

Solution to Midterm #2

General Information

- Date: Sunday, December 2nd, 2018
- Duration: 60 minutes
- Total marks: 20

Instructions and Guidelines

- No books or notes are permitted.
- Computer usage is prohibited.
- Cell phones must be turned off.
- Calculators are not allowed.
- Try to answer all questions.
- Write down your answers neatly in this booklet.
- To earn partial marks, justify your answers.
- If you need extra paper, request some from a proctor.

Grading

Question	Q1	Q2	Q3	Q4	Q5	Total
Points	$\overline{4}$	$\overline{3}$	$\overline{5}$	$\overline{3}$	$\overline{5}$	$\overline{20}$

Student Name:

ID Number:

Q1**[4 Points]**

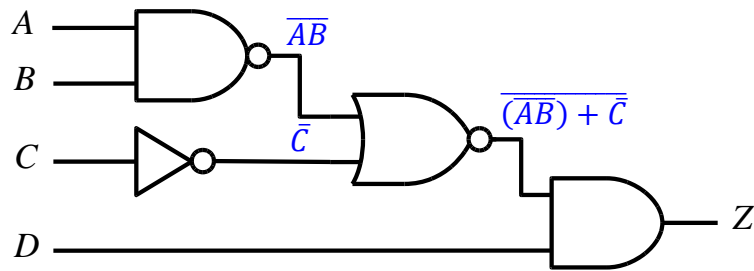
Simplify the following expression using Boolean algebra. Justify each step in your solution by referring to the Boolean rule or law or theorem you use.

$$Z = (B + \bar{B}C)(\overline{A\bar{B}}) + AC + \bar{B}\bar{C}$$

$$\begin{aligned} Z &= (B + \bar{B}C)(\overline{A\bar{B}}) + AC + \bar{B}\bar{C} \\ &= (B + C)(\overline{A\bar{B}}) + AC + \bar{B}\bar{C} && [\text{R11}] \\ &= (B + C)(\bar{A} + \bar{\bar{B}}) + AC + \bar{B}\bar{C} && [\text{DM Theorem}] \\ &= (B + C)(\bar{A} + B) + AC + \bar{B}\bar{C} && [\text{R9}] \\ &= B + \bar{A}C + AC + \bar{B}\bar{C} && [\text{R12}] \\ &= B + (\bar{A} + A)C + \bar{B}\bar{C} && [\text{Dist. Law}] \\ &= B + 1.C + \bar{B}\bar{C} && [\text{R6}] \\ &= B + C + \bar{B}\bar{C} && [\text{R4}] \\ &= B + C + \bar{B} && [\text{R11}] \\ &= 1 + C && [\text{R6}] \\ &= 1 && [\text{R2}] \end{aligned}$$

Q2**[3 Points]**

Write a Boolean expression for the output of the following circuit (Z) and then simplify that expression using Boolean algebra.



$$Z = \overline{(\overline{AB}) + \bar{C}} D$$

$$= \overline{\overline{AB} \bar{C}} D$$

$$= (ABC) D$$

$$= ABCD$$

Q3**[5 Points]**

Given below two copies of a Karnaugh map that describes a Boolean variable Z .

a. Construct a minimum SOP expression for Z .

CD	00	01	11	10
AB				
00	0	X	0	0
01	X	1	1	0
11	X	1	1	1
10	1	0	1	1

$$Z = BD + AC + A\bar{D}$$

b. Construct a minimum POS expression for Z .

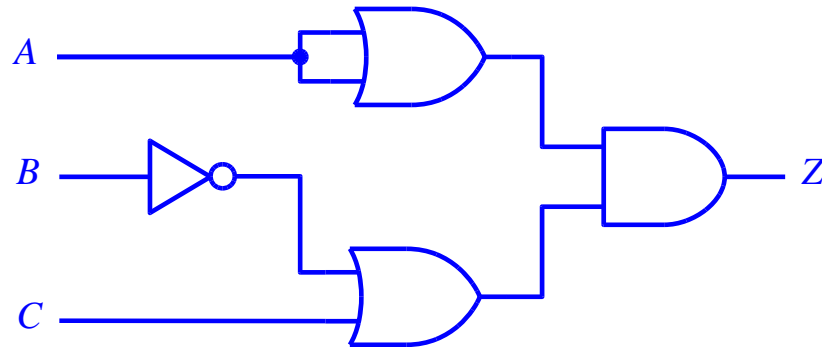
CD	00	01	11	10
AB				
00	0	X	0	0
01	X	1	1	0
11	X	1	1	1
10	1	0	1	1

$$Z = (A + B)(A + D)(B + C + \bar{D})$$

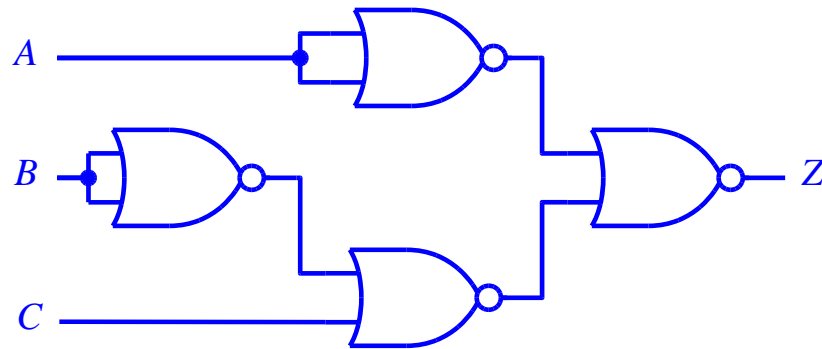
Q4**[3 Points]**

Implement the following Boolean expression using NOR gates: $Z = A(\bar{B} + C)$.

Step 1: Starting with the AND-OR implementation:

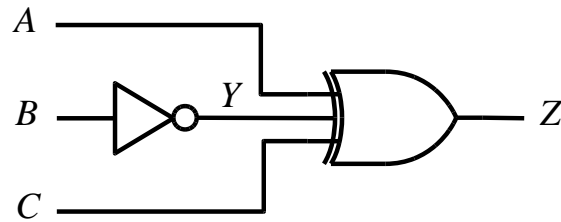


Step 2: Converting every NOT/AND/OR gate to NOR gate:



Q5**[5 Points]**

Given the following logic circuit:



a. Fill up the truth table of Y and Z .

Inputs			Outputs	
A	B	C	Y	Z
0	0	0	1	1
0	0	1	1	0
0	1	0	0	0
0	1	1	0	1
1	0	0	1	0
1	0	1	1	1
1	1	0	0	1
1	1	1	0	0

b. Draw the waveforms of Y and Z .

