CSE 220 Homework Assignment 1

Assigned Sep. 5, 2006
Due 12:30, Sep. 12, 2006

Note: Unsupported answers receive no credits.
Total points: 100

Question 1 (20 Points)
Implement the XOR function using only 4 two-input NAND gates.

Question 2 (20 Points)
A number code in which consecutive numbers are represented by binary patterns that differ only in one bit position is called a *Gray Code*. A truth table for a 3-bit Gray code to binary code converter is shown on the next page.
(a) Implement the three functions f_1, f_2 and f_3 using only NAND gates.
(b) A lower-cost network for performing this code conversion can be derived by noting the following relationships between the input and output variables.

$$f_1 = a$$
$$f_2 = f_1 \oplus b$$
$$f_3 = f_2 \oplus c$$

Using these relationships, specify the contents of a combinational network N that can be repeated (as shown on next page) to implement the conversion. Compare the total number of NAND gates required to implement the conversion in this form to the number required in Part (a).

Question 3 (20 Points)
A switching function to be implemented is described by the expression

$$f(x_1, x_2, x_3, x_4) = x_1 x_3 \overline{x}_4 + \overline{x}_1 \overline{x}_3 x_4 + \overline{x}_2 \overline{x}_3 \overline{x}_4$$

(a) Show an implementation of f in terms of an eight-input multiplexer circuit.
(b) Can f be realized with a four-input multiplexer circuit? If so, show how.

Question 4 (20 Points)
Repeat Question 3 for

$$f(x_1, x_2, x_3, x_4) = x_1 \overline{x}_2 x_3 + x_2 x_3 x_4 + \overline{x}_1 \overline{x}_4$$

Question 5 (20 Points)
The arithmetic expressions characterizing logic gates (Fig. 1.1 in the textbook) can be extended to gates with more than two inputs. This is trivial for AND gates. Write the equivalent arithmetic expressions for 3- and 4-input OR gates. Generalize the expression to an h-input OR gate.