Homework #2
CSE 140 – Summer Session 2 – 2017
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Only a subset of questions will be graded

1. Use K-maps to derive the minimal expression for the following functions. Note that “d” indicates a “don’t care” value.

Derive the minimal POS for the following:
   a. \( f(a,b,c) = \Sigma m(0,2) + \Sigma d(1,5) \)
   b. \( f(a,b,c,d) = \Pi M(1,3,8,9,12,14) + \Sigma d(11,13) \)

Derive the minimal SOP for the following:
   c. \( g(a,b,c) = \Pi M(5,6,7) + \Sigma d(2,4) \)
   d. \( g(a,b,c,d) = \Sigma m(0,2,4,7,10,13,15) + \Sigma d(5,6) \)

2. Given the following function:
   \( f(a,b,c) = \Pi M(3,4,5) + \Sigma d (2,7) \)

   a. List all prime implicates and implicants
   b. List essential prime implicates and implicants
   c. Derive all possible minimal POS (product of sum expressions)

3. A museum has four rooms, each with a motion sensor (m0, m1, m2 and m3) that outputs 1 when motion is detected. At night, the only person in the museum is one security guard who walks from room to room. Create a circuit that sounds an alarm (by setting an output A to 1) if motion is ever detected in more than one room at a time (i.e. in two or three rooms), meaning there must be one or more intruders in the museum

   a. Fill out the truth table
   b. Minimize the expression in POS form using Kmaps
   c. Draw circuit for minimum implementation obtained in part b

4. Given \( f(a, b, c, d) = \Sigma m(3, 4, 5, 10, 12, 14) + \Sigma d(1, 8) \):

   a. Derive a minimal expression for \( f \) with either SOP or POS form
   b. Implement the function using a minimal network of 2:1 multiplexers and minimum number of inverters. Do not use any other logic gate.

5. Implement the following functions using multiplexers. You can simplify the function using theorems whenever it is possible. If you do so, report the simplification steps.

   a. Implement \( F(a,b) = a'b + a'b' \) with a 2:1 MUX
   b. Implement \( H(a,b,c) = a'b'c + b'ca' \) with a 4:1 MUX

6. Use 2:4 decoders and a minimum number of other gates to output a 1 for any multiple (including 0) of 3 less than 16.
7. Analyze the following circuit and answer below.

a. Write the function for the following signals, in terms of the arguments specified between parentheses:

\[ \text{out}(r,x) = \ldots \]
\[ \text{x}(d,r) = \ldots \]
\[ \text{r}(z,c,y,b,d) = \ldots \]
\[ \text{z}(a) = \ldots \]
\[ \text{y}(a,b,d) = \ldots \]

b. Write the expression for the function \( \text{out}(a,b,c,d) \).

\[ \text{out}(a,b,c,d) = \ldots \]