Problem Set – 1

CS 230, Spring 2023

Questions

1. Which of the following are true regarding XOR ($\oplus$) operation if $A_1 \oplus A_2 \oplus A_3 = P$?
   a. $A_1 \oplus A_2 \oplus P = A_3$
   b. $A_2 \oplus A_3 \oplus P = A_1$
   c. $A_1 \oplus A_2 = A_3 \oplus P$
   d. $A_1 \oplus A_2 \oplus A_3 \oplus A_4 = P$

2. The minimum number of 2-input NOR gates required to implement the function is __

$$f = \bar{A} + \overline{\left[B + \bar{C}\left(\overline{AB + A\bar{C}}\right)\right]}$$

3. The minimum number of 2-input NOR gates required to implement a 4-variable function represented in the form of minterms as, $f = \sum(0,2,5,7,8,10,13,15)$ is?

4. Minimum how many 2-input NAND gates are required to implement the Boolean function $f = (A + C)(B + D)$?

5. A function f^d is said to be dual function of f if all the OR operations in f are changed to AND in f^d and all the AND operations are changed into OR respectively.
   f is an orthogonal function if dual of f and complement of f are same. $[f^d = f^c]$
   In a system of n literals, how many such orthogonal functions are possible?

6. If $M = \overline{XYZ + \bar{X}\bar{Y}} + YZ$ then dual and compliment of M are respectively,
   a. $(XYZ + \bar{X}\bar{Y}) \cdot (Y + Z)$ and $[(\overline{X + Y + Z}) + (\bar{X} + \bar{Y})] \cdot YZ$
   b. $[(X + Y + Z + \bar{X} \cdot \bar{Y})] \cdot \overline{YZ}$ and $[XYZ + (\overline{X + Y})] \cdot \overline{YZ}$
   c. $[(\overline{X + Y + Z}) + (\overline{\bar{X} + \bar{Y}})] \cdot (Y + Z)$ and $(XYZ + \bar{X}\bar{Y}) \cdot \overline{YZ}$
   d. $[\overline{XYZ} + \overline{\bar{X} + \bar{Y}}] \cdot \overline{YZ}$ and $[(X + Y + Z) + \overline{\bar{X} \cdot \bar{Y}}] \cdot YZ$

7. There exists a Boolean function $f(a, b, c, d)$ such that,

$$f(a, 0,0, d) = 1$$
$$f(1, b, 1, d) = b + d$$
$$f(a, 1, c, d) = ad + c$$

   How many literals are there in minimum SOP expression of f?

8. Consider the following K-map.

CD \ AB	00	01	11	10
00	1	1		1
01	X			
11	X			
10	1	1		X

Here X denotes “don’t care” term. Which means, the outcome of the function is not influenced by the value being 0 or 1. What is the minimal form of the function represented by above K-map?