# EE/CPE 422/522 Homework 1

Assigned: 04/06/03.
Due: 11/06/03.

1. (Textbook, 1.2) A full subtracter computes the difference of three inputs X, Y, and Bin, where Diff = X – Y – Bin. When X < (Y + Bin), the borrow output Bout is set. Fill in the truth table for the subtracter and derive the SOP (sum-of-products) and POS (product-of-sums) equations for Diff and Bout.

2. Find the minimum-cost SOP and POS forms for the function
(a)
$$f(x_1,..., x_5) = \prod M (1, 4, 6, 7, 9, 12, 15, 17, 20, 21, 22, 23, 28, 31)$$
(b)
$$f(x_1,..., x_5) = \sum m(0, 1, 3, 4, 6, 8, 9, 11, 13, 14, 16, 19, 20, 21, 22, 24, 25) + D(5, 7, 12, 15, 17, 23)$$

3. Implement the following functions using a minimum-size ROM module:
$$f_1(A, B, C, D) = \sum m(4, 5, 10, 11, 12)$$
$$f_2(A, B, C, D) = \sum m(0, 1, 3, 4, 8, 11)$$
$$f_3(A, B, C, D) = \sum m(0, 4, 10, 12, 14)$$
Draw the ROM module, clearly identify the inputs, outputs, and the content of the module.

4. Find a minimum-row PLA table to implement the following sets of functions:
$$f_1(A, B, C, D) = \sum m(4, 5, 8, 9, 10, 11, 12, 13)$$
$$f_2(A, B, C, D) = \sum m(5, 8, 10, 13)$$
$$f_3(A, B, C, D) = \sum m(9, 10, 11, 12, 14)$$
Using the style of drawing used in the lectures, draw a picture of a minimum-sized PLA programmed to implement the set of functions.

5. (Textbook 1.5).
(a) Find all static hazards in the following network.

NAND(NAND(a,b), OR(NOR(a,c), NOR(a',d))).

For each hazard, specify the values of the input variables and which variable is changing when the hazard occurs. For one of the hazards, specify the order in which the gate outputs must change.
(b) Design a NAND-gate network that is free of static hazards to realize the same function.