

University of California at Berkeley
College of Engineering
Department of Electrical Engineering and Computer Science

EECS 150
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Problem Set # 3 (Assigned 1 February, Due 9 February)

1. Use the K-map method to minimize the following Boolean expressions in SoP form:
 - (a) $F(A,B,C) = \sum m(1,2,6,7)$
 - (b) $F(A,B,C,D) = \sum m(0,1,3,9,11,12,14,15)$
 - (c) $F'(A,B,C,D) = \sum m(2,4,5,6,7,8,10,13)$
 - (d) $F(A,B,C,D) = (A B C + A' B') (C + D)$
 - (e) $F(A,B,C,D) = (A' + B + C) (A + B + C' + D) (A + B' + C + D') (A' + B')$
2. Show how to implement the following Boolean functions using first NAND and Inverter gates only and then NOR and Inverter gates only :
 - (a) $F(A,B,Cin) = A B + B Cin + A Cin$ (e.g., the full adder carry out)
 - (b) $F(A,B,Cin) = A \oplus B \oplus Cin$ (e.g., the full adder sum)
 - (c) $F(A,B,C,D) = 1$ if the 2-bit binary quantity $A B$ is strictly less than the 2-bit binary quantity $C D$ in magnitude.
3. Draw a waveform diagram that shows the timing behavior of the debounce circuit of Lab 3 and use this diagram to explain its behavior.
4. Show how to implement the full adder $Sum(A, B, Cin)$ and $Carry(A, B, Cin)$ in terms of:
 - (a) Two 8:1 multiplexers;
 - (b) Two 4:1 multiplexers;
 - (c) If you are limited to 2:1 multiplexers (and inverters) only, how would you use them to implement the full adder and how many 2:1 multiplexers would you need?
 - (d) EXTRA CREDIT: It is possible to implement the Full Adder function with only 5 2:1 multiplexers. Do you see how?
5. Consider the functions of Problem 1, which are five different functions over the inputs A,B,C,D .
 - (a) If you were to implement these in a single PLA structure with four inputs, five outputs, and an unlimited number of product terms, how many unique product terms are there in your solution to Problem 1?
 - (b) If you are trying to maximize the number of shared product terms across the five functions, rather than minimizing the literal count for each function independently, how many unique terms do you obtain? Draw the new K-maps with your selection of implicants that minimizes the number of unique terms across all five functions.