Homework #4 **Due: 10/7**

- Use separate sheets for your answers.
- Draw a box around each answer.
- You *must* show your work by attaching your worksheets.
- Drawings and tables should be clear and unambiguous. The use of quad-ruled paper is recommended.
- When writing logic equations, remember that "$\overline{AB}$" is not equivalent to "$\overline{A}\ \overline{B}$".

1. [25 points] Write a Boolean equation in sum-of-products canonical form for each of these truth tables:

a)

A	B	Y
0	0	0
0	1	1
1	0	1
1	1	1

b)

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

c)

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

d)

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

e)

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

2. [15 points]

   Simplify the following Boolean equations using a series of Boolean theorems. Show the result of each theorem in order and give its name. (You can check for correctness with a truth table or Karnaugh map, but you don't need to submit them.)

   a) $Y = \overline{A}\,CB + \overline{A}\,B\,\overline{C}$

   b) $Y = \overline{ABC} + A\,\overline{B}$

   c) $Y = ABC\,\overline{D} + A\,\overline{BCD} + (\,\overline{A + B + C + D}\,)$

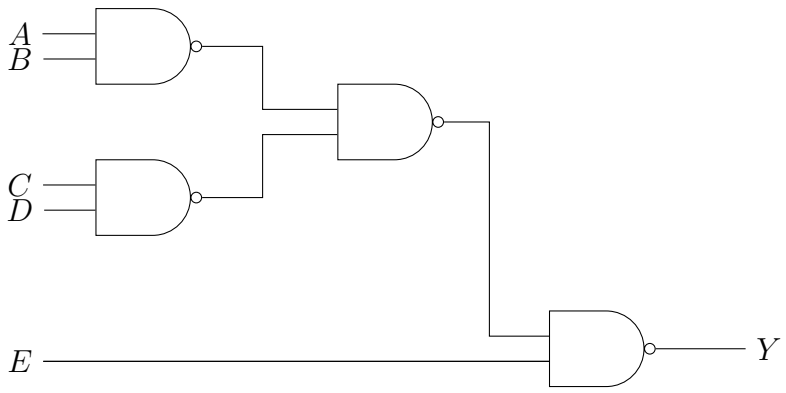
3. [15 points] Simplify each of the following Boolean equations. Sketch a reasonably simple combinational circuit implementing the simplified equation.

   (a) $Y = \overline{A}\,BC + \overline{B\,\overline{C}} + BC$

   (b) $Y = (\,\overline{A + B + C}\,)D + AD + B$

   (c) $Y = ABCD + \overline{A}\,B\,\overline{C}\,D + \overline{(\,\overline{B} + D)}\,E$

4. [10 points] Using De Morgan equivalent gates and bubble pushing methods, redraw the circuit below so that you can find the Boolean expression by inspection. Show that circuit and its expression.



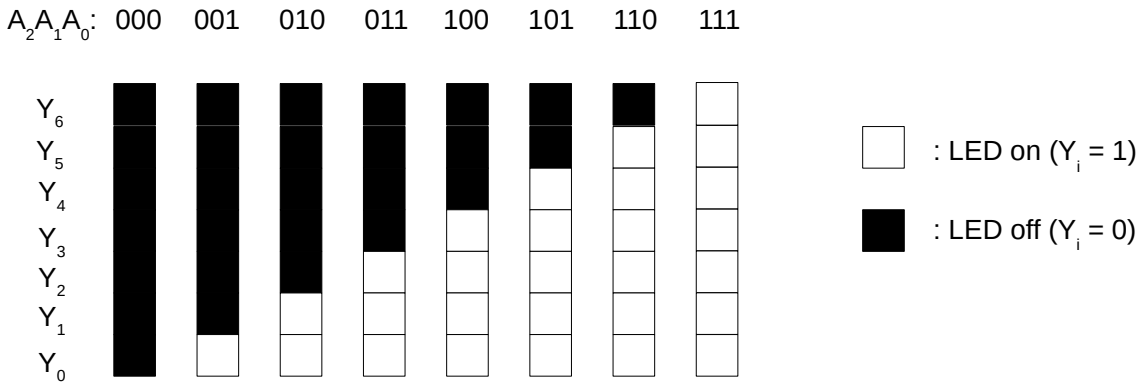
5. [35 points]

   An M-bit *thermometer code* for the number k consists of k 1's in the least significant bit positions and $M - k$ 0's in all the more significant bit positions.

   An $N : M$ *binary-to-thermometer code converter* has N bits input and $M = 2^N - 1$ outputs.

   Design a 3:7 binary-to-thermometer code converter. The inputs are A_2 to A_0, with A_2 being the high-order bit. The outputs are Y_0 to Y_6, with Y_6 being lit only on the maximum input ($A_0 = A_1 = A_2 = 1$).

   If we were to connect the outputs to an array of seven LED's, here's how they would respond to different values of the three input bits:



   These are often used to display digital sound levels.

   Submit a (single) truth table with 3 inputs and 7 outputs. Give simplified Boolean equations for each output and sketch schematics for them using only AND and OR gates.