Group Number:

NAMES (FIRST AND LAST NAME):

In-Class Assignment 1

ELEN 21/COEN 21 – Fall 2022
Instructor: Maria Kyrarini
Date: 10/4/2022
Time: 1 hour and 20 minutes
Number of Problems: 3

Important Notes:

- Be sure to read all the problems carefully and answer all questions.
- Be sure to answer all parts of each question.
- **Submit only one answer for each question.** Multiple solutions for one question will NOT be graded.
- **Clearly show all the steps of your work.**
- **Answers without detailed explanations will NOT be graded.**
- The Engineering School Honor Code applies.

Problem 1 (30 points)

Implement the following function using only 2-to-1 multiplexers and NOT gates:

$$f = \overline{w}_2 w_3 + \overline{w}_1 w_2 \overline{w}_3 + w_2 \overline{w}_3 w_4 + w_1 \overline{w}_2 \overline{w}_4$$

Note: AND, NAND, OR, NOR, XOR gates are not available.

Problem 2 (35 points)

For the logic function $f(w,x,y,z)=\prod M(1,7,12,13,14,15) \cdot d(0,2,8,10)$ (**Note:** the d represents the don't cares):

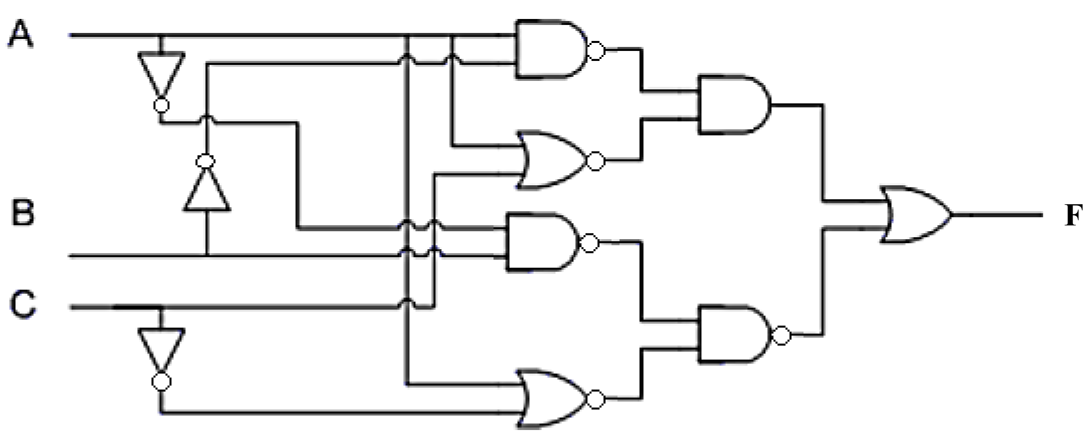
a) Show the truth table. [5 points]
b) Draw a completely labeled K-map. [5 points]
c) Write the algebraic expression for the minimized Sum of Products (SoP) and minimized Product of Sum (PoS) implementation of this function using the K-map. **Note:** Show the circles on the K-map. [10 points]
d) Write a Verilog program using structural code that implements the SoP. [5 points]

Problem 3 (35 points)

Simplify the following circuit by using Boolean Algebra properties. Assume that you have **only** 2-input and 3-input NAND gates. It is known that $\overline{x + y + z} = \bar{x} \cdot \bar{y} \cdot \bar{z}$. Draw the simplified circuit.

Note: NOT, AND, OR, NOR, XOR gates are not available.

Note: Simplification by K-maps will NOT be graded.



Boolean Algebra Properties

5a.	$x \cdot 0 = 0$
5b.	$x + 1 = 1$
6a.	$x \cdot 1 = x$
6b.	$x + 0 = x$
7a.	$x \cdot x = x$
7b.	$x + x = x$
8a.	$x \cdot \overline{x} = 0$
8b.	$x + \overline{x} = 1$
9.	$\overline{\overline{x}} = x$

10a.	$x \cdot y = y \cdot x$	*Commutative*
10b.	$x + y = y + x$	
11a.	$x \cdot (y \cdot z) = (x \cdot y) \cdot z$	*Associative*
11b.	$x + (y + z) = (x + y) + z$	
12a.	$x \cdot (y + z) = x \cdot y + x \cdot z$	*Distributive*
12b.	$x + y \cdot z = (x + y) \cdot (x + z)$	
13a.	$x + x \cdot y = x$	*Absorption*
13b.	$x \cdot (x + y) = x$	
14a.	$x \cdot y + x \cdot \overline{y} = x$	*Combining*
14b.	$(x + y) \cdot (x + \overline{y}) = x$	
15a.	$\overline{x \cdot y} = \overline{x} + \overline{y}$	*DeMorgan's theorem*
15b.	$\overline{x + y} = \overline{x} \cdot \overline{y}$	
16a.	$x + \overline{x} \cdot y = x + y$	
16b.	$x \cdot (\overline{x} + y) = x \cdot y$	
17a.	$x \cdot y + y \cdot z + \overline{x} \cdot z = x \cdot y + \overline{x} \cdot z$	*Consensus*
17b.	$(x + y) \cdot (y + z) \cdot (\overline{x} + z) = (x + y) \cdot (\overline{x} + z)$	