Homework #4

- 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:

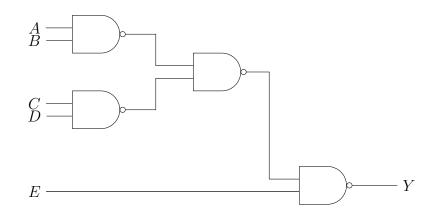
	А	В	Y	
	0	0	0	
a)	0	1	1	
/	1	0	1	
	1	1	1	
	А	В	C	Y
	0	0		$\begin{array}{c} Y \\ \hline 0 \\ 1 \end{array}$
	0	0	0 1	1
	0 0 0	1	0	1
b)	0	1	1	1 1
	1	0	0	1
	1	0	1	$\begin{array}{c} 1 \\ 0 \end{array}$
	1	1	0	1
	1	1	1	$\begin{array}{c} 1 \\ 0 \end{array}$
	A	В	С	Y 0
	0	0	0	0
	0	0	1	1
	0 0 0 0	1	0	0
c)	0	1	1	0
	1	0	0	0
	1	0	1	1 0 0 0
	1	1	0	
	1	1	1	1 1

	А	В	\mathbf{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
d)	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
	А	В	С	D	Y
	0	0	0	0	0
	0 0	0 0	0 0	0 1	0 0
	0 0 0	0 0 0	0 0 1	0 1 0	0 0 0
	0 0 0 0	0 0	0 0 1 1	0 1 0 1	$\begin{array}{c} 0 \\ 0 \\ 0 \\ 1 \end{array}$
	0 0 0 0 0	0 0 0 0 1	0 0 1 1 0	0 1 0 1 0	$egin{array}{c} 0 \\ 0 \\ 0 \\ 1 \\ 0 \end{array}$
	0 0 0 0 0 0	0 0 0 0	0 0 1 1	0 1 0 1	0 0 1 0 0
	0 0 0 0 0 0 0	0 0 0 0 1	0 0 1 1 0	0 1 0 1 0	0 0 1 0 0 1
e)	0 0 0 0 0 0	0 0 0 1 1	0 0 1 1 0 0	0 1 0 1 0 1	0 0 1 0 0 1 1 1
e)	0 0 0 0 0 0 0	0 0 0 1 1 1	0 0 1 1 0 0 1	0 1 0 1 0 1 0	0 0 1 0 0 1
e)	0 0 0 0 0 0 0 0 0	0 0 0 1 1 1 1 1	0 0 1 0 0 1 1 1	0 1 0 1 0 1 0 1 0	0 0 1 0 0 1 1 1
e)	$\begin{array}{c} 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 1 \end{array}$	$egin{array}{c} 0 \\ 0 \\ 0 \\ 1 \\ 1 \\ 1 \\ 1 \\ 0 \end{array}$	$\begin{array}{c} 0 \\ 0 \\ 1 \\ 1 \\ 0 \\ 0 \\ 1 \\ 1 \\ 0 \\ 0 \\$	$egin{array}{ccc} 0 \\ 1 \\ 0 \\ 1 \\ 0 \\ 1 \\ 0 \\ 1 \\ 0 \end{array}$	0 0 1 0 0 1 1 1 1 1 1 1
e)	$egin{array}{ccc} 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 1 \\ 1 \end{array}$	$egin{array}{ccc} 0 \\ 0 \\ 0 \\ 1 \\ 1 \\ 1 \\ 1 \\ 0 \\ 0 \end{array}$	$egin{array}{ccc} 0 \\ 0 \\ 1 \\ 1 \\ 0 \\ 0 \\ 1 \\ 1 \\ 0 \\ 0 \end{array}$	$\begin{array}{c} 0 \\ 1 \\ 0 \\ 1 \\ 0 \\ 1 \\ 0 \\ 1 \\ 0 \\ 1 \\ 0 \\ 1 \\ 0 \\ 1 \end{array}$	$\begin{array}{c} 0 \\ 0 \\ 0 \\ 1 \\ 0 \\ 0 \\ 1 \\ 1 \\ 1 \\ 1 \\$
e)	0 0 0 0 0 0 0 0 1 1 1 1 1 1	$\begin{array}{c} 0 \\ 0 \\ 0 \\ 1 \\ 1 \\ 1 \\ 1 \\ 0 \\ 0 \\ 0 \\$	$\begin{array}{c} 0 \\ 0 \\ 1 \\ 1 \\ 0 \\ 0 \\ 1 \\ 1 \\ 0 \\ 0 \\$	$\begin{array}{c} 0 \\ 1 \\ 0 \\ 1 \\ 0 \\ 1 \\ 0 \\ 1 \\ 0 \\ 1 \\ 0 \\ 1 \\ 0 \end{array}$	$\begin{array}{c} 0 \\ 0 \\ 0 \\ 1 \\ 0 \\ 0 \\ 1 \\ 1 \\ 1 \\ 1 \\$
e)	0 0 0 0 0 0 0 0 1 1 1 1 1 1 1 1	$\begin{array}{c} 0 \\ 0 \\ 0 \\ 1 \\ 1 \\ 1 \\ 0 \\ 0 \\ 0 \\ 0 \\$	$\begin{array}{c} 0 \\ 0 \\ 1 \\ 1 \\ 0 \\ 0 \\ 1 \\ 1 \\ 0 \\ 0 \\$	$\begin{array}{c} 0 \\ 1 \\ 0 \\ 1 \\ 0 \\ 1 \\ 0 \\ 1 \\ 0 \\ 1 \\ 0 \\ 1 \\ 0 \\ 1 \end{array}$	$\begin{array}{c} 0 \\ 0 \\ 0 \\ 1 \\ 0 \\ 0 \\ 1 \\ 1 \\ 1 \\ 1 \\$
e)	0 0 0 0 0 0 0 0 1 1 1 1 1 1	0 0 0 1 1 1 1 1 0 0 0 0 0 1	0 0 1 1 0 0 1 1 0 0 1 1 1 0	0 1 0 1 0 1 0 1 0 1 0 1 0 1 0	$\begin{array}{c} 0 \\ 0 \\ 0 \\ 1 \\ 0 \\ 0 \\ 1 \\ 1 \\ 1 \\ 1 \\$

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) $Y = ABC\overline{D} + A\overline{B}C\overline{D} + (\overline{A+B+C+D})$
- 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.



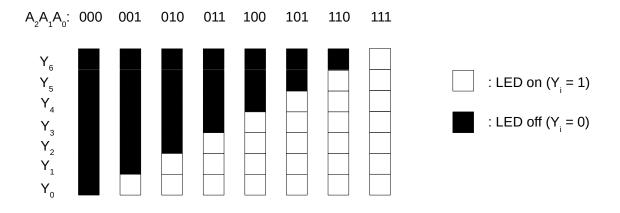
5. [35 points]

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.