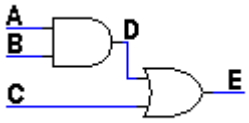
ELEN 21, COEN 21 Logic Design Winter 2021

Homework 1

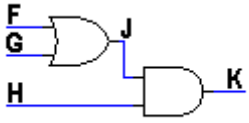
due Wednesday 13 January 2021 at 11:59pm

1. For each of the three logic circuits shown:
   a. Write the logic expression for every logic symbol's output in terms of the input variables at the left edge of the circuit. Use parentheses to show the order of the operations.
   b. Write the truth table.

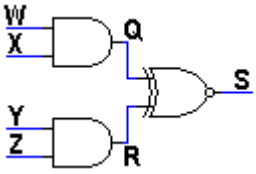
      Identify the circuit inputs at the left edge of each circuit. Make a truth table row for each input possibility and write them in binary counting order starting with all zeros. Make a column for every logic gate output (e.g. D is an internal signal, but include it in the truth table along with output E) and explicitly show the value of each output for each truth table row.



a.)



b.)



c.)

2. Write truth tables for the following functions. (Use additional columns as needed for intermediate results.)

   a.) f1(a,b) = ab' + b
   b.) f2(a,b) = (a + b')b
   c.) f3(a,b) = (a' + b)b'
   d.) f4(a,b) = a'b + b
   e.) f5(a,b) = (a) XOR (ab)

   Which function above is the complement of f1(a,b)?

3. According to the consensus theorem, f1(x,y,z) = xz + yz' + xy is equal to f2(x,y,z) = xz + yz'.
   a.) Write a truth table showing a column for each product appearing in f1(x,y,z) and f2(x,y,z). Show the truth table for f1(x,y,z) and f2(x,y,z) and demonstrate that they are equal.
   b.) Write the expression for the dual of the consensus theorem.

4. Write the algebraic expression for the following functions:

a.) f(a,b,c) = m3 + m4 + m5 b.) f(a,b,c,d) = m3 + m14 c.) f(a,b,c) = (M2)(M5)

Draw the circuits for the functions using AND, OR, and NOT symbols.

5. Write each of the following functions in canonical SOP form (minterm notation) and canonical POS form (maxterm notation). Write the complement of each function in both canonical forms.

a.) f(x,y) = x $\oplus$ y b.) f (x,y,z) = xz + yz' c.) f (x,y,z) = xz + yz' + xy d.) f(x,y,z) = (x+y')(x'+z)

6. For the two functions $f_1(b,c) = b + c$ and $f_2(b,c) = bc$:
   a. Show each function on a 2-variable K-map.
   b. Write each function in both canonical SOP and canonical POS form.
   c. Using the distributive law, write an algebraic expression in terms of inputs a, b, and c for the new function
      $f_3(a,b,c) = a' \cdot f_1(b,c) + a \cdot f_2(b,c)$
   d. Show $f_3(a,b,c)$ on a K-map. How are the contents of the three variable K-map related to the two two-variable K-maps for $f_1(b,c)$ and $f_2(b,c)$?
   e. Based on the K-map for $f_3(a,b,c)$, simplify the results from (c).