CS/EE 260 - Homework 3

Due 2/12/2001

1. (12 points) Find complements for the following expressions.
   (a) \((A + B)C' + B'D\)
   (b) \(AB'D + BCD' + A'C\)
   (c) \((A' + B + C'D)(B' + D)\)
   (d) \(A'C + (B'D + C)(A' + D)\)

2. (16 points) For each expression, list its minterms and its maxterms.
   (a) \((A + B)C'\)
   (b) \(AB' + BC' + A'C\)
   (c) \(A'C + (B' + C)\)
   (d) \((A' + AB + C')(B' + C)\)

3. (9 points) For each equation below, derive the dual equation.
   (a) \(A'B' + A'B + AB = A' + B\)
   (b) \(B + A'C + AB' = A + B + C\)
   (c) \(A'B' + B'C + AC + AB + BC' = A'B' + AC + BC'\)

4. (8 points) For each expression below, simplify it using the general simplification procedure described on page 2-29 of the course notes. Show all the steps.
   (a) \(A(B + B'C) + (A'B + B'C)\)
   (b) \(A'B + BC + (A + C')B\)

5. (8 points) For each function given below, simplify it using a 3 variable Karnaugh map.
   (a) \(F(A,B,C) = \Sigma m(2,3,5,6,7)\)
   (b) \(F(A,B,C) = \Sigma m(0,1,4,5,7)\)
   (c) \(F(W,X,Y) = \Sigma m(1,2,4,5,6)\)
   (d) \(F(A,B,C) = \Sigma m(0,2,3,4,6)\)

6. (12 points) For each function given below, simplify it using a 4 variable Karnaugh map.
   (a) \(F(A,B,C,D) = \Sigma m(2,3,4,6,7,9,10,11,13,14)\)
   (b) \(F(A,B,C,D) = \Sigma m(0,1,3,5,6,7,12,13,14)\)
   (c) \(F(A,B,C,D) = \Sigma m(2,3,6,7,11,12,13,14,15)\)
   (d) \(F(W,X,Y,Z) = \Sigma m(1,4,5,7,8,10,12,13,15)\)
7. (9 points) For each function given below, simplify it using a 4 variable Karnaugh map and taking advantage of the don’t care conditions.
   (a) \( F(A,B,C,D) = \Sigma m(2,8,14,15), \ d(A,B,C,D) = \Sigma m(3,6,7,11,12) \)
   (b) \( F(W,X,Y,Z) = \Sigma m(1,7,10,13,15), \ d(W,X,Y,Z) = \Sigma m(3,6,9,14) \)
   (c) \( F(A,B,C,D) = \Sigma m(0,4,8,9,11,13), \ d(A,B,C,D) = \Sigma m(2,3,7,10,12) \)

8. (8 points) For each of the following expressions, give a NAND circuit (that is, a circuit using only NAND gates) that implements the expression, and a NOR circuit that implements the expression. Use only 2-input gates.
   (a) \((A + B)C' + B'D\)
   (b) \((A' + B + C'D)(B' + D)\)

9. (20 points) Create a schematic diagram of the circuit shown below and simulate it, using the functional simulation mode, and using the unit delay simulation with the simulation precision set to 1 ns. In your simulations, connect inputs A-D to counter outputs B1-B3 (in the stimulator), respectively. Your simulation should show all inputs and all outputs. Run the simulation for 200 ns, so that all possible input combinations are shown. Turn in copies of your schematic and the simulation outputs from both simulation runs. At what point in the unit delay simulation, do you observe the longest delay from the time inputs change to the time outputs change? Indicate this point on your output. Explain the reason for this longest delay.