	0	1
1	0	1	0
1	1	0	0
1	1	1	0

c) [8 points]



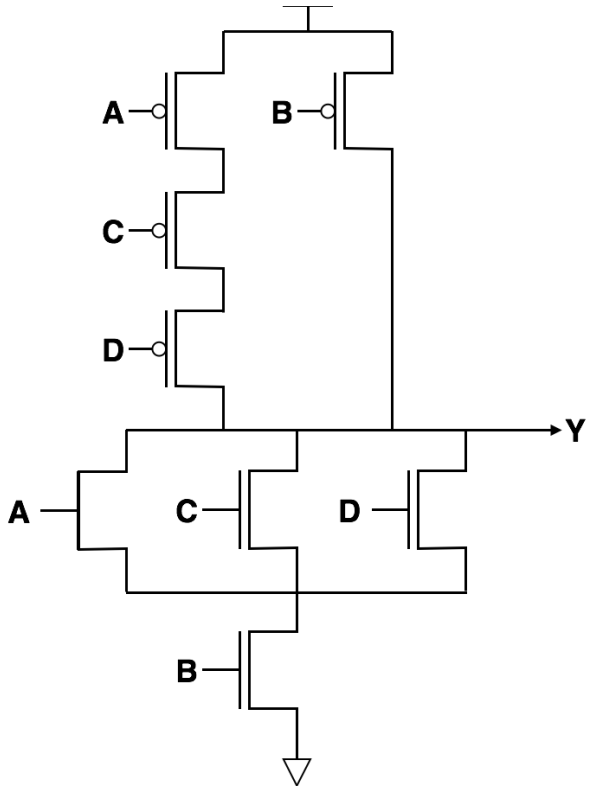
A	B	C	out
0	0	0	1
0	0	1	1
0	1	0	1
0	1	1	0
1	0	0	1
1	0	1	1
1	1	0	0
1	1	1	0

d) [10 points]



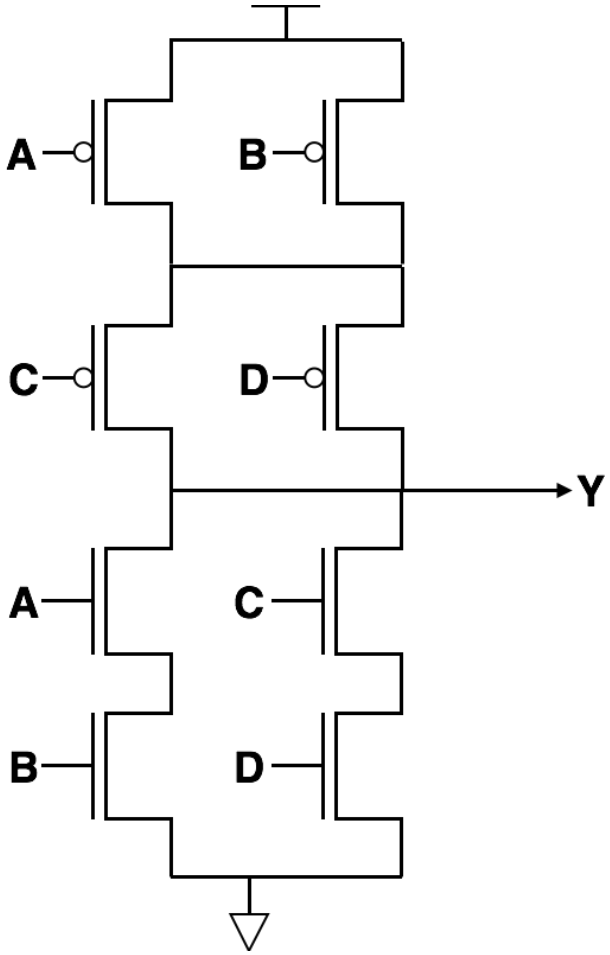
A	B	C	D	out
0	0	0	0	1
0	0	1	0	0
0	1	0	0	1
0	1	1	0	0
1	0	0	0	0
1	0	1	0	0
1	1	0	0	0
1	1	1	0	0
0	0	0	1	1
0	0	1	1	0
0	1	0	1	0
0	1	1	1	0
1	0	0	1	0
1	0	1	1	0
1	1	0	1	0
1	1	1	1	0

e) [10 points]



A	B	C	D	out
0	0	0	0	1
0	0	1	0	1
0	1	0	0	1
0	1	1	0	0
1	0	0	0	1
1	0	1	0	1
1	1	0	0	0
1	1	1	0	0
0	0	0	1	1
0	0	1	1	1
0	1	0	1	0
0	1	1	1	0
1	0	0	1	1
1	0	1	1	1
1	1	0	1	0
1	1	1	1	0

f) [12 points]

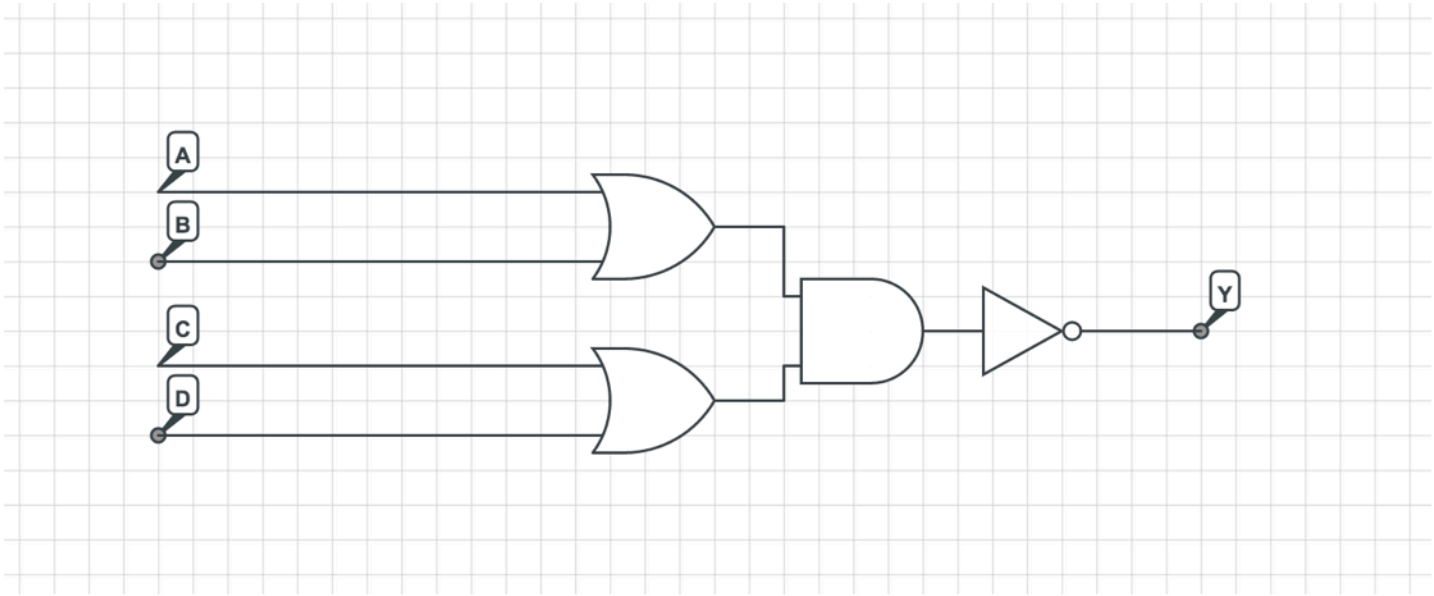


A	B	C	D	out
0	0	0	0	1
0	0	1	0	1
0	1	0	0	1
0	1	1	0	1
1	0	0	0	1
1	0	1	0	1
1	1	0	0	0
1	1	1	0	0
0	0	0	1	1
0	0	1	1	0
0	1	0	1	1
0	1	1	1	0
1	0	0	1	1
1	0	1	1	0
1	1	0	1	0
1	1	1	1	0

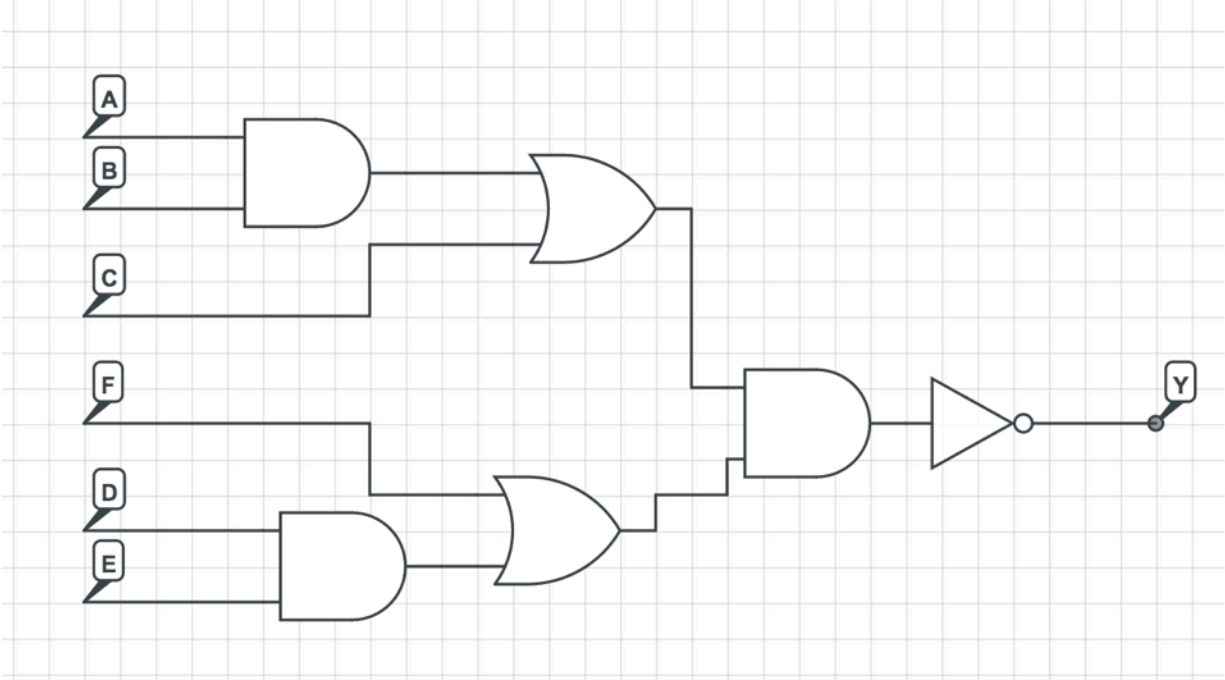
Problem 2. Complex Gates from Boolean Formulas (22 points)

For each of the parts, you are to draw a circuit that implements the given function, *using elementary logic gates* (AND, NAND, OR, NOR, inverter, buffer). That is, draw a circuit consisting of these aforementioned elementary gates. Be sure that the gate you draw corresponds exactly to the expressions given, i.e., do not perform any simplification.

a) $Y = \overline{(A + B)(C + D)}$ [10 points]

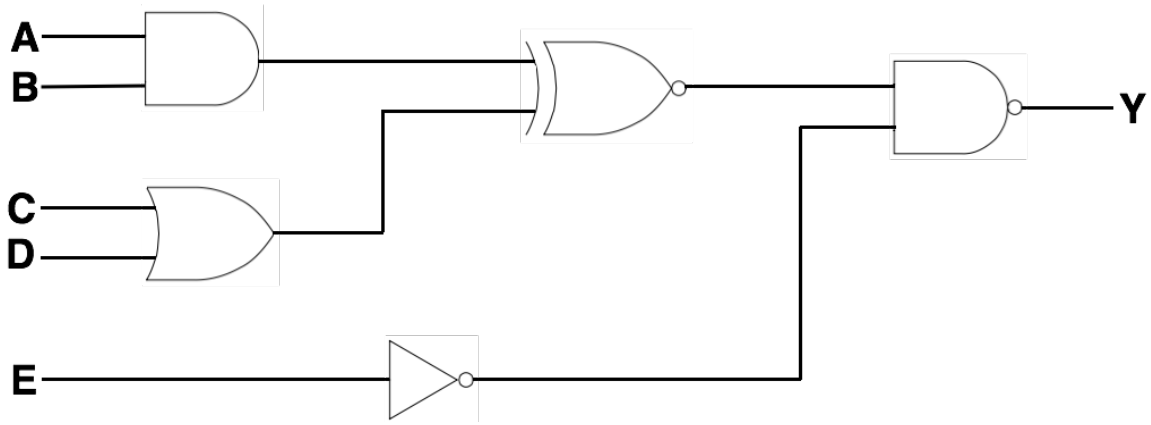


b) $Y = \overline{(AB + C)(DE + F)}$ [12 points]



Problem 3. Truth Tables from Circuits (12 points)

Given the circuit below, create the corresponding truth table.



A	B	C	D	E	out
0	0	0	0	0	1
0	0	1	0	0	1-
0	1	0	0	0	0
0	1	1	0	0	1
1	0	0	0	0	0
1	0	1	0	0	1
1	1	0	0	0	1
1	1	1	0	0	0
0	0	0	1	0	1
0	0	1	1	0	1
0	1	0	1	0	1
0	1	1	1	0	1-
1	0	0	1	0	1
1	0	1	1	0	1
1	1	0	1	0	0
1	1	1	1	0	0
0	0	0	0	1	1
0	0	1	0	1	1
0	1	0	0	1	1
0	1	1	0	1	1
1	0	0	0	1	1
1	0	1	0	1	1
1	1	0	0	1	1
1	1	1	0	1	1
0	0	0	1	1	1
0	0	1	1	1	1
0	1	0	1	1	1
0	1	1	1	1	1
1	0	0	1	1	1
1	0	1	1	1	1
1	1	0	1	1	1
1	1	1	1	1	1

For E=0, out is invert of top result.

For E=1, out is always 1

Problem 4. Circuits from Truth Tables (12 points)

Given the truth table below—with inputs A-D and output Y—create the corresponding circuit consisting of gates using the sum of products technique. Note that this might not be the simplest solution.

A	B	C	D	Y
1	1	1	1	0
1	1	1	0	0
1	1	0	1	1
1	1	0	0	0
1	0	1	1	1
1	0	1	0	1
1	0	0	1	1
1	0	0	0	0
0	1	1	1	0
0	1	1	0	0
0	1	0	1	0
0	1	0	0	1
0	0	1	1	1
0	0	1	0	0
0	0	0	1	0
0	0	0	0	0