EE 231 – Homework 2
Due September 10, 2010

1. Convert the decimal numbers +75 and +32 to 8-bit hexadecimal numbers, unsing the signed 2's complement representation. Then perform the following operations: (a) $(+75) + (-32)$, (b) $(-75) + (+32)$, (c) $(-75) + (-32)$. Convert the answers back to decimal and verify that they are correct.

   $+75_{10} = 4B_{16}$ $\quad\quad$ $+32_{10} = 20_{16}$

   For use below, we need the 2's complement negative representations:

   $-75_{10} = B5_{16}$ $\quad\quad$ $-32_{10} = E0_{16}$

   (a) $(+75_{10}) + (-32_{10}) = 4B_{16} + E0_{16} = 2B_{16} = +43_{10}$, correct.

   Note: $4B_{16} + E0_{16} = 112B_{16}$, but you drop the leading 1 because the result must be 8 bits long. The first bit of the 8-bit result is 0, so the answer is positive.

   (b) $(-75_{10}) + (+32_{10}) = B5_{16} + 20_{16} = D5_{16} = -43_{10}$, correct. The first bit of the eight-bit answer is 1, so the result is negative; the 2's complement of $D5_{16}$ is $2B_{16} = 43_{10}$, so the answer is -43.

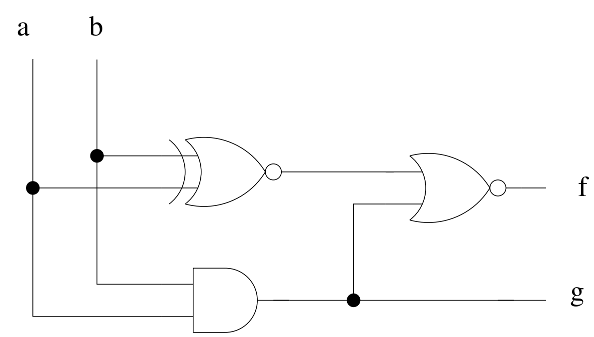
   (b) $(-75_{10}) + (-32_{10}) = B5_{16} + E0_{16} = 95_{16} = -107_{10}$, correct. Drop the 9'th bit; the first bit of the of the 8-bit answer is 1, so the result is negative; the 2's complement of 95_{16} is $6B_{16} = 107_{10}$, so the answer is -107.

2. Convert the following binary numbers to ASCII code:
   1001110 1100101 1110111 0100000 1001101 1100101 1111000 1101001
   1100011 1101111 0100000 1011000 1100101 1100011 1101000

   New Mexico Xech

   (I meant to put New Mexico Tech, put wrote it down wrong.)

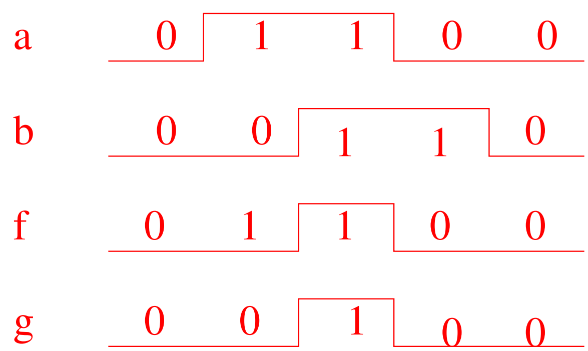
3. By means of a timing diagram similar to Figure 1.5, show the signals of the outputs f and g in the figure below as functions of the two inputs a and b. Use all four possible combinations of a and b.



Start with a truth table:

a	b	$g = ab$	$(a \oplus b)'$	$f = (g + (a \oplus b)')'$
0	0	0	1	0
0	1	0	0	1
1	0	0	0	1
1	1	1	1	0

Now draw the timing diagram:



4. Use Boolean algebra to prove that the following Boolean equalities are true:

   (a) $a'b' + ab' + a'b = a' + b'$
   $a'b' + ab' + a'b = a'b' + a'b' + a'b + ab' = a'(b' + b) + (a' + a)b' = a' + ab' = a' + b$

   (b) $abc + bc' = b(a + c')$
   $abc + bc' = b(ac + c') = b(c' + a)(c' + c) = b(c' + a)$

   (c) $(a + b)'bc = 0$
   $(a + b)'bc = (a'b')bc = a'(b'b)c = 0$

   (d) $(ab' + a'b)' = a'b' + ab$
   $(ab' + a'b)' = (ab')'(a'b)' = (a' + b)(a + b') = aa' + a'b' + ab + bb' = a'b' + ab$

   (e) $[(a + b(c + a')]' = a'b'$
   $[a + b(c + a')]' = a'[b(c + a')]' = a'[b' + (c + a')'] = a'[b' + ac'] = a'b' + a'ac' = a'b'$

5. Simplify the following Boolean expressions to a minumum number of literals

   (a) $[(a' + bc')d']' = (a' + bc')' + d = a(bc')' + d = \boxed{a(b' + c) + d}$ Four literals

   (b) $\{(ab + c)[(ab)' + c']\}' = (ab + c)' + (ab)c = (ab)'c' + abc = \boxed{(a' + b')c' + abc}$ All have four literals

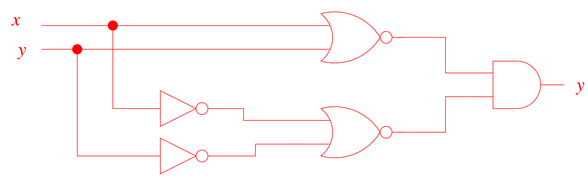
   (c) $(x + y)'(x' + y')' = (x'y')(xy) = \boxed{0}$ No literals

   (d) $abc' + a'bc' + a'b'c' = abc' + a'bc' + a'bc' + a'b'c' = (a + a')bc' + a'c'(b + b') = \boxed{bc' + a'c'}$ Four literals

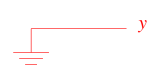
6. Draw logic diagrams of the circuits that implement the original and simplified expressions in Problem 5 (c) and (d)

   (c)

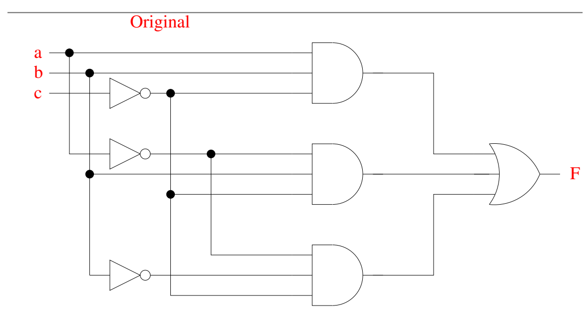
   Original



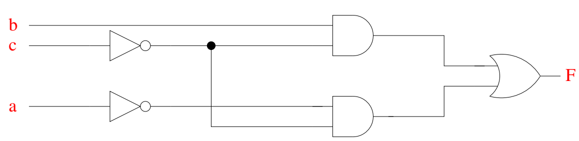
   Simplified



   (d)



   Simplified



7. Find the complements of the following expressions:

   (a) $(x+y')(x'+y)$: $[(x+y')(x'+y)]' = (x+y')' + (x'+y)' = x'y + xy'$

   (b) $(A'B+CD)E+E'$: $[(A'B+CD)E+E']' = [(A'B+CD)E]'E = [(A'B+CD)'+E']E = [(A'B)'(CD)'+E']E = [(A+B')(C'+D')+E']E = [AC'+AD'+B'C'+B'D'+E']E = AC'E + AD'E + B'C'E + B'D'E$

   (c) $(x'+y'+z)(x+y)(x+z')$: $[(x'+y'+z)(x+y)(x+z')]' = (x'+y'+z)' + [(x+y)(x+z')]' = xyz' + (x+y)' + (x+z')' = xyz' + x'y' + x'z$