CSE 232 SPRING 2020

HOMEWORK 2

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1. Assume for a particular year that a particular size chip using state-of-the-art technology can contain 1 billion transistors. Assuming Moore's Law (doubling each 18 months) holds, how many transistors will the same size chip be able to contain in ten years?

   According to Moore's Law the transistor count is going to double every 18 months so after 10 years i.e. after 120 months it is going to be the current transistor count times 2^6 after the first 9 years then for the last year it's going to be the count after nine years times 1.34,
   i.e. $10^9 * 2^6 * 1.34$ = 85 760 000 000 i.e. 85 billion 760 million transistors.

2. Evaluate the Boolean equation `F = (a AND b) OR c OR d` for the given values of variables `a`, `b`, `c`, and `d`:

   a. `a=1, b=1, c=1, d=0`
   `F = (1 AND 1) OR 1 OR 0 = 1 OR 1 OR 0 = 1 OR 0 = 1`

   b. `a=0, b=1, c=1, d=0`
   `F = (0 AND 1) OR 1 OR 0 = 0 OR 1 OR 0 = 1 OR 0 = 1`

   c. `a=1, b=1, c=0, d=0`
   `F = (1 AND 1) OR 0 OR 0 = 1 OR 0 OR 0 = 1 OR 0 = 1`

   d. `a=1, b=0, c=1, d=1`
   `F = (1 AND 0) OR 1 OR 1 = 0 OR 1 OR 1 = 1 OR 1 = 1`

3. For the function `F = a + a'b + acd + c'`:

   a. List all the variables.
   a, b, c, d

   b. List all the literals.
   a, a', b, c, c'

   c. List all the product terms.
   a, a'b , acd, c'

4. Convert the function F shown in the truth table in the table to an equation. Don't minimize the equation.

a	b	c	F
0	0	0	0
0	0	1	1
0	1	0	1
0	1	1	1
1	0	0	0
1	0	1	1
1	1	0	1
1	1	1	1

F = (a'b'c)+(a'bc')+(a'bc)+(ab'c)+(abc')+(abc)

5. Use algebraic manipulation to minimize the equation obtained in Exercise 4.

F = (a'b'c)+(a'bc')+(a'bc)+(ab'c)+(abc')+(abc)
= a'(b'c + bc' + bc) + a(b'c + bc' + bc)
= a'(b'c + b(c' + c)) + a(b'c + b(c' + c))
= a'(b'c + b) + a(b'c + b)
= (a' + a) (b'c + b) = b'c + b
= (b + b') (b + c) = b + c

6. Determine whether the Boolean functions F = (a + b)'*a and G = a + b' are equivalent, using: (a) algebraic manipulation, and (b) truth tables.

a) First, we convert the functions to the sum of minterms form
F = (a + b)'*a
= a'b'a = 0b' = 0

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

As we can see from the algebraic manipulation F and G are not equivalent

a	b	F
0	0	0
0	1	0
1	0	0
1	1	0

a	b	G
0	0	1
0	1	0
1	0	1
1	1	1

As we can see from the Truth Tables F and G are not equivalent

7. Using the combinational design process, create a 4-bit prime number detector. The circuit has four inputs, N3, N2, N1, and N0 that correspond to a 4-bit number (N3 is the most significant bit) and one output P that is 1 when the input is a prime number and that is 0 otherwise.

N3 = a , N2 = b , N1 = c , N0 = d

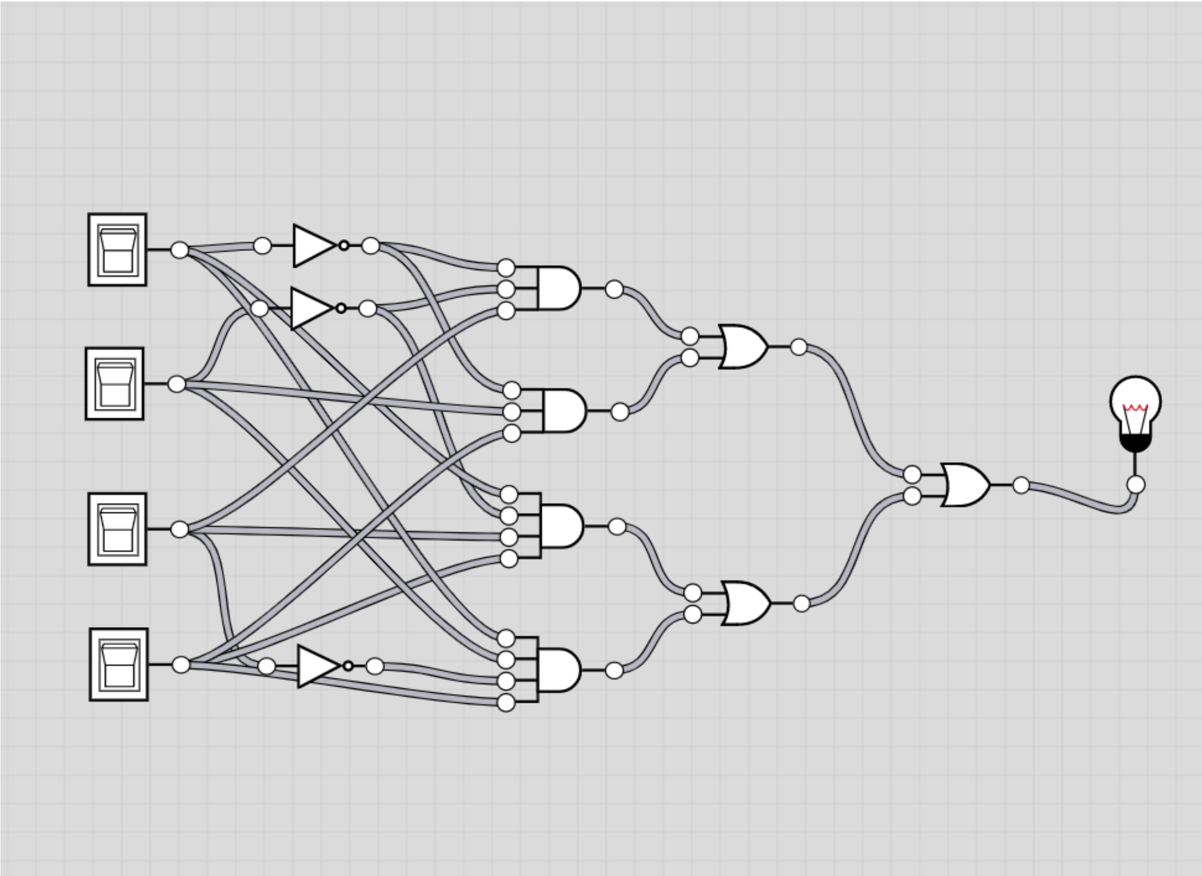
a	b	c	d	F
0	0	0	0	0
0	0	0	1	0
0	0	1	0	1
0	0	1	1	1
0	1	0	0	0
0	1	0	1	1
0	1	1	0	0
0	1	1	1	1
1	0	0	0	0
1	0	0	1	0
1	0	1	0	0
1	0	1	1	1
1	1	0	0	0
1	1	0	1	1
1	1	1	0	0
1	1	1	1	0

Equation:

F = (a'b'cd') + (a'b'cd) + (a'bc'd) + (a'bcd) + (ab'cd) + (abc'd)

F = a'b'c + a'bd + ab'cd + abc'd

In the image the switches from top to bottom a, b, c, d respectively



8. A network router connects multiple computers together and allows them to send messages to each other. If two or more computers send messages simultaneously, the messages “collide” and the messages must be resent. Using the combinational design process of Table 2.5, create a collision detection circuit for a router that connects 4 computers. The circuit has 4 inputs labeled `M0` through `M3` that are `1` when the corresponding computer is sending a message and `0` otherwise. The circuit has one output labeled `C` that is `1` when a collision is detected and `0` otherwise.

M0	M1	M2	M3	C
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	1
0	1	1	0	1
0	1	1	1	1
1	0	0	0	0
1	0	0	1	1
1	0	1	0	1
1	0	1	1	1
1	1	0	0	1
1	1	0	1	1
1	1	1	0	1
1	1	1	1	1

Equation:

M0 = a, M1 = b, M2 = c, M3 = d

Because the 1s are more than the 0s it is better to make an equation using the 0s and then taking its inverse

C = ((a'b'c'd') + (a'b'c'd) + (a'b'cd') + (a'bc'd') + (ab'c'd'))'

= ((a'b'c') + (a'b'cd') + (ab'c'd'))'

In the image the switches from top to bottom a, b, c, d respectively