EECE 2160 – Embedded Design, Enabling Robotics

Homework #2

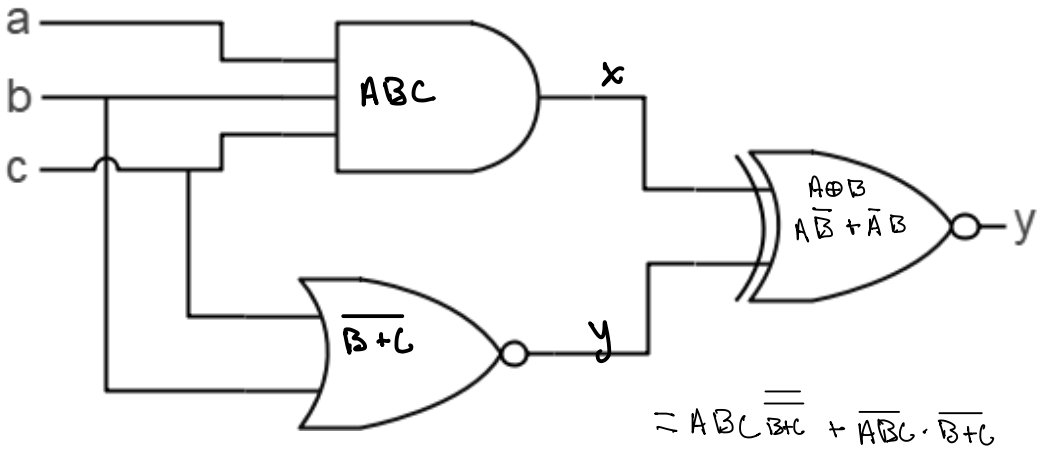
Assigned: Monday, Sept. 23, 2024. Due: Monday, Sept. 30 at 11:59pm on Canvas

5 Problems, 100 points Total

Problem 1. (20 points)

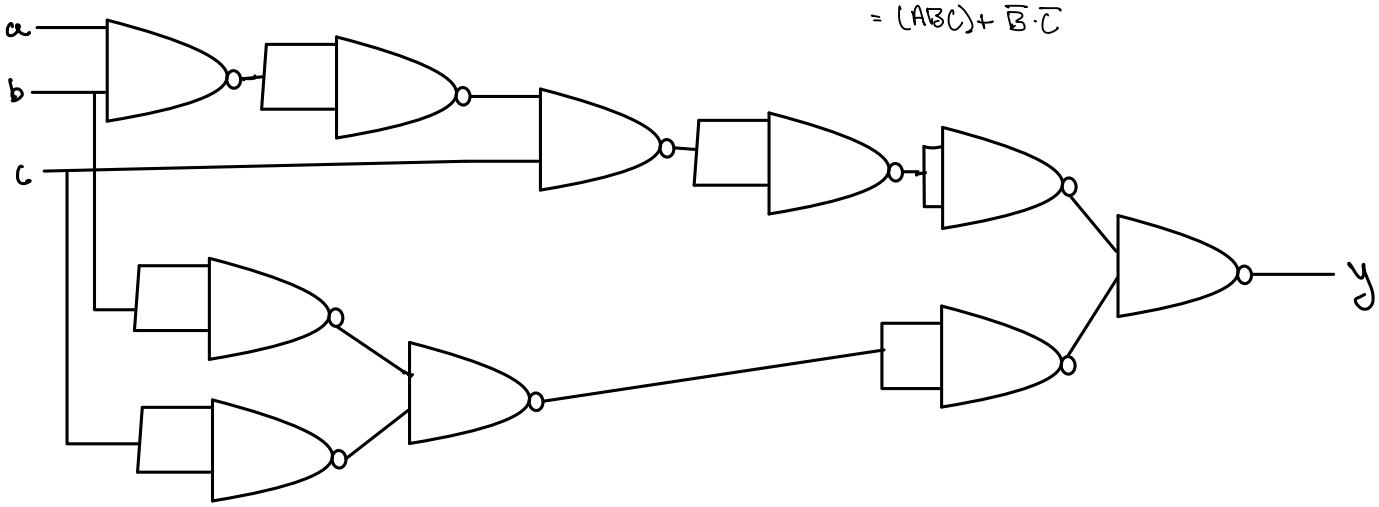
Redraw this circuit using only 2-input NAND gates. Draw neatly!!

See Lecture 3 slides 41 to 45.



$= ABC\overline{B+C} + \overline{ABC} \cdot \overline{B+C}$

$= (ABC) + \overline{B} \cdot \overline{C}$



$\left(\overline{\overline{AB} \cdot \overline{AB}) \cdot C} \cdot \overline{(\overline{AB} \cdot \overline{AB}) \cdot C}\right) \cdot \left(\overline{\overline{\overline{AB} \cdot \overline{AB}) \cdot C} \cdot \overline{(\overline{AB} \cdot \overline{AB}) \cdot C}}\right) \cdot \overline{\left(\overline{\overline{BB} \cdot \overline{u}}\right) \cdot \left(\overline{\overline{BB} \cdot \overline{u}}\right)}$

Problem 2. (20 points total, 5 points each)

Consider the following Truth Table:

Inputs			Output	
A	B	C	Y	
0	0	0	0	
0	0	1	1	$\bar{A}\bar{B}C$
0	1	0	0	
0	1	1	0	
1	0	0	0	
1	0	1	0	
1	1	0	1	$AB\bar{C}$
1	1	1	1	ABC

a. (5 points) Write the Boolean equation for this truth table in Sum of Products form.
b. (10 points) Minimize the Boolean equation using the axiom and theorems of Boolean Algebra. State the theorems and axioms used.
c. (5 points) Draw the digital circuit from the simplified equation.

A.

$$y = \bar{A}\bar{B}C + AB\bar{C} + ABC$$

B.

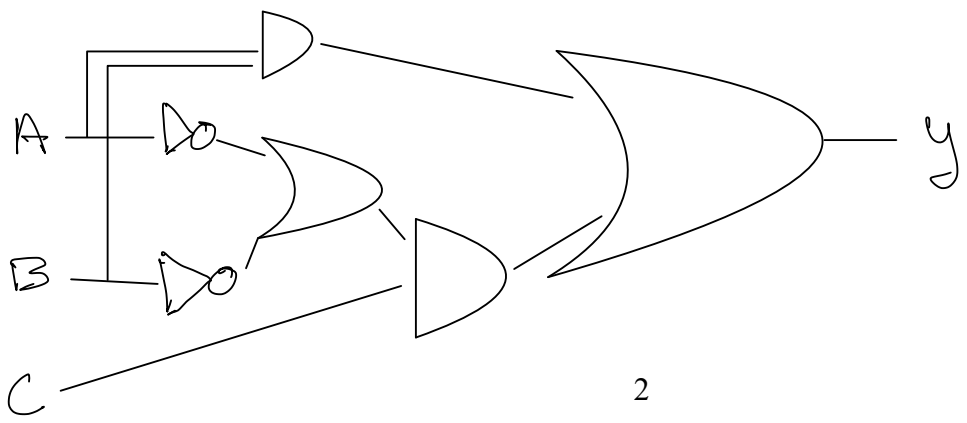
$$y = \bar{A}\bar{B}C + AB\bar{C} + ABC$$

$$= (\bar{A}+\bar{B})C + AB\bar{C} + ABC \quad \text{de morgan}$$

$$= (\bar{A}+\bar{B})C + AB(\bar{C}+C) \quad \text{Distributive}$$

$$= (\bar{A}+\bar{B})C + AB \quad \text{Complement}$$

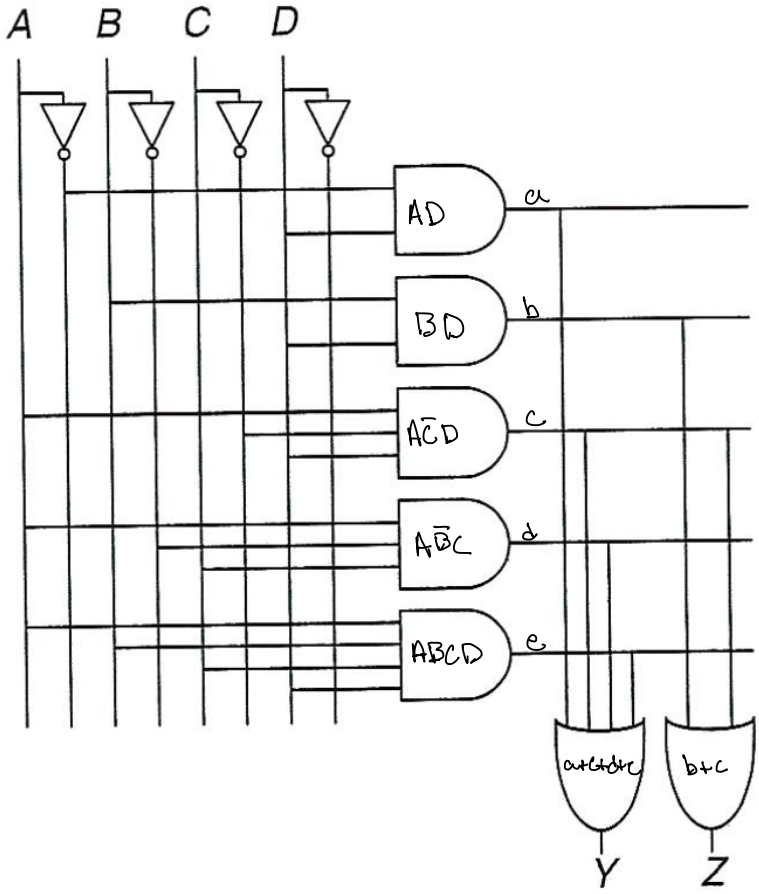
C.



Problem 3. (20 points total)

Write the Boolean equations (note plural) for the circuit shown below. No need to simplify.

Hint: Think Sum of Products.



$y = a + c + d + e$

$= AD + A\bar{C}D + A\bar{B}C + ABC$

$z = b + c$

$= BD + A\bar{C}D$

Problem 4. (30 points)

Consider this truth table:

Inputs			Output	
X	Y	Z	F	
0	0	0	1	$\bar{x}\bar{y}\bar{z}$
0	0	1	1	$\bar{x}\bar{y}z$
0	1	0	0	
0	1	1	0	
1	0	0	1	$x\bar{y}\bar{z}$
1	0	1	1	$x\bar{y}z$
1	1	0	0	
1	1	1	0	

a. (5 points) Write the Boolean equation from the truth table using the sum of products method.

b. (10 points) Simplify the equation using the Theorems and Axioms of Boolean algebra. State the theorems and axioms used.

c. (10 points) Write the Boolean equation from the truth table using a Karnaugh map.

d. (5 points) Do the equations from parts b and c agree? If not, then can you transform one of the equations into the other?

A. $F = \bar{x}\bar{y}\bar{z} + \bar{x}\bar{y}z + x\bar{y}\bar{z} + x\bar{y}z$

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

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

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

$= \bar{y}\bar{z} + x\bar{y}z$ null element

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

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

$= \bar{y}$ null element

C.

F

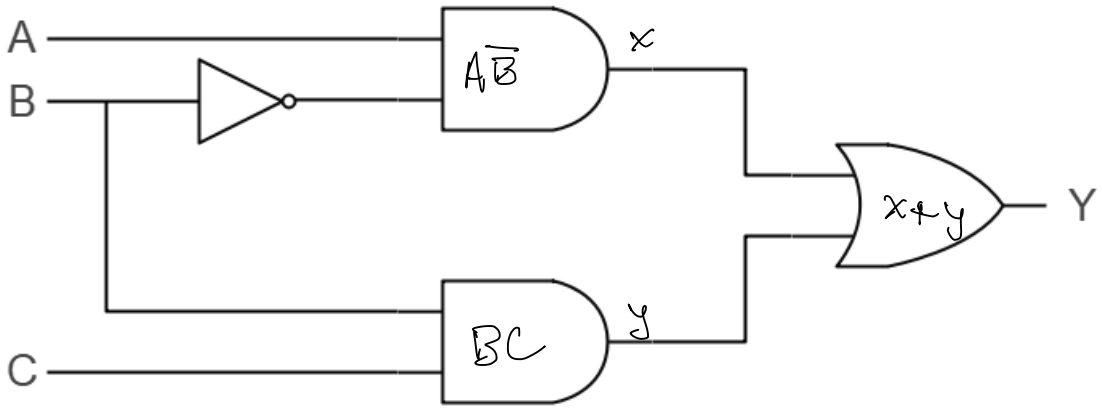
x \ yz	00	01	11	10
0	1	1	0	0
1	1	1	0	0

$= \bar{y}$

D. The equations agree.

Problem 5. (10 points total, 5 points each)

a. Write the Boolean equation for the circuit shown below. No need to simplify.



$A\overline{B} + BC$

b. Rename the inputs and outputs as follows:

A = D0

C = D1

B = Select

Y = Out

$(D0 \cdot \overline{Select}) + (Select \cdot D1)$

What is the name of this circuit? It is a widely used combinational circuit (see Lecture 6).

Its a 2-to multiplexer