BEE 271 Spring 2017
Homework 1 answers

Please answer the following questions.

1. Convert 709 base 10 to binary. Show your steps. What is the minimum number of bits needed to represent this number?

	Remainder	
709 ÷ 2 = 354	1	LSB
354 ÷ 2 = 177	0	
177 ÷ 2 = 88	1	
88 ÷ 2 = 44	0	
44 ÷ 2 = 22	0	
22 ÷ 2 = 11	0	
11 ÷ 2 = 5	1	
5 ÷ 2 = 2	1	
2 ÷ 2 = 1	0	
1 ÷ 2 = 0	1	MSB

Resulting bitstring = 1011000101

It requires 10 bits.

2. How are ones and zeros represented in digital systems?

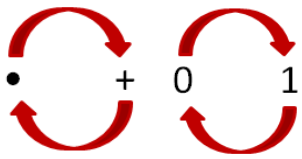
As different voltage levels.

3. One of the axioms of Boolean algebra is that 1 + 0 = 1. Why is it called an axiom? What's the difference between that and a theorem?

Because we accept it's true as a basis of Boolean algebra. We don't try to prove axioms. By contrast, theorems can be proved based on the axioms.

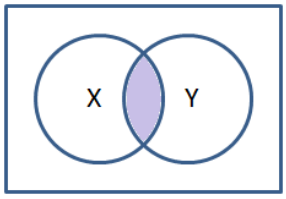
4. What is the principle of duality?

Given any logic expression, its dual is obtained by swapping all the + and • operators and the ones and zeros.

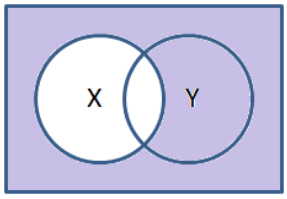


5. What is DeMorgan's theorem? Use Venn diagrams to prove it.

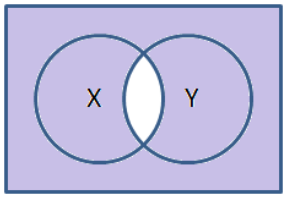
X' + Y' = (X • Y)'



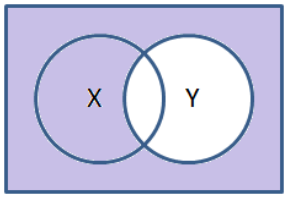
X • Y



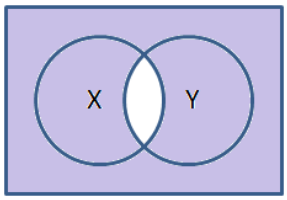
X
'



(X • Y)'



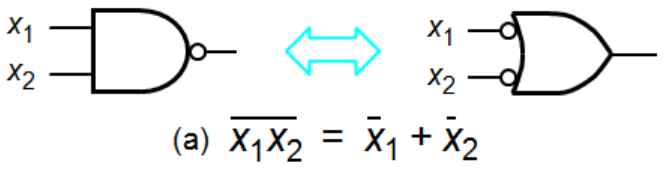
Y'



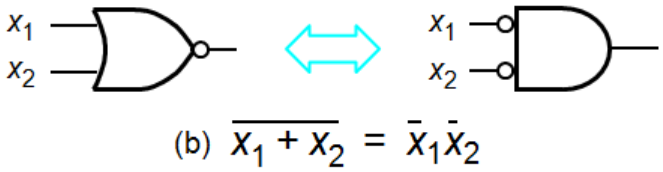
X' + Y'

6. DeMorgan's theorem allows us to do what with bubbles? Draw an example.

   It allows us to push bubbles through a gate, changing NANDs to ORs with inverted inputs and NORs to ANDs with inverted inputs.



(a) $\overline{x_1 x_2} = \bar{x}_1 + \bar{x}_2$



(b) $\overline{x_1 + x_2} = \bar{x}_1 \bar{x}_2$

The remaining questions refer to the following truth table, where f is a combinatorial result of the inputs, A, B and C:

row	A	B	C	f
0	0	0	0	0
1	0	0	1	0
2	0	1	0	1
3	0	1	1	0
4	1	0	0	1
5	1	0	1	1
6	1	1	0	0
7	1	1	1	0

Notice I've added row numbers, which always start at 0, meaning all inputs = 0.

7. What are the minterms?

   The minterms are m2, m4 and m5.

8. What are the maxterms?

   The maxterms are M0, M1, M3, M6 and M7.

9. Write a canonical POS solution.

   f = M0 • M1 • M3 • M6 • M7
   = (A + B + C) (A + B + C') (A + B' + C') (A' + B' + C) (A' + B' + C')

10. Write a canonical SOP solution.

    f = m2 + m4 + m5 = A' B C' + A B' C' + A B' C