NAMES:

Group Number:

In-Class Assignment 4

ELEN 21/COEN 21 – Fall 2022
Instructor: Maria Kyrarini
Date: 11/29/2022
Time: 1 hour and 20 minutes
Number of pages: 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 explanation will not be graded.**
- The Engineering School Honor Code applies.

Problem 1 (35 points)

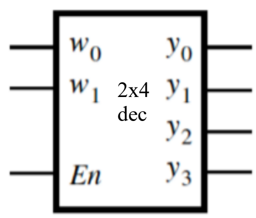
Implement the circuit that accepts two binary numbers A and B and performs the operation A^B using two 2-to-4 decoders with enable and a minimum network of OR, NOT, AND gates. The number A consists of 2 bits ($A = a_1a_0$) and B consists of 1 bit ($B = b_0$)

Reminder 1: $0^0 = 1$.

Reminder 2: Truth table and graphic symbol for 2-to-4 decoder with enable:

En	w_1	w_0	y_0	y_1	y_2	y_3
1	0	0	1	0	0	0
1	0	1	0	1	0	0
1	1	0	0	0	1	0
1	1	1	0	0	0	1
0	x	x	0	0	0	0

(a) Truth table



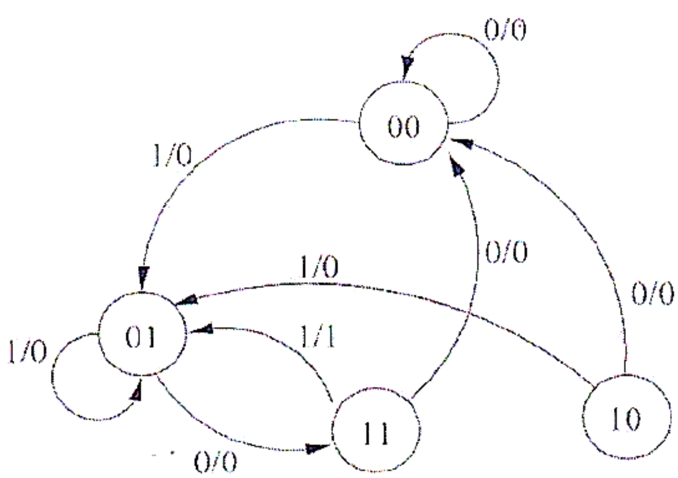
(b) Graphical symbol

Problem 2 (30 points)

A Mealy-style state machine has an input w and an output z. The machine is a sequence detector that produces z = 1 when it detects 1101; otherwise z = 0. Derive a circuit that realizes this state machine using one-hot encoding approach, T flip-flops and a network of AND-OR-NOT gates. **Note:** You do not need to draw the circuit – Show the Boolean expressions for the simplified circuit.

Problem 3 (35 points)

Consider the following state diagram for a circuit with one input X and one output Z. Draw the circuit implementation of this state diagram using JK positive-edge flip-flop (state Q_0), T positive-edge flip-flop (state Q_1), and a minimal AND-OR-NOT-XOR network. The states are in the form Q_1Q_0.



Boolean Algebra Properties

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