University of California, Santa Barbara

Department of Electrical and Computer Engineering

Homework #5

(Due by 5:00PM on 02/14/03)

Note: Place your homework in the homework-box for ECE 152A located on the fifth floor of Eng. I

1. (a) Find a minimum multiple-output two-level NAND-NAND network to realize
   $f_1 = \Sigma m(3,6,7,11,13,14,15)$ and $f_2 = \Sigma m(3,4,6,11,12,13,14)$. **(20 points)**
   (b) Repeat for a minimum two-level NOR-NOR network.

2. A combinational circuit is specified by the following three Boolean functions: **(10 points)**

   $F_1(A,B,C) = \Sigma m(1,5,7)$

   $F_2(A,B,C) = \Sigma m(2,3,6)$

   $F_3(A,B,C) = \Sigma m(0,4,7)$

   Implement the circuit with a decoder constructed with NAND gates and external NAND gates.

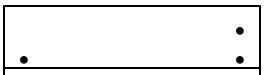
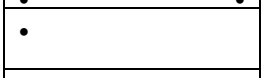
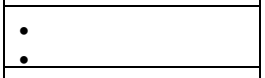
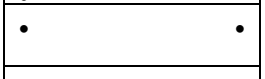
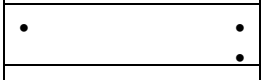
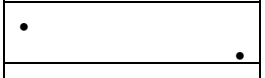
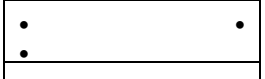
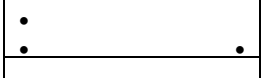
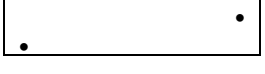
3. Realize the function of **(20 points)**

   $F(a,b,c,d,e) = \Sigma m(0,1,2,6,7,9,10,15,16,18,20,21,27,30) + \Sigma d(3,4,11,12,19)$

   (a) Using a 16-to-1 MUX with control inputs *a*, *b*, *c*, and *d*
   (b) Using an 8-to-1 MUX with control inputs *a*, *b*, and *c* and added gates

4. (a) An adder for excess-3 coded decimal digits is to be designed using a ROM. The adder should add two excess-3 coded digits and give the excess-3 coded sum and a carry. For example, 1010 + 1001 = 0110 with a carry of 1 (7 + 6 = 13). Draw a block diagram showing the required ROM inputs and outputs. What size ROM is required? Indicate how the truth table for the ROM would be specified by giving some typical rows. **(10 points)**
   (b) If the same adder were implemented using a PLA, what size PLA would be required? (Assume that only the 10 legal excess-3 coded digits can occur as inputs.)

5. Braille is a system which allows a blind person to "read" alphanumerics by feeling a pattern of raised dots. Design a network that converts BCD to Braille. The table shows the correspondence between BCD and Braille. **(20 points)**

A	B	C	D	W X / Z Y
0	0	0	0	
0	0	0	1	
0	0	1	0	
0	0	1	1	
0	1	0	0	
0	1	0	1	
0	1	1	0	
0	1	1	1	
1	0	0	0	
1	0	0	1	

(a) Use a multiple-output NAND-gate network and draw the diagram.
(b) Use a PAL. Specify the PAL type and fuse pattern

6. A binary-coded-decimal priority encoder has nine inputs $(X_1, X_2, \cdots, X_9)$ and four outputs (A, B, C, D) . If only the X_i input is 1, the output *ABCD* represent a binary number equal to *i*. For example, if $X_1 = 1$, then *ABCD* = 0001, and if $X_9 = 1$, *ABCD* = 1001. If two or more of the X_i's are 1, then the largest value of *i* takes priority. For example, if $X_1 = X_2 = X_5 = X_8 = 1$ (and the other inputs are 0), then *ABCD* = 1000. If all inputs are 0, then *ABCD* = 0000. **(20 points)**

(a) Derive a PLA table and draw AND-OR array for the priority encoder (10 rows).
(b) By inspection of the table, find product-of-sums expressions for *A*, *B*, *C*, and *D*.