Homework Set 6
Physics 3500/8800

1. By use of Truth tables, show that the following are true:

   a. $\overline{A \bullet B} = \overline{A} + \overline{B}$

   b. $\overline{A + B} = \overline{A} \bullet \overline{B}$

   c. $A \cdot 1 = A$

   d. $\overline{A \bullet A} = \overline{A}$

   e. $A + 1 = 1$

   f. $\overline{A + A} = \overline{A}$

   g. $A + 0 = A$

   h. $A \cdot 0 = 0$

2. Using the most straightforward approach, design a logic circuit to provide the following:

   a. out = 1 for A = 1, or B = 1, or C = 1
   b. out = 0 for (A = 0, or B = 1) & C = 1
   c. out = 1 for A = 1 & B = 1 or A = 0 & B = 0

3. Repeat #2 using ***only*** 2-input NAND gates.

4. Work out the algebraic relation to accomplish the tasks of #2 using NAND gates as in #3.

5. For each Boolean algebra expression below, sketch the corresponding circuit relating the variables indicated to the output (***use only 2-input gates and inverters***):

   a. $(\overline{A} \cdot \overline{B}) + C = OUT$

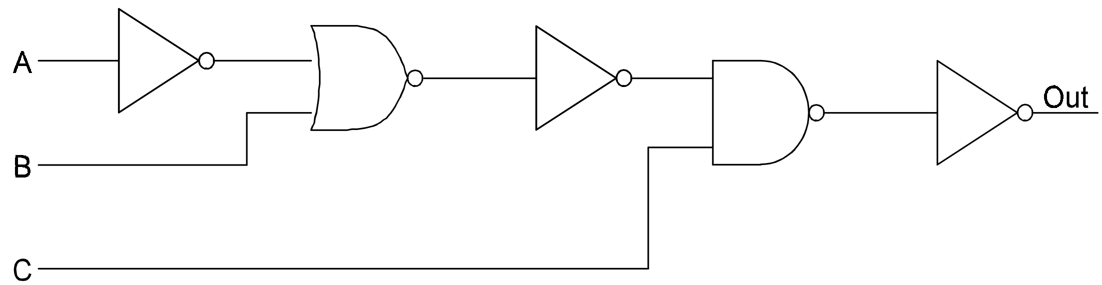
   b. $(A + \overline{B}) \cdot \overline{C} = OUT$

   c. $A \cdot \overline{B} \cdot \overline{C} = OUT$

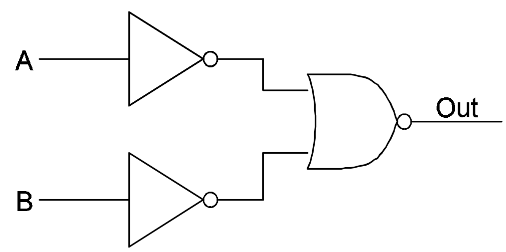
   d. $[(A \cdot \overline{B}) + (B \cdot \overline{A})] \cdot C = OUT$

6. Write the Boolean algebraic relation between the inputs and the outputs for the circuits shown:

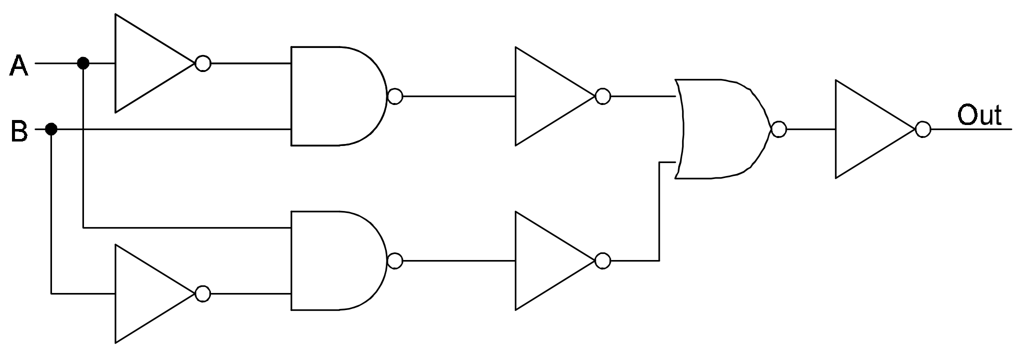
a.



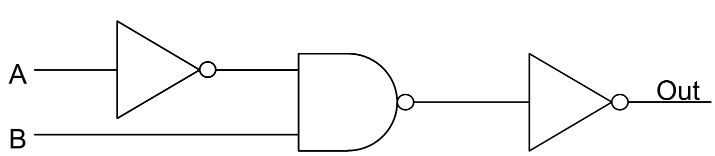
b.



c.



d.



7. Draw the circuit for each of the following Boolean expressions using ***only*** gates of the type indicated:

a. $A \cdot B \cdot \overline{C} = OUT$, 2-input NOR gates

b. $A \cdot B \cdot \overline{C} = OUT$, 2-input NAND gates

c. $(A \cdot \overline{B}) + (B \cdot \overline{A}) = OUT$, 2-input NOR gates

d. $(A + \overline{B}) \cdot \overline{C} = OUT$, 2-input NAND gates

8. Convert the following ***decimal*** numbers to ***binary and to hexadecimal***:

a. 42	b. 784	c. 481	d. 25	e. 106
f. 14	g. 999	h. 1024	i. 511	j. 255

9. Convert the following ***hexadecimal*** numbers to ***binary and to decimal***:

a. 15	b. 1AC	c. 2C	d. EF	e. A
f. 20	g. 1000	h. FFF	i. 999	j. ABC

10. Perform the indicated binary arithmetic operations using ***2's complement*** arithmetic for any subtractions:

a. $\begin{array}{r} 1011 \\ \underline{+0101} \end{array}$ b. $\begin{array}{r} 11011 \\ \underline{-01100} \end{array}$ c. $\begin{array}{r} 1001 \\ \underline{-0110} \end{array}$

d. $\begin{array}{r} 11011 \\ \underline{+01100} \end{array}$ e. $\begin{array}{r} 101101 \\ \underline{-010110} \end{array}$ f. $\begin{array}{r} 101101 \\ \underline{+101001} \end{array}$

11. Sketch the most straightforward circuit to implement the following:

a. OUT = 1 only if A = 0, B = 1, and C = 1

b. OUT = 0 only if A = 1, B = 1, and C = 0

c. OUT = 1 only if A = 1, B = 0, and C = 1 or if B = 1

d. OUT = 1 only for A = 0, B = 0, and C = 0

12. Write the logic relations necessary for comparing two 2-bit binary numbers and indicating with OUT = 1 if they are equal. (Note that such binary numbers can be written as $A = A_1A_0$, where A_0 represents the least significant bit, and A_1 represents the most signifficant bit.)

13. Sketch the circuit to compare two 2-bit binary numbers and indicate by OUT = 1 if they are equal.

14. Write the logic relations necessary for comparing two 2-bit binary numbers and indicating with OUT = 1 if A > B. (The case A ≤ B should give OUT = 0.)

15. Add to the circuit of #13 the additional circuitry necessary to give a ***second*** output which is ONE if A > B, and which is ZERO (NOT ONE) if A ≤ B.

16. Write the logic equation, and sketch the circuit necessary to implement the following truth table:

A	B	C	OUT
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	1
1	0	0	0
1	0	1	1
1	1	0	0
1	1	1	1