Group Number:

NAMES (FIRST AND LAST NAME):

In-Class Assignment 2

ELEN 21/COEN 21 – Fall 2022
Instructor: Maria Kyrarini
Date: 10/18/2022
Time: 1 hour and 30 minutes
Number of Problems: 4

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 and EXPLAIN all the steps of your work.**
- **Answers without detailed explanations will NOT be graded (excluding Problem 1).**
- The Engineering School Honor Code applies.

Problem 1 (20 points)

True/False questions – Circle the correct answer (**no explanation is needed**).

i. The decimal value of the following 2's complement number 10010011 is -115.	**True/False**
ii. Latch is an edge-sensitive device, while Flip-flop is a level-sensitive device.	**True/False**
iii. An arithmetic logic unit (ALU) is a digital circuit used to perform only arithmetic operations.	**True/False**
iv. A D-flip flop and a NOT gate are only needed to implement a T-flip flop.	**True/False**
v. We wrote our full names and our group number on page 1.	**True/False**

Problem 2 (40 points)

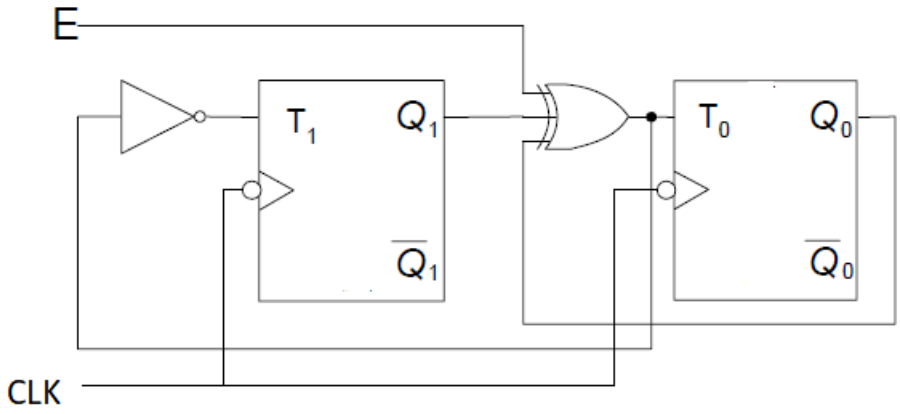
For the following sequential circuit, do the following:

(a) Write the truth table. [10 points]

(b) Redesign this circuit by replacing the T_1 Flip-Flop with negative edge D Flip-Flop, the T_0 Flip-Flop with negative edge JK Flip-Flop and a minimal AND-OR-NOT-XOR gate network. [20 points]

(c) Draw the circuit you have redesigned. [10 points]

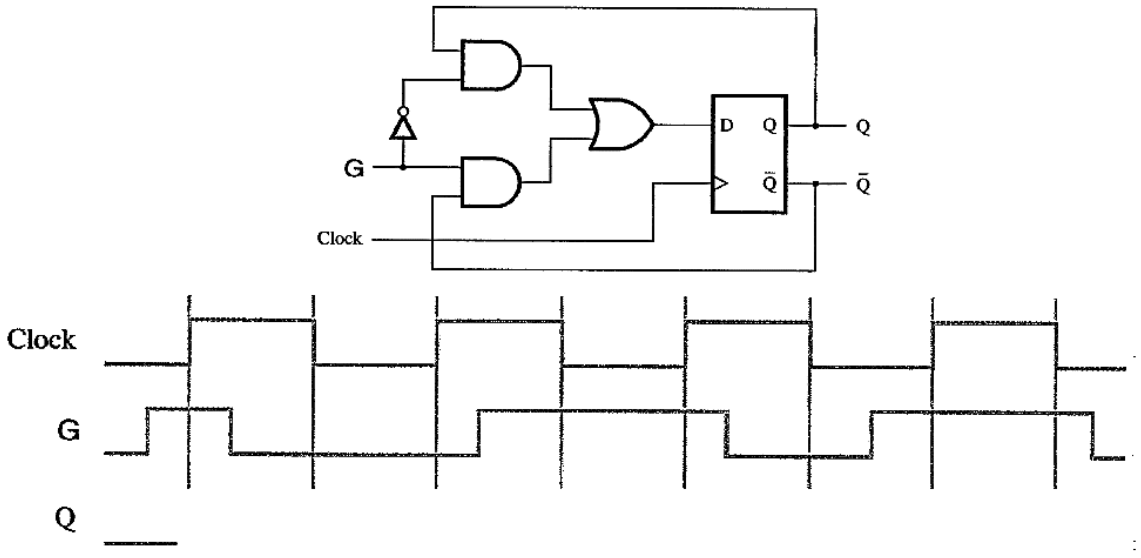
Reminder: $\overline{x \oplus y} = \bar{x} \cdot \bar{y} + x \cdot y$



Problem 3 (20 points)

a) Draw the timing diagram of the output Q of the following circuit. Consider that initially Q = 0. (15 pomts)

b) What circuit is this? (5 points)



Problem 4 (20 points)

The following two signed 2's complement numbers are given: A = 1001 0111 0101 and B = 1100 1001 0110.

(a) Subtract number A from number B and show the result. DO NOT use decimal equivalents. [10 points]

(b) Is the result correct? Explain your answer. [10 points]

Boolean Algebra Properties

5*a*.	$x \cdot 0 = 0$	
5*b*.	$x + 1 = 1$	
6*a*.	$x \cdot 1 = x$	
6*b*.	$x + 0 = x$	
7*a*.	$x \cdot x = x$	
7*b*.	$x + x = x$	
8*a*.	$x \cdot \overline{x} = 0$	
8*b*.	$x + \overline{x} = 1$	
9.	$\overline{\overline{x}} = x$	
10*a*.	$x \cdot y = y \cdot x$	*Commutative*
10*b*.	$x + y = y + x$	
11*a*.	$x \cdot (y \cdot z) = (x \cdot y) \cdot z$	*Associative*
11*b*.	$x + (y + z) = (x + y) + z$	
12*a*.	$x \cdot (y + z) = x \cdot y + x \cdot z$	*Distributive*
12*b*.	$x + y \cdot z = (x + y) \cdot (x + z)$	
13*a*.	$x + x \cdot y = x$	*Absorption*
13*b*.	$x \cdot (x + y) = x$	
14*a*.	$x \cdot y + x \cdot \overline{y} = x$	*Combining*
14*b*.	$(x + y) \cdot (x + \overline{y}) = x$	
15*a*.	$\overline{x \cdot y} = \overline{x} + \overline{y}$	*DeMorgan's theorem*
15*b*.	$\overline{x + y} = \overline{x} \cdot \overline{y}$	
16*a*.	$x + \overline{x} \cdot y = x + y$	
16*b*.	$x \cdot (\overline{x} + y) = x \cdot y$	
17*a*.	$x \cdot y + y \cdot z + \overline{x} \cdot z = x \cdot y + \overline{x} \cdot z$	*Consensus*
17*b*.	$(x + y) \cdot (y + z) \cdot (\overline{x} + z) = (x + y) \cdot (\overline{x} + z)$	