ECE 370: Digital Systems-Logic Design

Sample Test: Chapter 4
Spring 2005

1. Do problem 4.1 in the Brown & Vranesic textbook, 2nd Edition.
   (a) For the minimum cost SOP form, draw the corresponding circuit composed of NAND gates only. You may assume that the complements of the input signals are available as inputs, but use only NAND gates in your design.
   (b) For the minimum cost POS form, draw the corresponding circuit composed of NOR gates only. You may assume that the complements of the input signals are available as inputs, but use only NOR gates in you design.
2. Do problem 4.3 in the Brown & Vranesic textbook, 2nd Edition.

3. Do problem 4.4 in the Brown & Vranesic textbook, 2nd Edition.

4. Do problem 4.10 in the Brown & Vranesic textbook, 2nd Edition.

5. Consider a prime number detector that inputs a four-bit number (i.e., values 0 to 15) and outputs a 1 if the number is prime. (The numbers 0 and 1 are not prime.) Give the truth table and minimum sum of products.

6. The following is the minimal product-of-sums (POS) expression for function *f(A,B,C,D).*: It has a cost of 13 (4 gates + 9 inputs to the gates).

$$f(A,B,C,D) = \left(\overline{B} + C\right)\left(\overline{B} + \overline{D}\right)\left(\overline{C} + \overline{D}\right)$$

   (a) Find the minimal sum-of-products (SOP) expression for F. What is the cost?
   (b) Now assume that the input combination *(A,B,C,D) = (1,0,1,1)* will never occur. Why doesn't this simplify the SOP?

7. The minimum cost realization of a function is not necessarily unique (i.e., there can be more than one solution that is equally as good). Find all four minimum cost SOP expressions for the function.

$$f(A,B,C,D) = \sum m(1,4,5,7,12,14,15)$$

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8. A circuit with two outputs has to implement the following functions.

$$f(A,B,C,D) = \sum m(5,6,7,13,15)$$
$$g(A,B,C,D) = \sum m(2,4,5,6,7,12,13,15)$$

Design the minimum cost SOP circuit, assuming that you can share product terms for the two outputs. Compare the cost of the combined circuit with the costs of two circuits that implement *f* and *g* separately.