Name: Diong Chen Xi
Student ID: 32722656
Class Number: FIT1047
Tutor Name: Dr. Tan Chee Keong

Assignment 01

Truth table given in the Student ID Generated PDF

X1	X2	X3	X4	Z1	Z2
0	0	0	0	1	0
0	0	0	1	1	0
0	0	1	0	0	1
0	0	1	1	1	1
0	1	0	0	1	0
0	1	0	1	1	1
0	1	1	0	0	0
0	1	1	1	1	1
1	0	0	0	0	1
1	0	0	1	1	1
1	0	1	0	1	0
1	0	1	1	0	1
1	1	0	0	1	1
1	1	0	1	0	1
1	1	1	0	1	0
1	1	1	1	0	1

Answer 1.1:

From the truth table, I analysed the matchups for X1, X2, X3 and X4 which result in "1" for Z1 and Z2 outputs respectively.(For example, when X1 = 0, X2 = 0, X3 = 0, X4 = 0, Z1 = 1, therefore $\overline{X1}\ \overline{X2}\,\overline{X3}\,\overline{X4}$ is included) Then I recorded the matchups in Sum of Products (SOP) notation.

Z1(X1,X2,X3,X4) = $\overline{X1}\ \overline{X2}\,\overline{X3}\,\overline{X4}$ + $\overline{X1}\,\overline{X2}\,\overline{X3}$ X4 + $\overline{X1}\,\overline{X2}$ X3 X4 + $\overline{X1}$ X2 $\overline{X3}\,\overline{X4}$ + $\overline{X1}$ X2 $\overline{X3}$ X4 + $\overline{X1}\,X2$ X3 X4 + X1 $\overline{X2}\,\overline{X3}\,X4$ + X1 $\overline{X2}\,X3\,\overline{X4}$ + X1 X2 $\overline{X3}\,\overline{X4}$ + X1 X2 X3 $\overline{X4}$

Z2(X1,X2,X3,X4) = $\overline{X1}\ \overline{X2}$ X3 $\overline{X4}$ + $\overline{X1}\,\overline{X2}$ X3 X4 + $\overline{X1}$ X2 $\overline{X3}$ X4 + $\overline{X1}$ X2 X3 X4 + X1 $\overline{X2}\,\overline{X3}\,\overline{X4}$ + $X1\,\overline{X2}\,\overline{X3}$ X4 + X1 $\overline{X2}\,X3\,X4$ + X1 X2 $\overline{X3}\,\overline{X4}$ + X1 X2 $\overline{X3}\,X4$ + X1 X2 X3 X4

Answer 1.2:

From the Boolean expression, I constructed AND gates using the products respectively, as only those specific inputs of X1, X2, X3 and X4 result in a "1" for Z1 and Z2. After laying out all the "1" input assemblies, I use OR gates to show the results of Z1 and Z2 respectively. The inputs for $\overline{X1}\ \overline{X2}\,\overline{X3}$ and $\overline{X4}$ were constructed using NOT gates.

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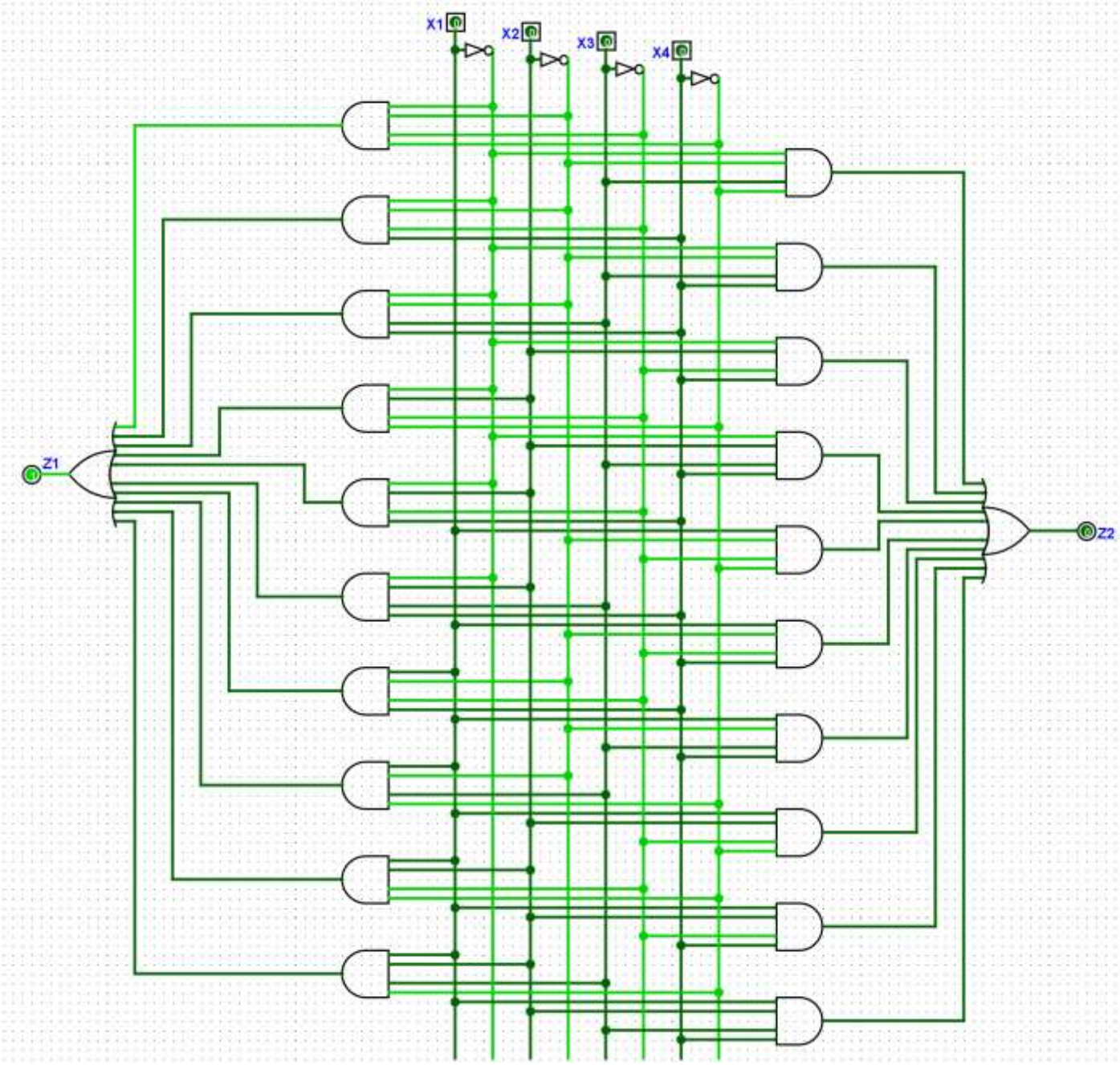
Circuit of Z1 and Z2

Input: X1 = 0, X2 = 0, X3 = 0, X4 = 0 Output: Z1 = 1, Z2 = 0



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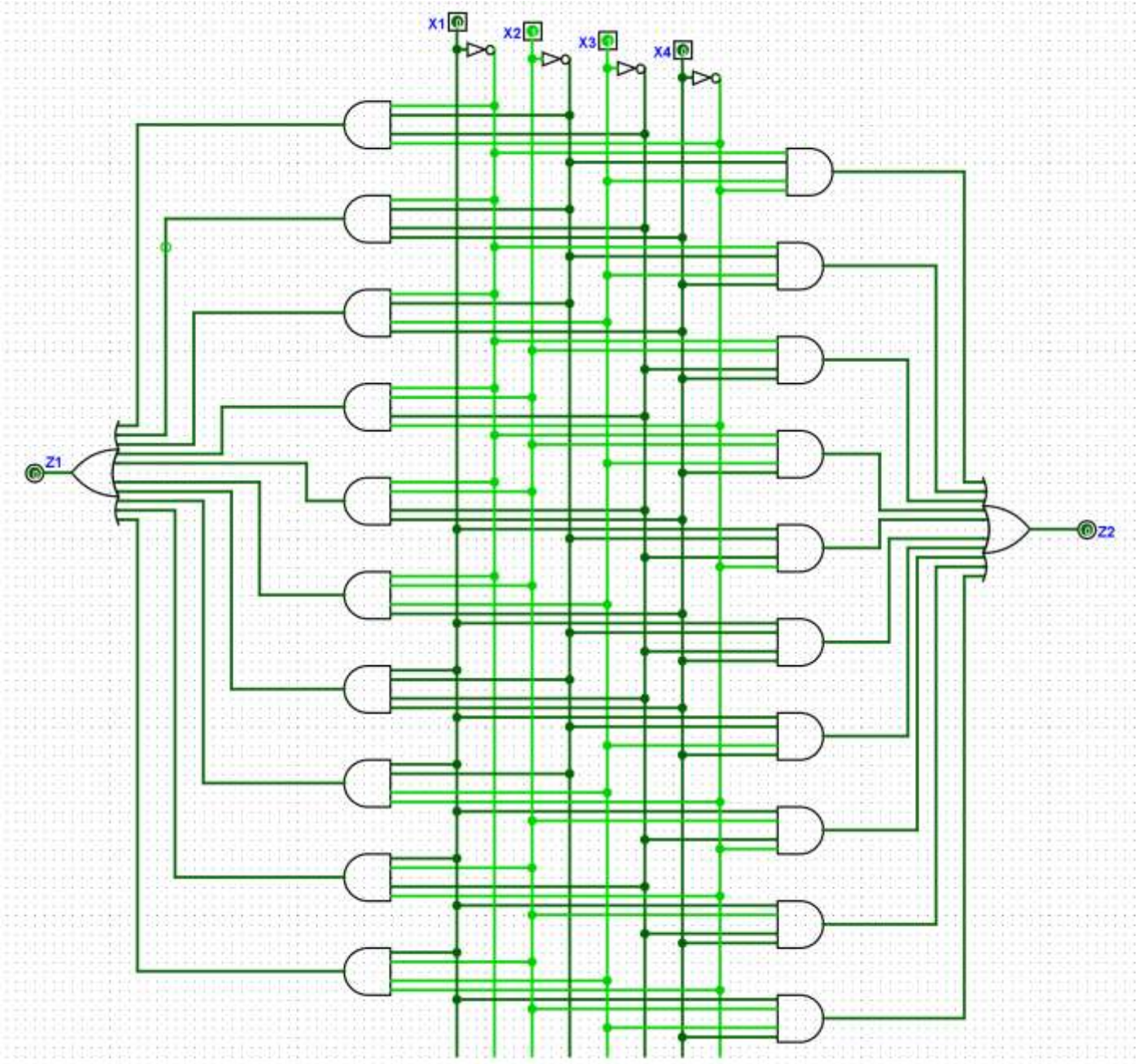
Input: X1 = 0, X2 = 1, X3 = 1, X4 = 0 Output: Z1 = 0, Z2 = 0



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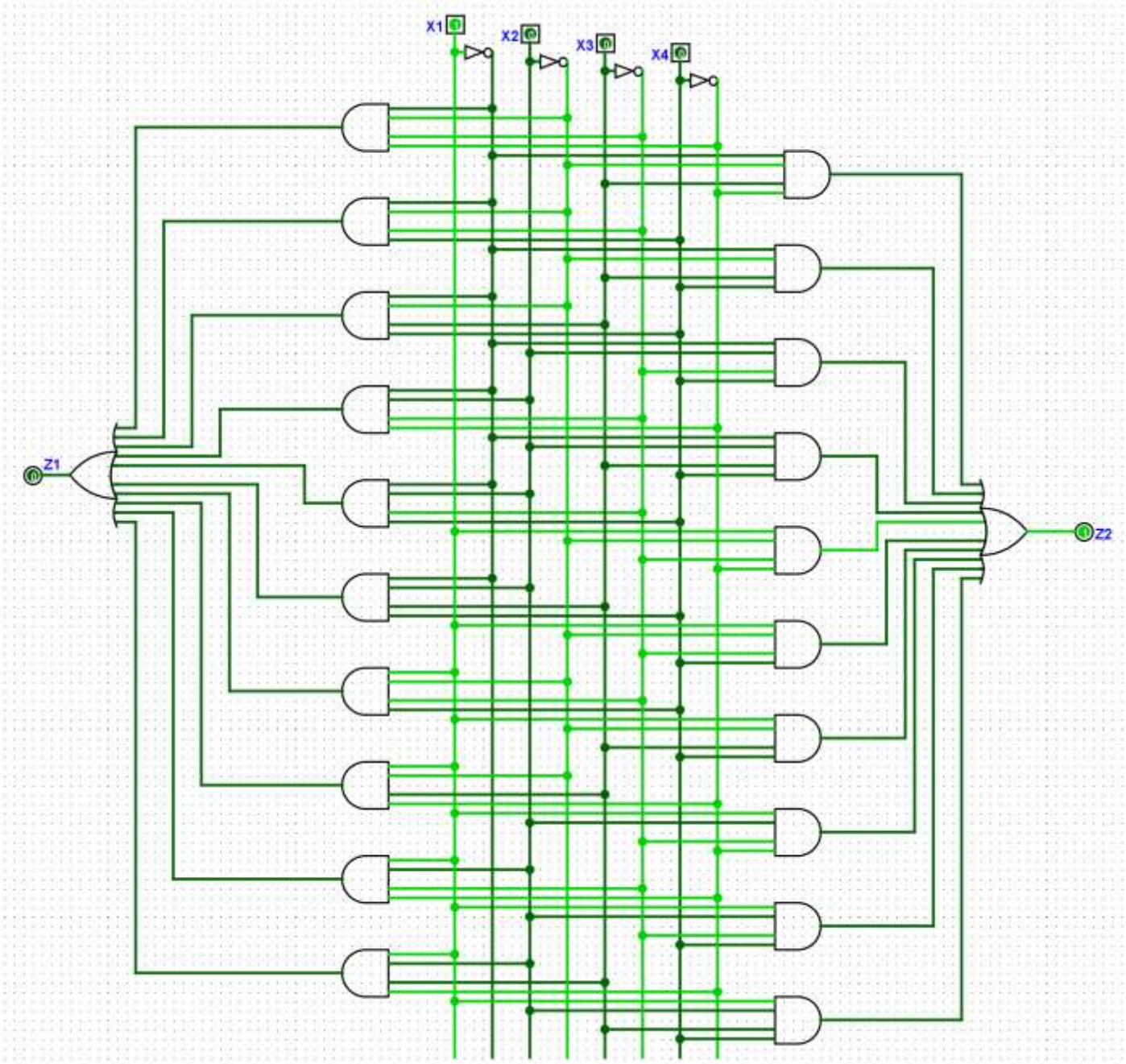
Input: X1 = 1, X2 = 0, X3 = 0, X4 = 0 Output: Z1 = 0, Z2 = 1



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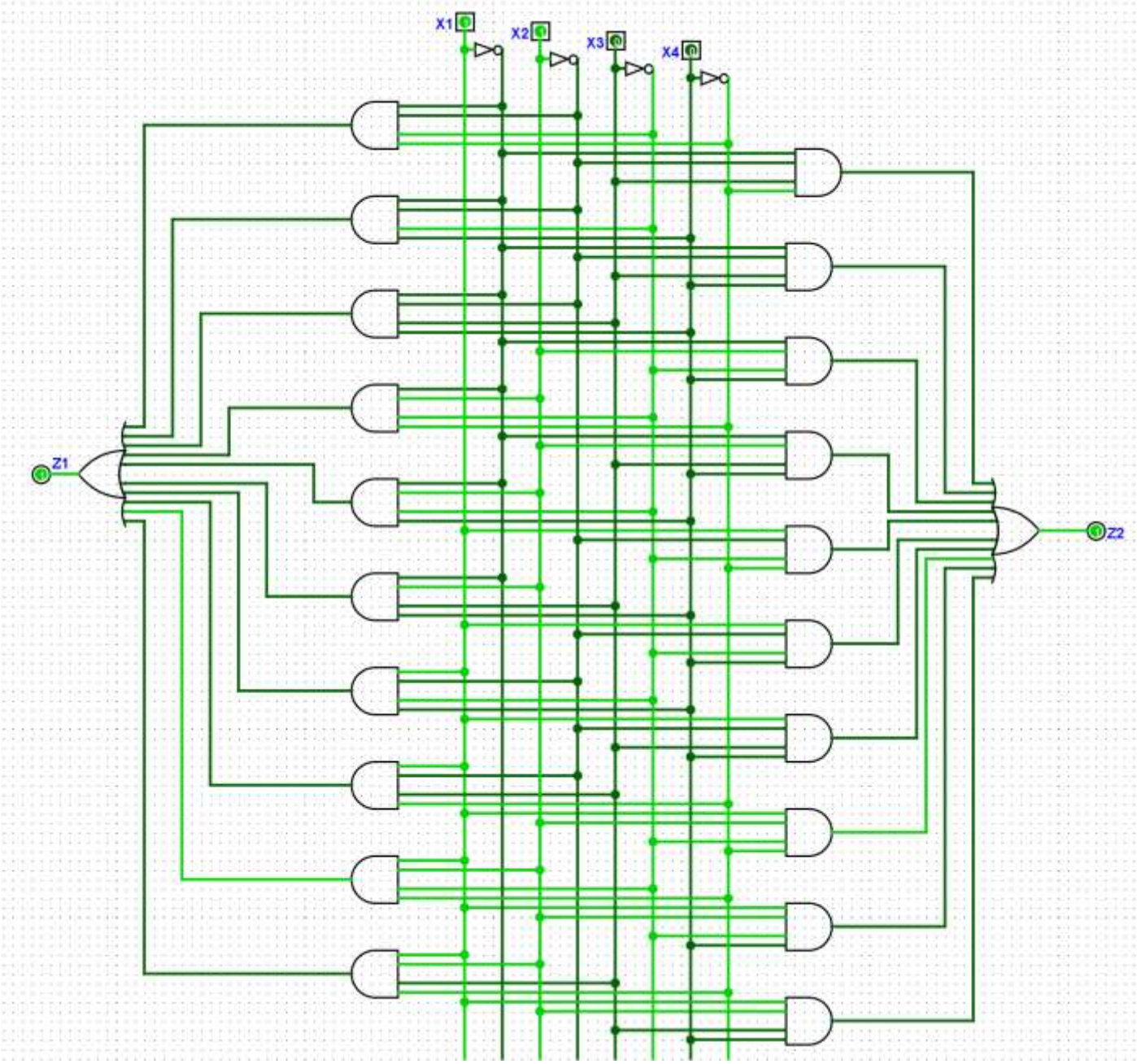
Input: X1 = 1, X2 = 1, X3 = 0, X4 = 0 Output: Z1 = 1, Z2 = 1



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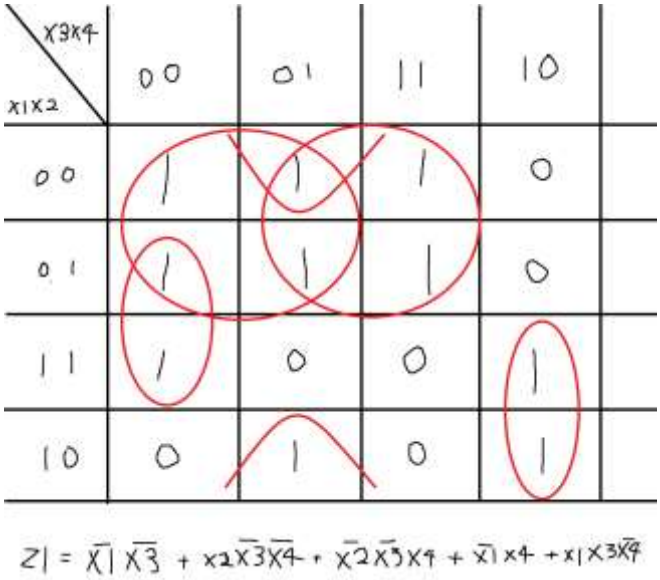
Answer 1.3:

Z1 Subtask1 Karnaugh Map simplification



Z1 Subtask2 Boolean Identities simplification

Z1 = $\overline{X1}$ $\overline{X2}$ $\overline{X3}$ $\overline{X4}$ + $\overline{X1}$ $\overline{X2}$ $\overline{X3}$ X4 + $\overline{X1}$ $\overline{X2}$ X3 X4 + $\overline{X1}$ X2 $\overline{X3}$ $\overline{X4}$ + $\overline{X1}$ X2 $\overline{X3}$ X4 + $\overline{X1}$ X2 X3 X4 + X1 $\overline{X2}$ $\overline{X3}$ X4 + X1 $\overline{X2}$ X3 $\overline{X4}$ + X1 X2 $\overline{X3}$ $\overline{X4}$ + X1 X2 X3 $\overline{X4}$

= $\overline{X1}$ $\overline{X2}$ $\overline{X3}$ $\overline{X4}$ + ($\overline{X1}$ $\overline{X2}$ $\overline{X3}$ X4 + $\overline{X1}$ $\overline{X2}$ $\overline{X3}$ X4)+ $\overline{X1}$ $\overline{X2}$ X3 X4 + ($\overline{X1}$ X2 $\overline{X3}$ $\overline{X4}$ + $\overline{X1}$ X2 $\overline{X3}$ $\overline{X4}$) + $\overline{X1}$ X2 $\overline{X3}$ X4 + $\overline{X1}$ X2 X3 X4 + X1 $\overline{X2}$ $\overline{X3}$ X4 + X1 $\overline{X2}$ X3 $\overline{X4}$ + X1 X2 $\overline{X3}$ $\overline{X4}$ + X1 X2 X3 $\overline{X4}$ **[Idempotent OR]**

= ($\overline{X1}$ $\overline{X2}$ $\overline{X3}$ $\overline{X4}$ + $\overline{X1}$ $\overline{X2}$ $\overline{X3}$ X4) + ($\overline{X1}$ $\overline{X2}$ $\overline{X3}$ X4 + X1 $\overline{X2}$ $\overline{X3}$ X4) + ($\overline{X1}$ $\overline{X2}$ X3 X4 + $\overline{X1}$ X2 X3 X4) + ($\overline{X1}$ X2 $\overline{X3}$ $\overline{X4}$ + $\overline{X1}$ X2 $\overline{X3}$ X4) + ($\overline{X1}$ X2 $\overline{X3}$ $\overline{X4}$ + X1 X2 $\overline{X3}$ $\overline{X4}$) + (X1 $\overline{X2}$ X3 $\overline{X4}$ + X1 X2 X3 $\overline{X4}$) **[Associative OR]**

= $\overline{X1}$ $\overline{X2}$ $\overline{X3}$ + $\overline{X2}$ $\overline{X3}$ X4 + $\overline{X1}$ X3 X4 + $\overline{X1}$ X2 $\overline{X3}$ + X2 $\overline{X3}$ $\overline{X4}$ + X1 X3 $\overline{X4}$ **[Inverse OR]**

= ($\overline{X1}$ $\overline{X2}$ $\overline{X3}$ + $\overline{X1}$ X2 $\overline{X3}$) + $\overline{X1}$ X3 X4 + X1 X3 $\overline{X4}$ + $\overline{X2}$ $\overline{X3}$ X4 + X2 $\overline{X3}$ $\overline{X4}$ **[Associative OR]**

= $\overline{X1}$ $\overline{X3}$ + $\overline{X1}$ X3 X4 + X1 X3 $\overline{X4}$ + $\overline{X2}$ $\overline{X3}$ X4 + X2 $\overline{X3}$ $\overline{X4}$ **[Inverse OR]**

By comparing the results of the K-map method and the Boolean Identities method, I found out that both of the optimised Boolean Function have equal amount of terms. The terms are also similar in grouping.

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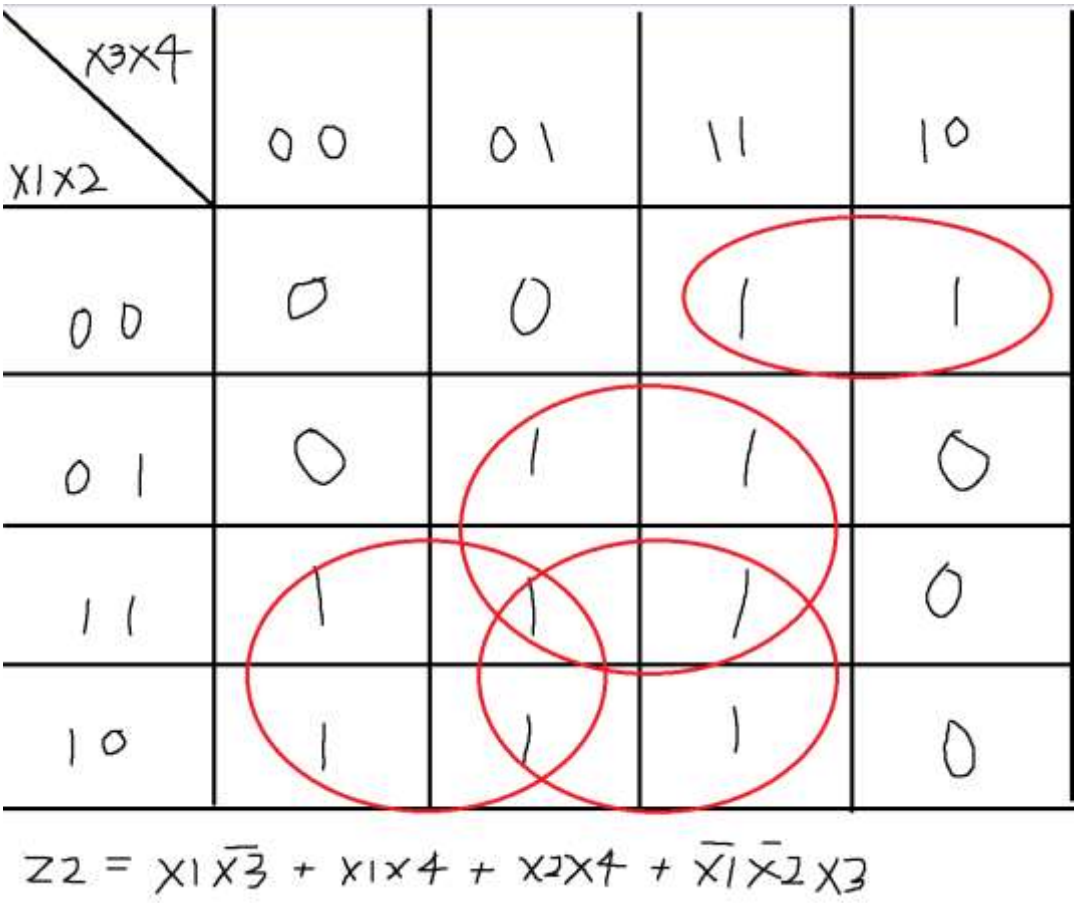
Z2 Subtask1 Karnaugh Map simplification



Z2 Subtask2 Boolean Identities simplification

Z2 = $\overline{X1}\ \overline{X2}$ X3 $\overline{X4}$ + $\overline{X1}$ $\overline{X2}$ X3 X4 + $\overline{X1}$ X2 $\overline{X3}$ X4 + $\overline{X1}$ X2 X3 X4 + X1 $\overline{X2}$ $\overline{X3}$ $\overline{X4}$ + $X1$ $\overline{X2}$ $\overline{X3}$ X4 + X1 $\overline{X2}$ $X3$ $X4$ + X1 X2 $\overline{X3}$ $\overline{X4}$ + X1 X2 $\overline{X3}$ $X4$ + X1 X2 X3 X4

= $\overline{X1}\ \overline{X2}$ X3 $\overline{X4}$ + $\overline{X1}$ $\overline{X2}$ X3 X4 + $\overline{X1}$ X2 $\overline{X3}$ X4 + $\overline{X1}$ X2 X3 X4 + X1 $\overline{X2}$ $\overline{X3}$ $\overline{X4}$ + ($X1$ $\overline{X2}$ $\overline{X3}$ X4 + $X1$ $\overline{X2}$ $\overline{X3}$ X4) + X1 $\overline{X2}$ $X3$ $X4$ + X1 X2 $\overline{X3}$ $\overline{X4}$ + (X1 X2 $\overline{X3}$ $X4$ + X1 X2 $\overline{X3}$ $X4$) + X1 X2 X3 X4
[Idempotent OR]

= ($\overline{X1}\ \overline{X2}$ X3 $\overline{X4}$ + $\overline{X1}$ $\overline{X2}$ X3 X4) + ($\overline{X1}$ X2 $\overline{X3}$ X4 + $\overline{X1}$ X2 X3 X4) + (X1 $\overline{X2}$ $\overline{X3}$ $\overline{X4}$ + $X1$ $\overline{X2}$ $\overline{X3}$ X4) + ($X1$ $\overline{X2}$ $\overline{X3}$ X4 + X1 $\overline{X2}$ $X3$ $X4$) + (X1 X2 $\overline{X3}$ $\overline{X4}$ + X1 X2 $\overline{X3}$ $X4$) + (X1 X2 $\overline{X3}$ $X4$ + X1 X2 X3 X4)
[Associative OR]

= $\overline{X1}\ \overline{X2}$ X3 + $\overline{X1}$ X2 X4 + X1 $\overline{X2}$ $\overline{X3}$ + $X1$ $\overline{X2}$ X4 + X1 X2 $\overline{X3}$ + X1 X2 $X4$ **[Inverse OR]**

= $\overline{X1}\ \overline{X2}$ X3 + $\overline{X1}$ X2 X4 + X1 $\overline{X2}$ $\overline{X3}$ + $X1$ $\overline{X2}$ X4 + X1 X2 $\overline{X3}$ + (X1 X2 $X4$ + X1 X2 $X4$) **[Idempotent OR]**

= $\overline{X1}\ \overline{X2}$ X3 + ($\overline{X1}$ X2 X4 + X1 X2 $X4$) + (X1 $\overline{X2}$ $\overline{X3}$ + X1 X2 $\overline{X3}$) + ($X1$ $\overline{X2}$ X4 + X1 X2 $X4$) **[Associative OR]**

= $\overline{X1}\ \overline{X2}$ X3 + X2 X4 + X1 $\overline{X3}$ + X1 $X4$ **[Inverse OR]**

By comparing the results of the K-map method and the Boolean Identities method, I found out that both of the optimised Boolean Function have equal amount of terms. The terms are identical in this case.

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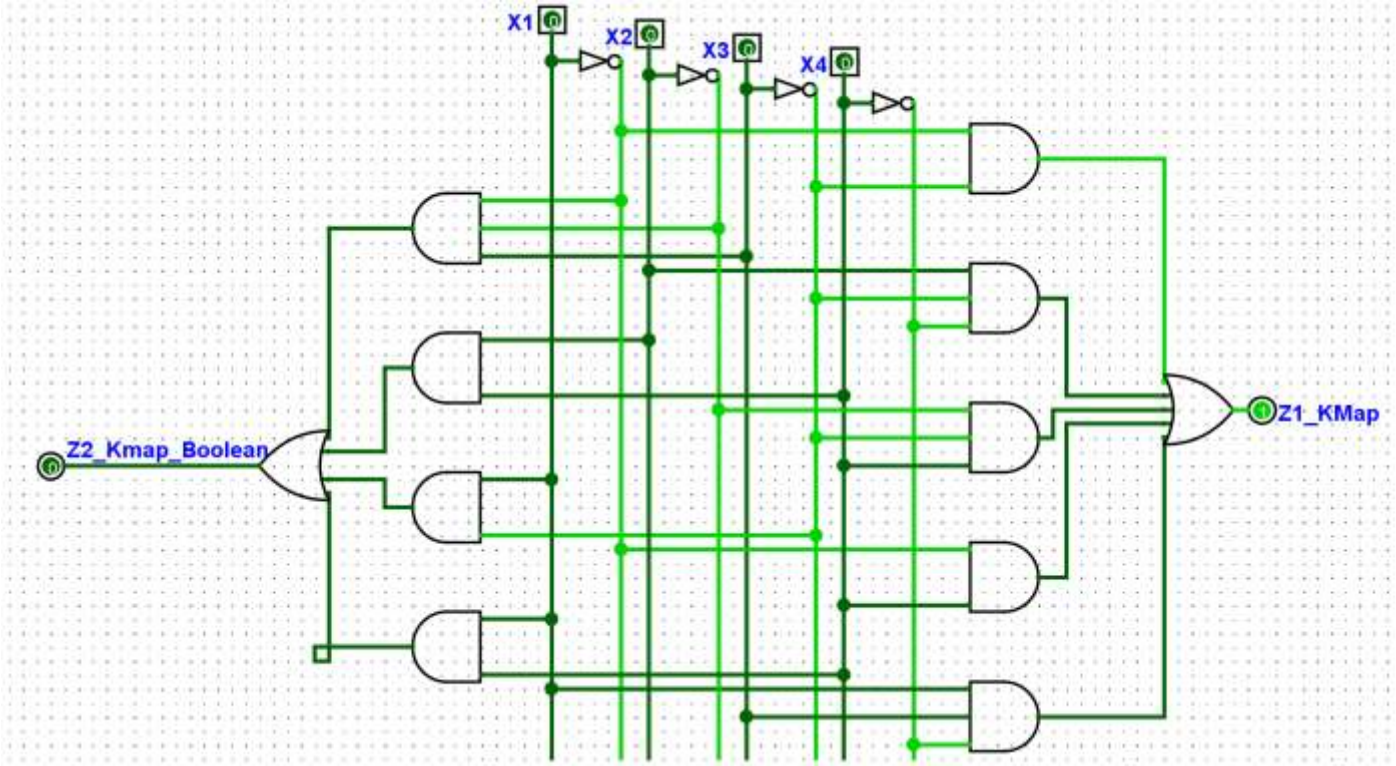
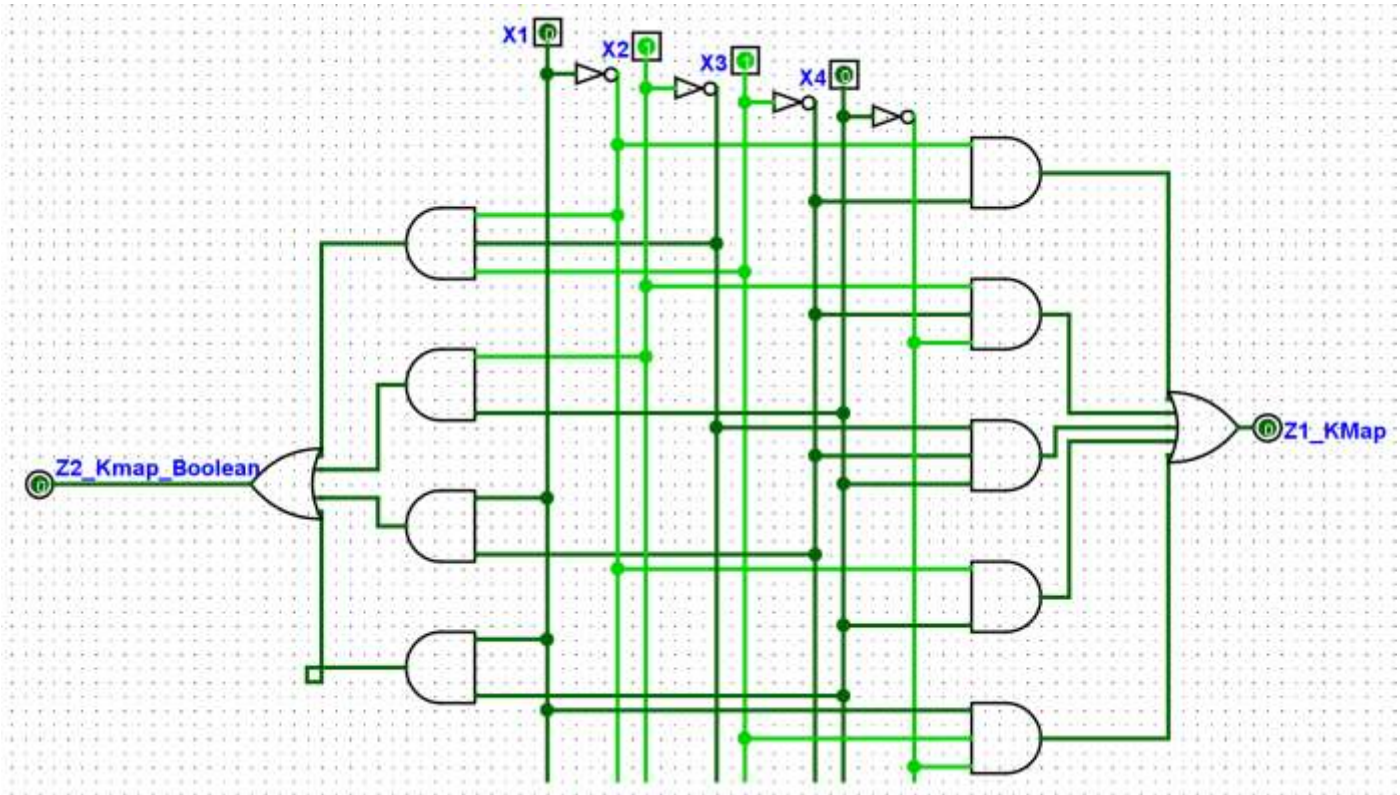
Optimized circuits of Z1 using Kmap and Z2

Input: X1 = 0, X2 = 0, X3 = 0, X4 = 0 Output: Z1 = 1, Z2 = 0



Input: X1 = 0, X2 = 1, X3 = 1, X4 = 0 Output: Z1 = 0, Z2 = 0



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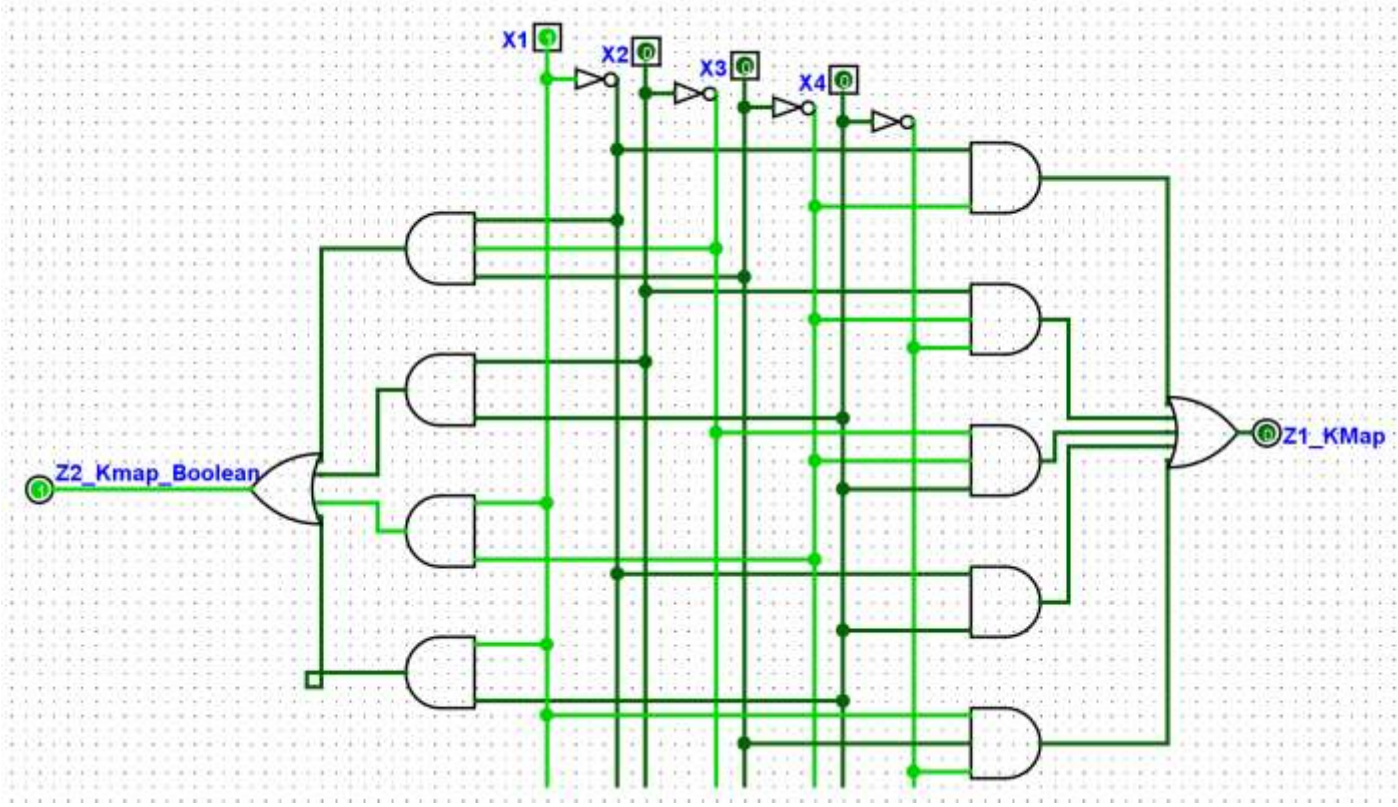
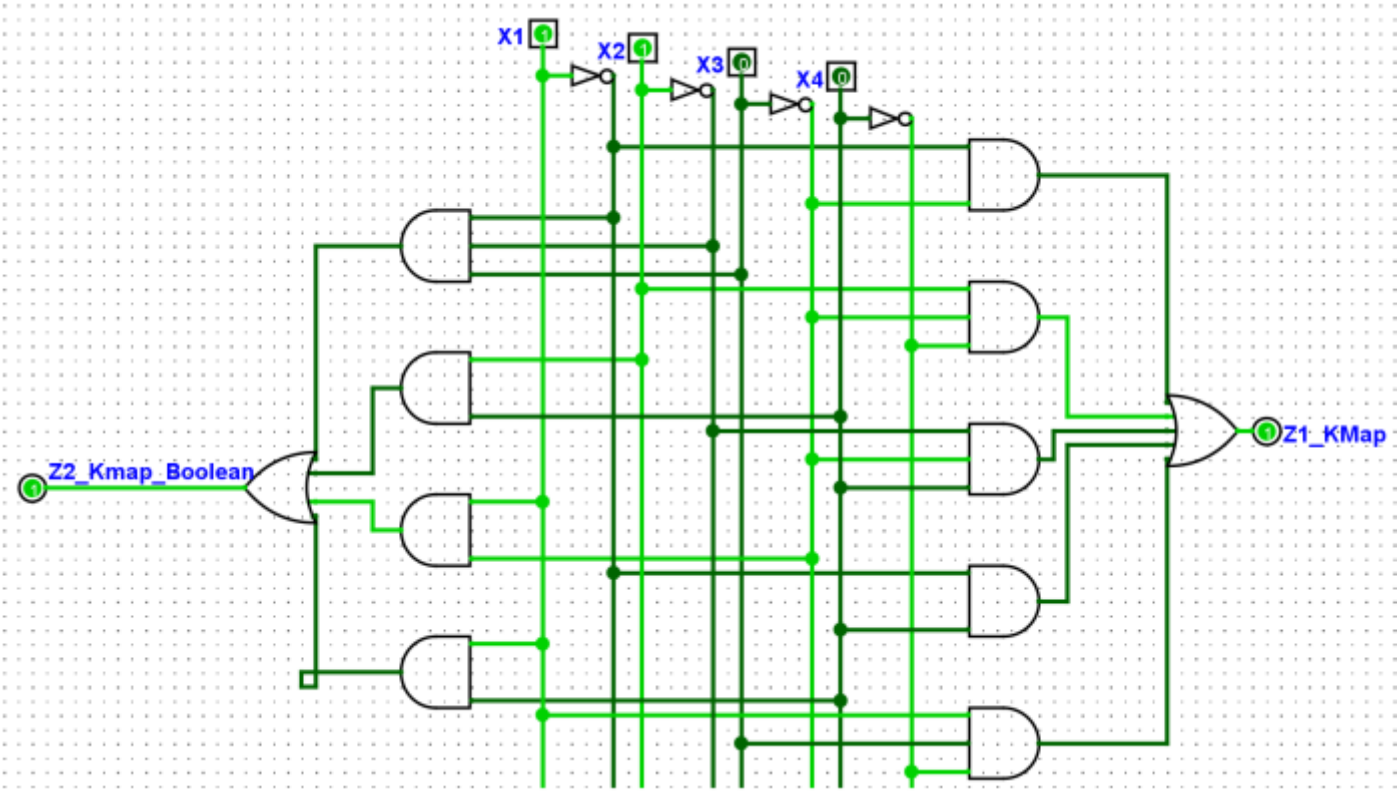
Input: X1 = 1, X2 = 0, X3 = 0, X4 = 0 Output: Z1 = 0, Z2 = 1



Input: X1 = 1, X2 = 1, X3 = 0, X4 = 0 Output: Z1 = 1, Z2 = 1



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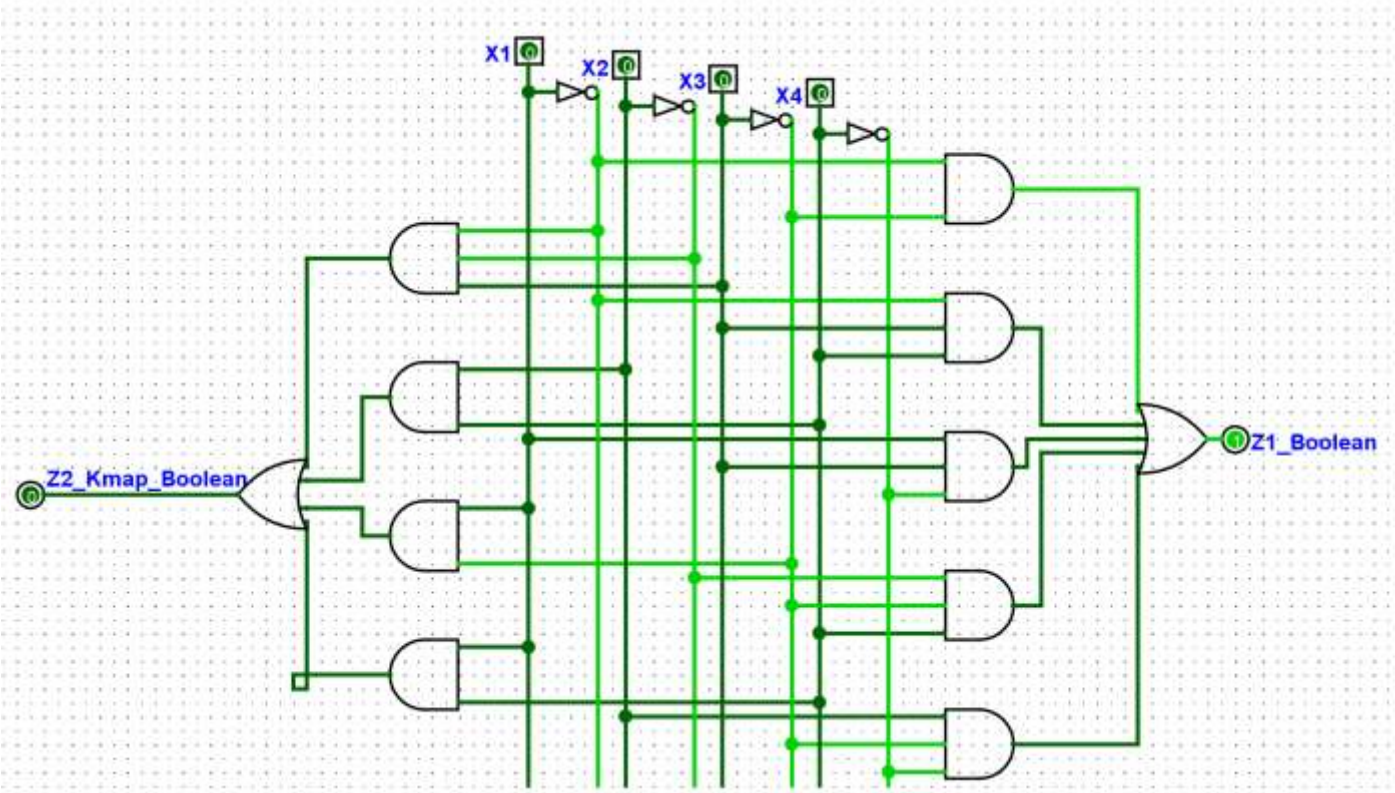
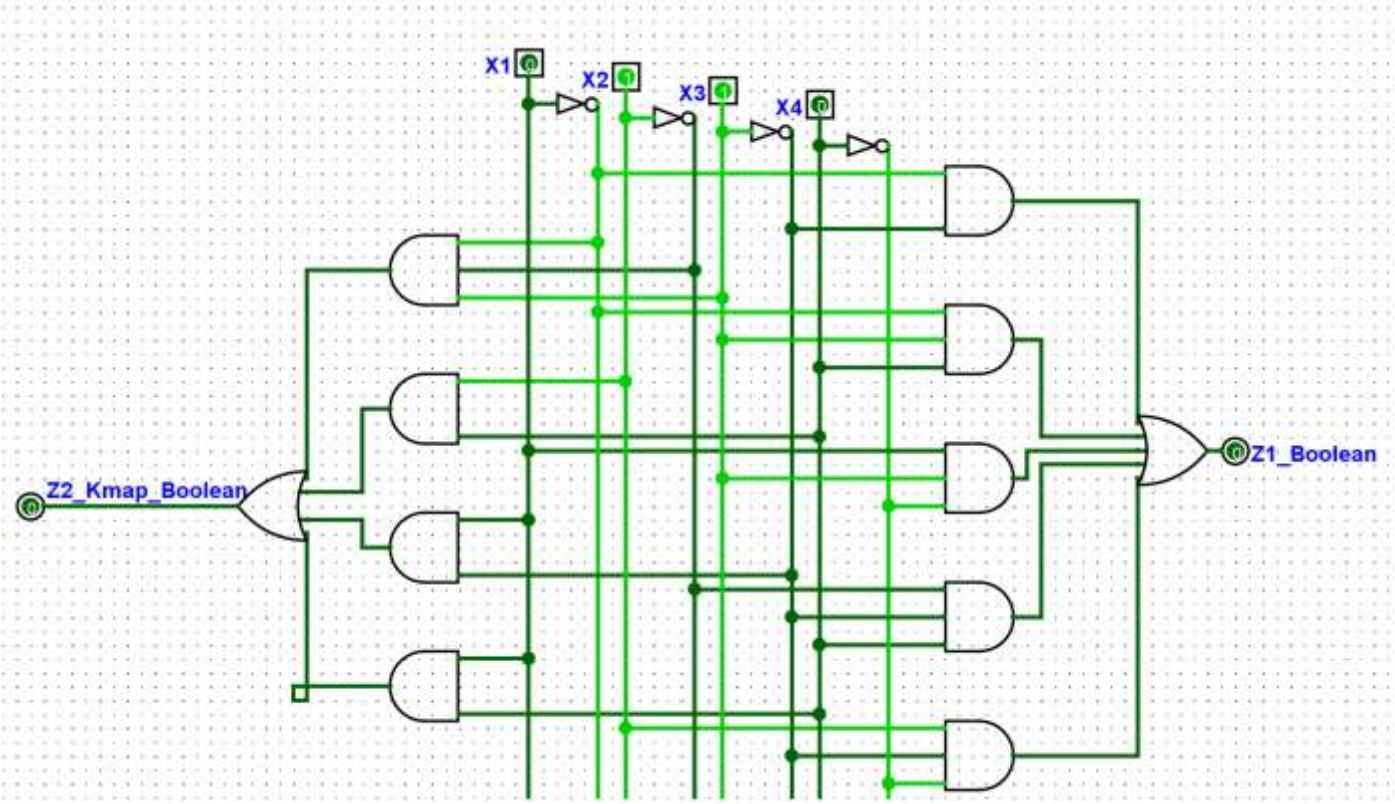
Optimized Circuits of Z1 using Boolean Identities and Z2

Input: X1 = 0, X2 = 0, X3 = 0, X4 = 0 Output: Z1 = 1, Z2 = 0



Input: X1 = 0, X2 = 1, X3 = 1, X4 = 0 Output: Z1 = 0, Z2 = 0



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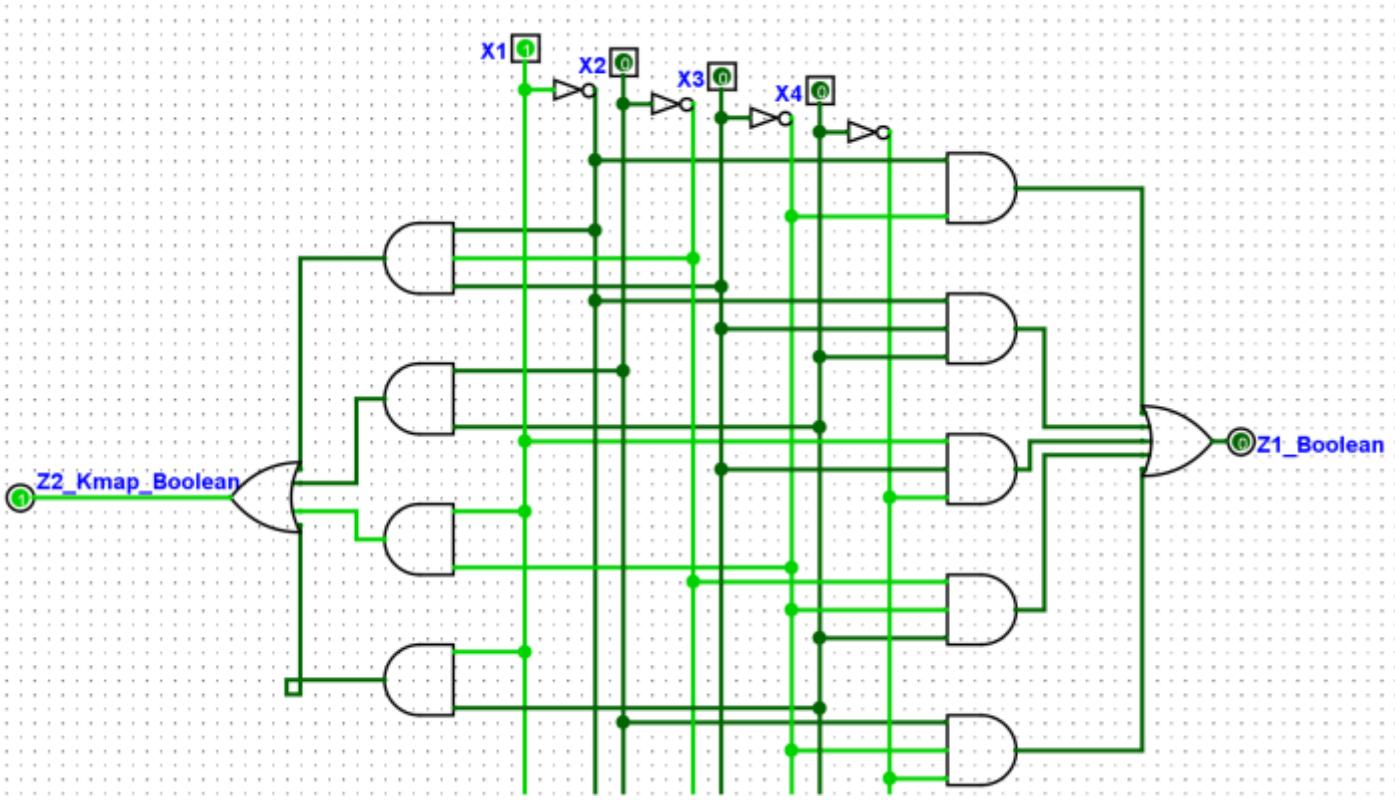
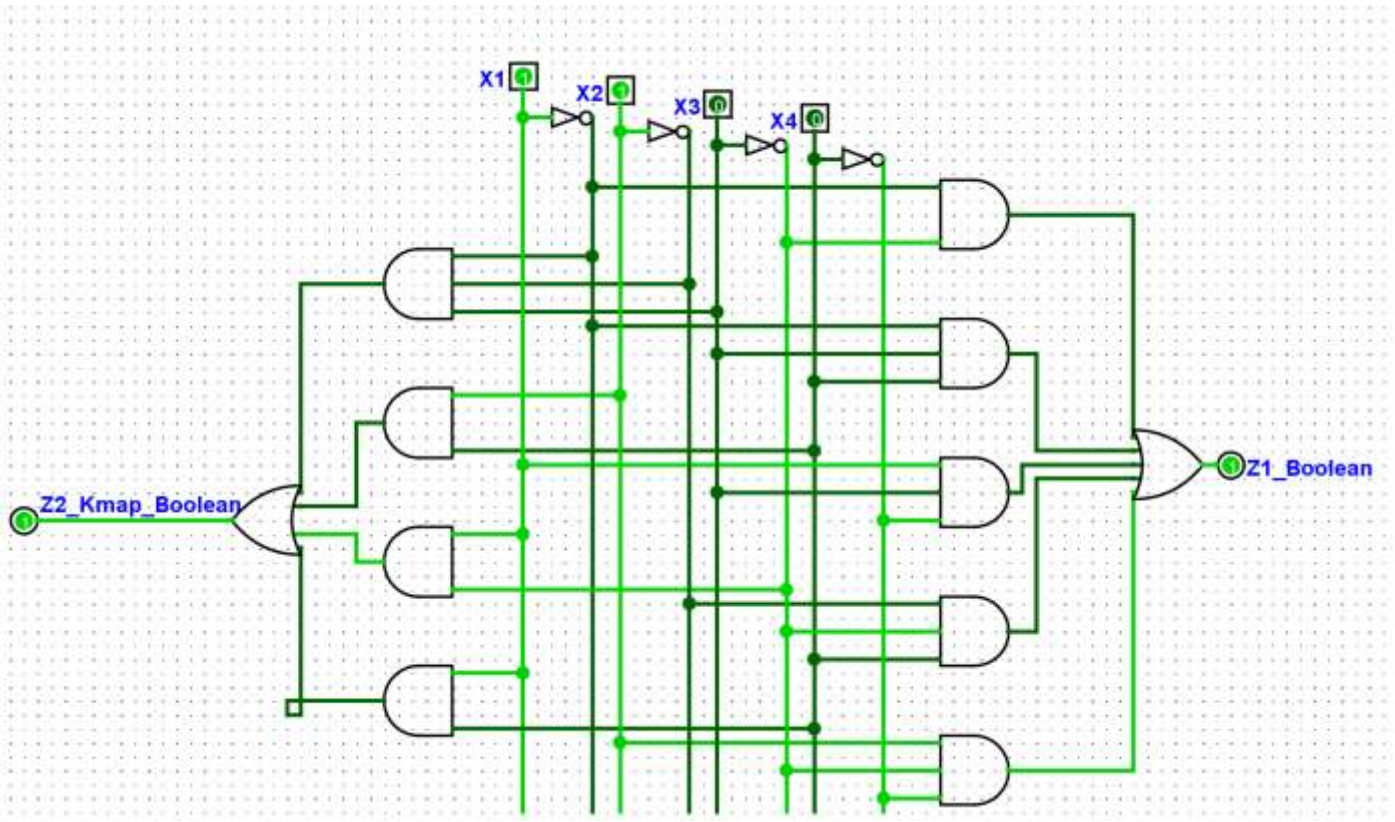
Input: X1 = 1, X2 = 0, X3 = 0, X4 = 0 Output: Z1 = 0, Z2 = 1



Input: X1 = 1, X2 = 1, X3 = 0, X4 = 0 Output: Z1 = 1, Z2 = 1



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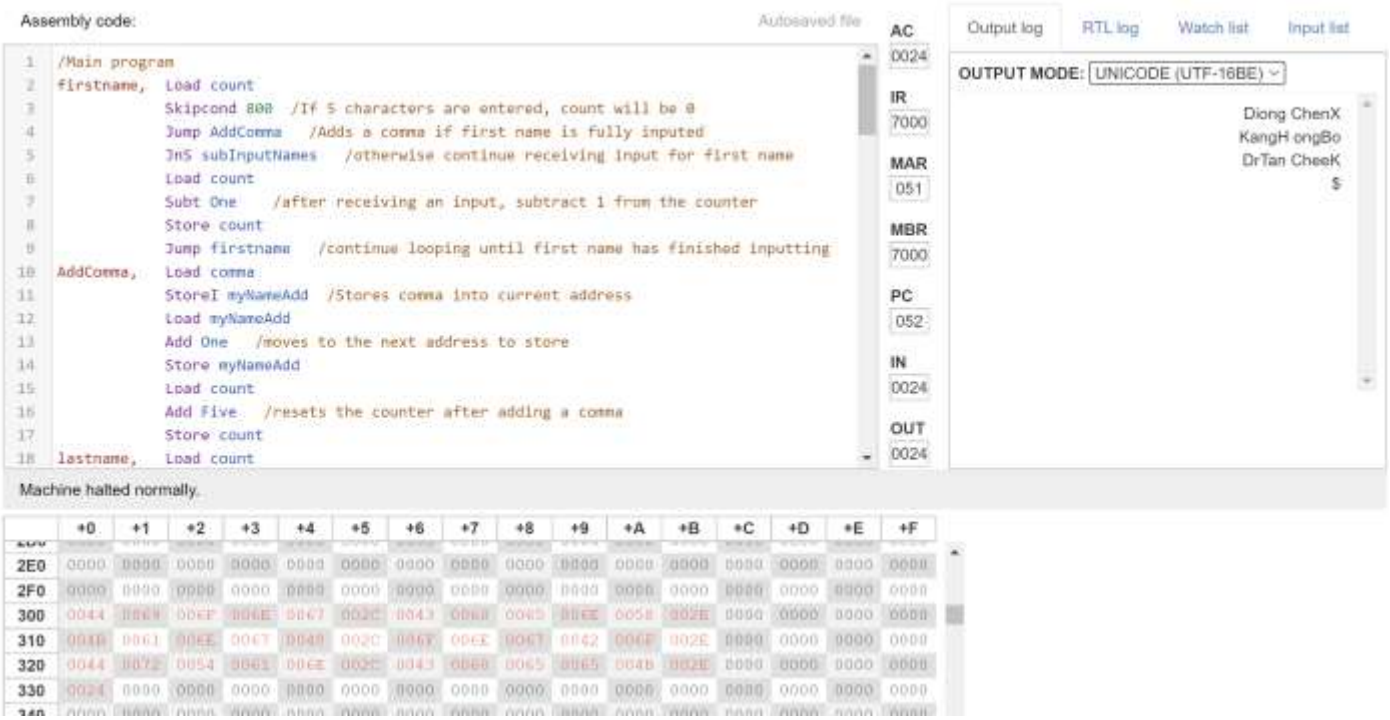
Documentation of Task 2

Task 2.1



From the screenshot, I entered three names as the input, namely Diong ChenX, KangH ongBo and DrTan CheeK (my name, my friend's name, and my tutor's name). I programmed the MARIE code such that the user only needs to input the first name and last name, while the commas and full stops are automatically stored inside the respective addresses.

As we can see, the output is as desired, a space is printed in place of a comma, and a new line is printed in place of a full stop. Also the '$' sign is printed out as an indication of the end of the program. The name strings are also stored in three different lines of addresses (i.e. 300, 310, and 320) while the '$' sign is stored in address 330.

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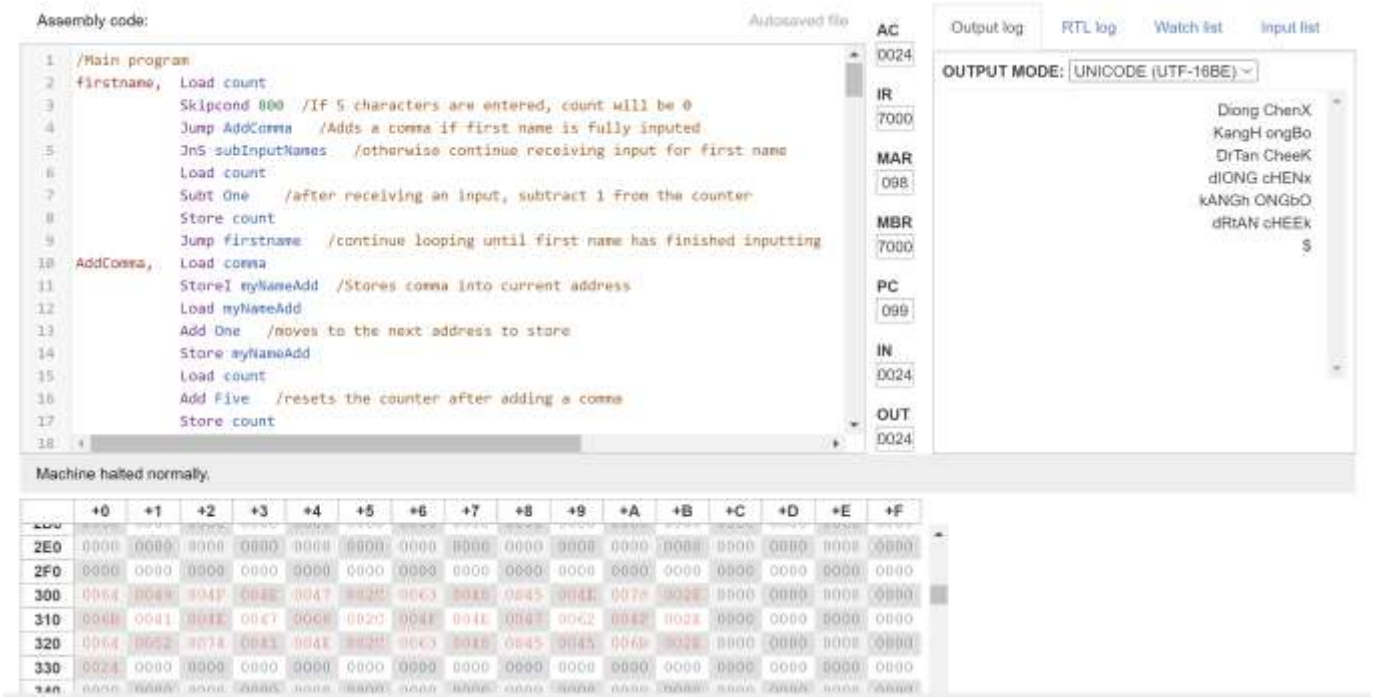
Task 2.2



From the screenshot, I entered three names as the input, namely Diong ChenX, KangH ongBo and DrTan CheeK (my name, my friend's name, and my tutor's name). I programmed the MARIE code such that the user only needs to input the first name and last name, while the commas and full stops are automatically stored inside the respective addresses.

As we can see, the output is as desired, a space is printed in place of a comma, and a new line is printed in place of a full stop. Also the names with switched cases are printed out after the original names, and the '$' sign is printed out as an indication of the end of the program. The name strings are also stored in three different lines of addresses (i.e. 300, 310, and 320) while the '$' sign is stored in address 330.

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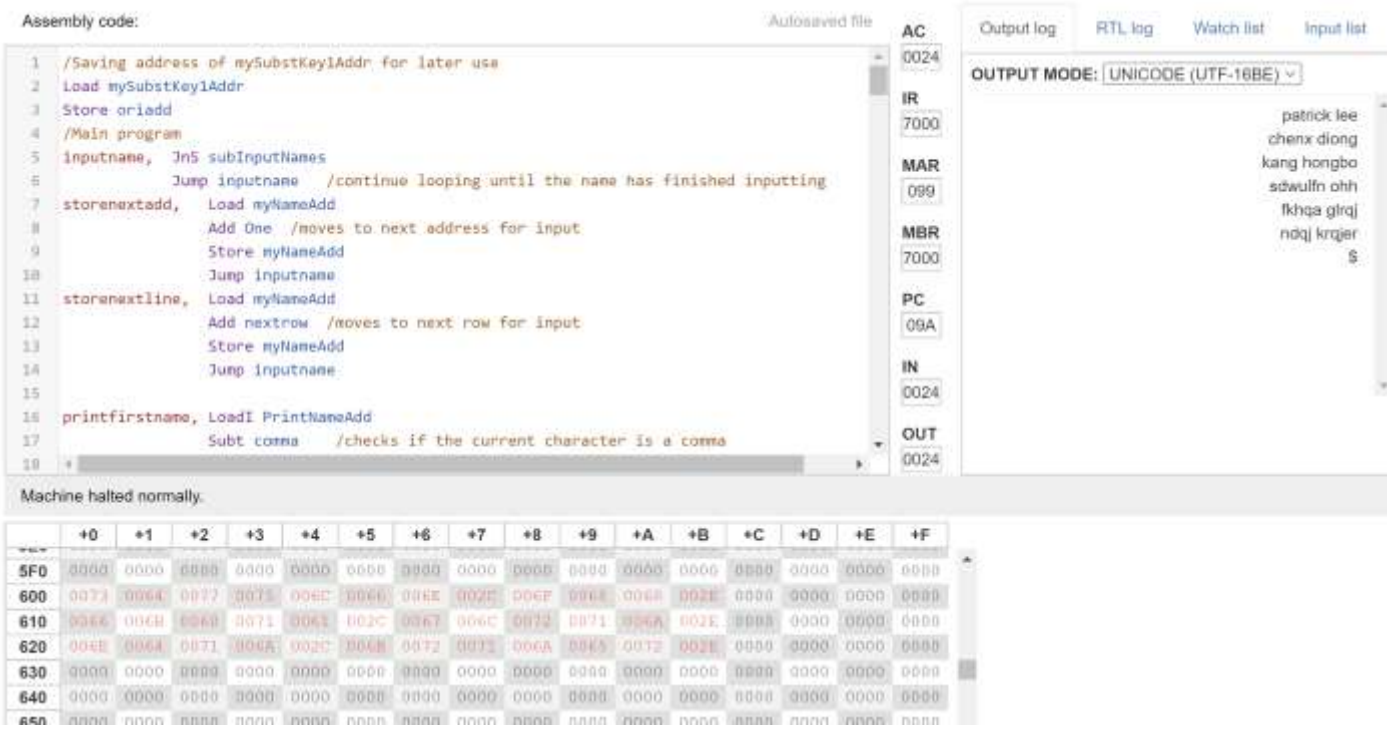
Task 2.3



From the screenshot, I entered three names as the input, namely “patrick,lee.” , “chenx,diong.” and “kang,hongbo.”. For this MARIE code I did not program in such a way that the commas and full stops are automatically stored and instead require user input.

As we can see, the output is as desired, a space is printed in place of a comma, and a new line is printed in place of a full stop. Also the names after substitution are printed out after the original names, and the ‘$’ sign is printed out as an indication of the end of the program. The name strings are also stored in three different lines of addresses (i.e. 300, 310, and 320) while the ‘$’ sign is stored in address 330. Meanwhile the substituted name strings are stored in other addresses (i.e. 600, 610 and 620).