EECS 140/141 Introduction to Digital Logic Design
Spring Semester 2020
Assignment **#4** Due **18 February 2020**

Reading: Sections 3.9.1, 2.7, 4.1, 4.2 in Brown/Vranesic

All logic networks on this (and every other assignment) *must* be drawn using a logic template. Points will be deducted for failure to do this! You should have had time by now to secure one of these templates.

1. This is a follow-up to problem 7 of the previous assignment. Use the solutions to the previous assignment as a starting point for this problem.
    a. Convert the SoP synthesis (using AND/OR/NOT gates) of an XOR gate to a NAND-only synthesis.
    b. Convert the PoS synthesis (using AND/OR/NOT gates) of an XOR gate to a NOR-only synthesis.
2. This problem uses the logic network shown in Figure P3.1 (p. 157).
    a. Draw the NAND-only synthesis of this logic network.
    b. If each gate in the NAND-only circuit is implemented as a CMOS gate, how many transistors are needed? For this calculation, INCLUDE the NAND gates implementing the NOT functions. Compare the transistor count with the count for the AND/OR/NOT implementation of Figure P3.1 from the Assignment 3 solutions.
3. Draw a NAND-only synthesis for the following logic function: $f(a,b,c,d) = b\bar{d}a + \bar{b} + \bar{c}d$
4. Draw a NOR-only synthesis for the following logic function: $g(a,b,c,d) = (\bar{a})(a+b+\bar{c})(c+\bar{d})$
5. Consider the solution to Problem 13 of Assignment 1. Note that this logic implementation is neither in SoP nor PoS form. Convert that implementation to use only NOR gates.
6. This problem again uses the logic network shown in Figure P3.1 (p. 157).
    a. Use a 3-input Karnaugh map to find the minimum-cost SoP logic expression for this CSoP logic network.
    b. Compare the cost of this minimum-cost synthesis to the cost of the CSOP synthesis given in Figure P3.1.
7. Use a 3-input K-map to find the minimum-cost SoP logic expression for the function $f = \Sigma\, m(1,3,5,6)$
8. Use a 4-input Karnaugh map to find the minimum-cost SoP logic expression for the CSoP logic expression/network given as the solution of Problem 10a/b of Assignment 2 (or equivalently, the truth table given as the solution to Problem 12 of Assignment 1). This is our simple security system that we have been working with since Assignment 1.

