ECE 275, Homework 4

Note that to find the "minimum-cost circuit", you must find both the SOP and POS forms, compute the cost of each, and then indicate which is best. Show your work (including costs).

1. Derive a minimum-cost circuit that implements the function $f(x_1, \ldots, x_4) = \sum m(4, 7, 8, 11) + d(12, 15)$.
2. Implement the function of Problem 1 using only NOR gates (do minimally).
3. Implement the function of Problem 1 using only NAND gates (do minimally).
4. Derive a minimum-cost circuit that implements the function $f(x_1, \ldots, x_4) = \sum m(4, 6, 9, 10, 15) + d(2, 3, 5, 11, 13)$.
5. For the function f = $\bar{x}_1x_3x_5 + x_1x_3x_5 + \bar{x}_1x_2x_4 + x_1\bar{x}_2\bar{x}_4 + x_1x_3\bar{x}_4 + \bar{x}_1x_3x_4 + \bar{x}_1x_2x_5 + x_1\bar{x}_2x_5$. Derive a minimum-cost circuit that implements this function using NOT, AND, and OR gates.
6. Derive a minimum-cost SOP that implements the function $f(x_1, \ldots, x_5) = \sum m(2, 5,6,7,8,12,13,15,18,21,24, 26, 28,31) + d(1,4,14, 23, 25,29,30)$. (Hint: the minimum cost is 22.)
7. A circuit with two outputs has to implement the following functions:

$$f(x_1, \ldots, x_4) = \sum m(0, 2, 4, 6, 7, 9) + d(10, 11).$$

$$g(x_1, \ldots, x_4) = \sum m(2, 4, 9, 10,15) + d(0, 13, 14).$$

   Design a minimum-cost SOP circuit and compare its cost with combined costs of two SOP circuits that implement f and g separately. Assume the input variables are available in both complemented and uncomplemented forms.