EECE 2160 – Embedded Design: Enabling Robotics

Homework #4

Assigned: Tues., Oct. 15, 2024. Due Tues., Oct. 22, at 11:59pm on Canvas

3 Problems 100 points total

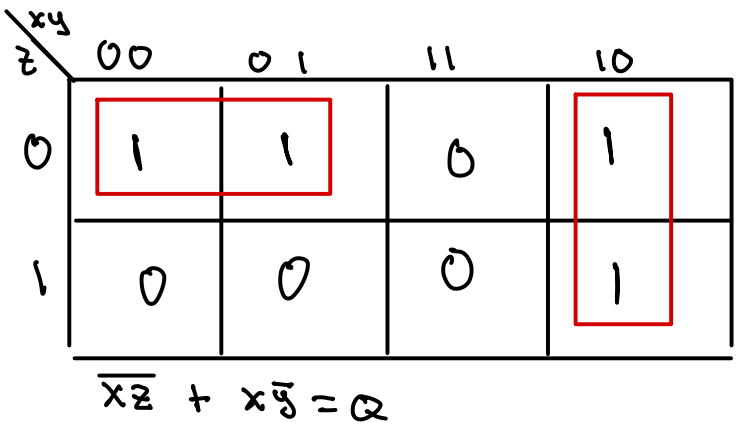
Show your work!

Problem 1 (20 points)

a. (15 points) Generate the simplified Boolean equation for this truth table using a Karnaugh Map.
b. (5 points) Draw the corresponding digital logic circuit.

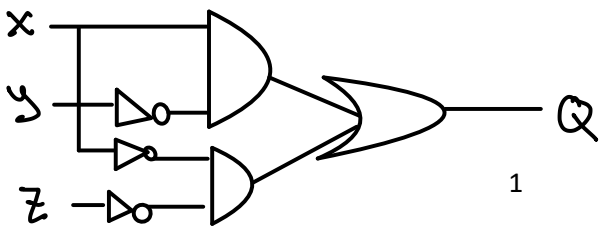
Inputs			Output
X	**Y**	**Z**	**Q**
0	0	0	1
0	0	1	0
0	1	0	1
0	1	1	0
1	0	0	1
1	0	1	1
1	1	0	0
1	1	1	0

A.



$\bar{x}\bar{z} + x\bar{y} = Q$

B.



Problem 2 (40 points total, 10 points each)

Design a combinational circuit with three inputs x, y, and z and three outputs A, B, and C. When the binary input is 0, 1, 2, or 3, the binary output is one greater than the input. When the binary input is 4, 5, 6, or 7, the binary output is two less than the binary input.

a. Draw the truth table for this circuit
b. Derive the Boolean equations using sum of products
c. Simplify the equations using the theorems and axioms of Boolean Algebra. State the theorems and axioms used.
d. Draw the circuit.

A.

	x	y	z	A	B	C	
0	0	0	0	0	0	1	1
1	0	0	1	0	1	0	2
2	0	1	0	0	1	1	3
3	0	1	1	1	0	0	4
4	1	0	0	0	1	0	2
5	1	0	1	0	1	1	3
6	1	1	0	1	0	0	4
7	1	1	1	1	0	1	5

B.

$A = 3 + 6 + 7$

$A = \bar{x}yz + xy\bar{z} + xyz$

$B = 1 + 2 + 4 + 5$

$B = \bar{x}\bar{y}z + \bar{x}y\bar{z} + x\bar{y}\bar{z} + x\bar{y}z$

$C = 0 + 2 + 5 + 7$

$C = \bar{x}\bar{y}\bar{z} + \bar{x}y\bar{z} + x\bar{y}z + xyz$

C.

$A = \bar{x}yz + xy\bar{z} + xyz$

$= y(\bar{x}z + x\bar{z} + xz)$ Distributive

$= y((\bar{x}+x)z + x\bar{z})$ Distributive

$= y(z(1) + x\bar{z})$ Complements

$= y(z + x)$ redundancy

$D = \bar{x}\bar{y}z + \bar{x}y\bar{z} + x\bar{y}\bar{z} + x\bar{y}z$

$= \bar{y}(\bar{x}z + x\bar{z} + xz) + \bar{x}y\bar{z}$ Distributive

$= \bar{y}(z(\bar{x}+x) + x\bar{z}) + \bar{x}y\bar{z}$ Distributive

$= \bar{y}(z(1) + x\bar{z}) + \bar{x}y\bar{z}$ Complements

$= \bar{y}(z + x\bar{z}) + \bar{x}y\bar{z}$ identity

$= \bar{x}y\bar{z} + \bar{y}z + x\bar{y}\bar{z}$ Distributive

$= \bar{z}(\bar{x}y + y\bar{x}) + \bar{y}z$ Distributive

$= \bar{z}(1) + \bar{y}z$ Complements

$= \bar{z} + \bar{y}z$ 1 identity

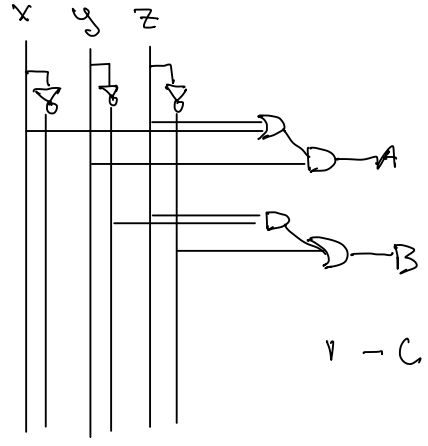
$C = \overline{xyz} + \bar{x}y\bar{z} + x\bar{y}z + xyz$

$= \bar{x}y\bar{z} + x\bar{y}z + 1$ Complements

$= 1 + 1$ Complements

$= 1$ 1 identity

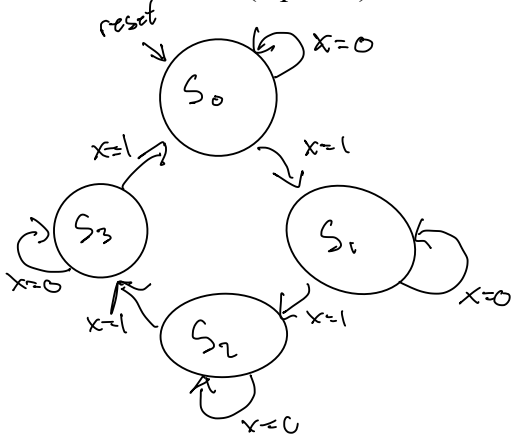
D.



Problem 3 (40 points)

Design a sequential circuit with one input x. When x = 0, the state of the circuit remains the same. When x = 1 the circuit goes through the state transitions from 00 to 11, to 01, to 10, back to 00 and repeats. The circuit is a Moore Machine.

a. (10 points) Draw the state transition diagram.
b. (10 points) Write the state transition table.
c. (5 points) Write the output table.
d. (5 points) Write the Boolean equations for the state transitions.
e. (5 points) Write the Boolean equations for the outputs.
f. (5 points) Draw the circuit.



No outputs

Current State	input	next state
S_0	0	S_0
S_1	0	S_1
S_2	0	S_2
S_3	0	S_3
S_0	1	S_1
S_1	1	S_2
S_2	1	S_3
S_3	1	S_0

encoding

$S_0 = 00$

$S_1 = 11$

$S_2 = 01$

$S_3 = 10$

S_1 S_2	I	S_1' S_2'
0 0	0	0 0
1 1	0	1 1
0 1	0	0 1
1 0	0	1 0
0 0	1	1 1
1 1	1	0 1
0 1	1	1 0
1 0	1	0 0

$S_1' = S_1 S_2 \bar{I} + S_1 \bar{S}_2 \bar{I} + \overline{S_1 S_2} I + \bar{S}_1 S_2 I$

$S_2' = S_1 S_2 \bar{I} + \bar{S}_1 S_2 \bar{I} + \overline{S_1 S_2} I + S_1 S_2 I$