De Morgan's theorem

Logic Design – section 3

Boolean algebra laws and rules:

$$A \cdot 0 = 0$$

$$A \cdot A = A$$

$$\overline{\overline{A}} = A$$

$$A \cdot 1 = A$$

$$A + A = A$$

$$A + \overline{A}B = A + B$$
$$\overline{A} + AB = \overline{A} + B$$

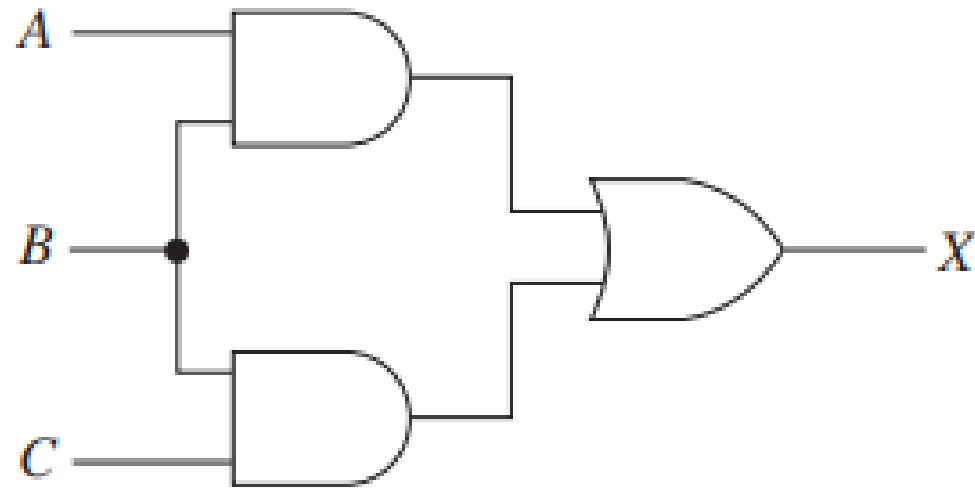$$A + 0 \equiv A$$

$$A \cdot A' = 0$$

$$A + 1 = 1$$

$$A + A' = 1$$

(a) $\overline{B} + AB = ?$
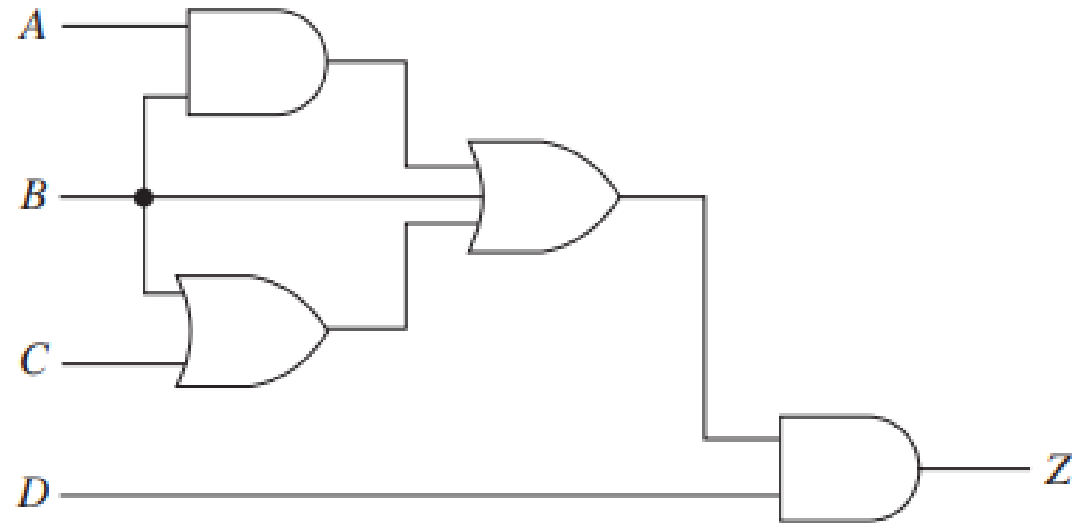
(b) $B + \overline{B}C = ?$

Q1:

Write the Boolean equation for each of the logic circuits shown in the following figures:
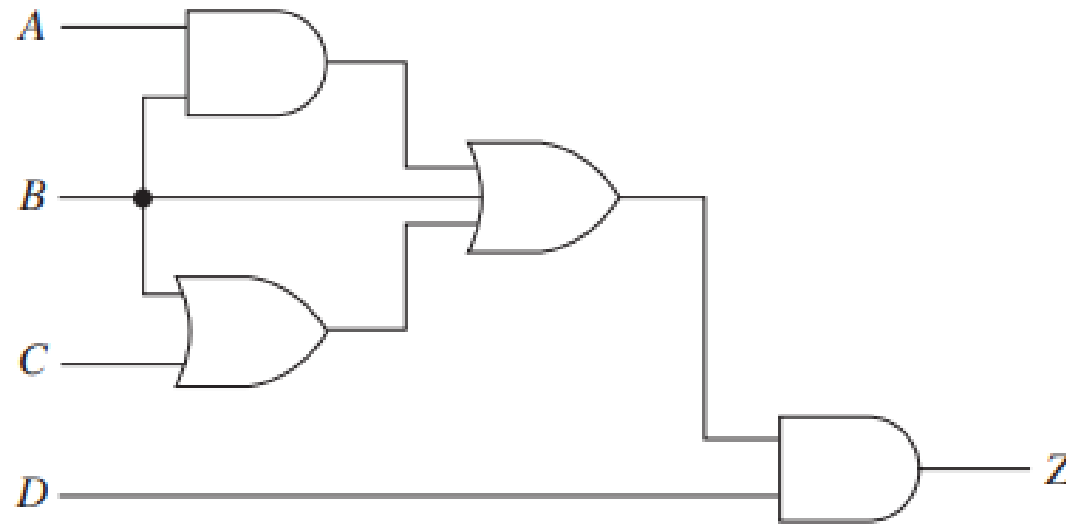

Boolean equation $x = AB + BC$

Q2:

Write the Boolean equation for each of the logic circuits shown in the following figures:

Answer ??

Q2:

Write the Boolean equation for each of the logic circuits shown in the following figures:

Boolean equation $x = B.D$

Q3:

Draw the logic circuit that would be used to implement the following Boolean equations. Also, construct a truth table for each of the equations. Simplify the equation for this problem and then draw the simplification circuit:
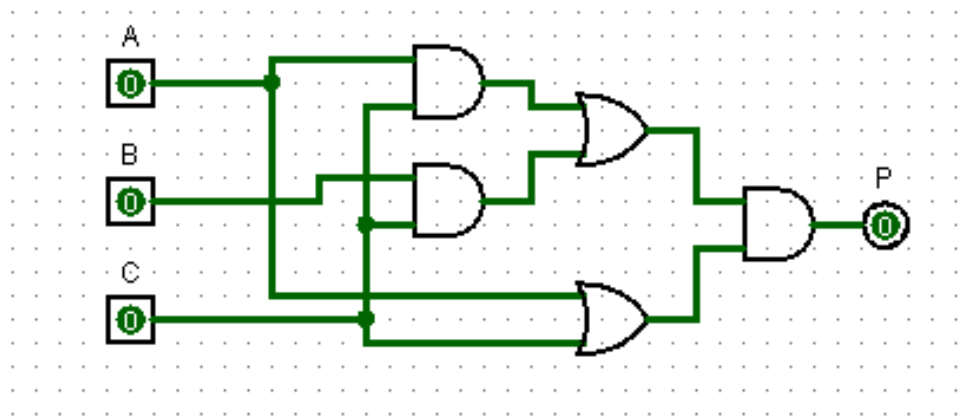
a. $P = (AC + BC)(A + C)$

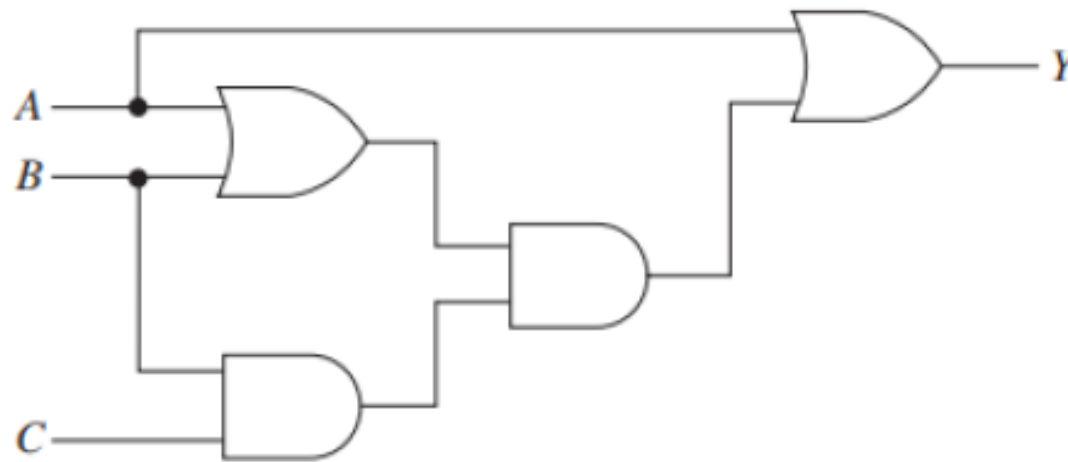**Answer ??**

Q3:

Answer:

a. $P = (AC + BC)(A + C)$

Simplified equation $x = AC + BC$

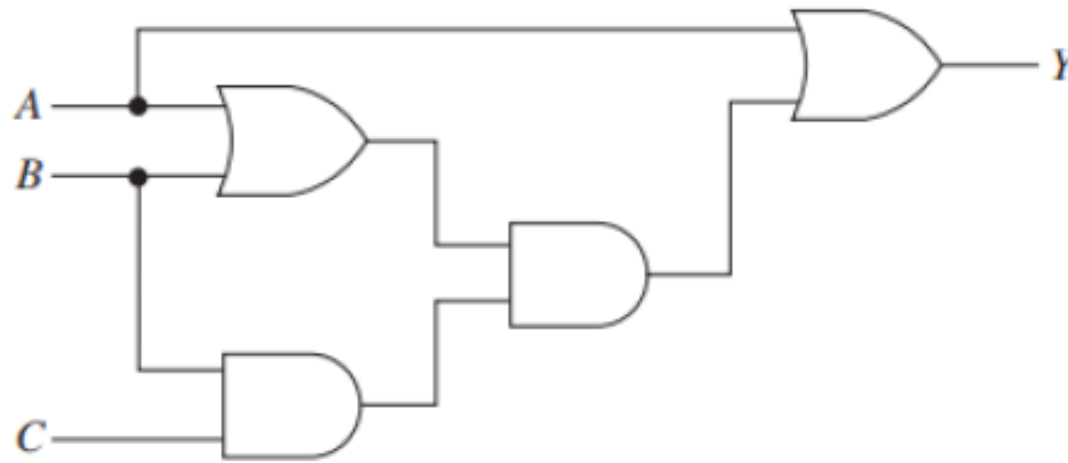| A	B	C	P
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	1
1	0	0	0
1	0	1	1
1	1	0	0
1	1	1	1

Q4:

Write the equation of the circuit in the following figure, then simplify the equation, and draw the logic circuit of the simplified equation:

Simplified equation $x =???$

Q4:

Answer:

Simplified equation $x = BC + A$

The first De Morgan's theorem:

$$\overline{A \cdot B} = \overline{A} + \overline{B}$$

For three variables:

$$\overline{A \cdot B \cdot C} = \overline{A} + \overline{B} + \overline{C}$$
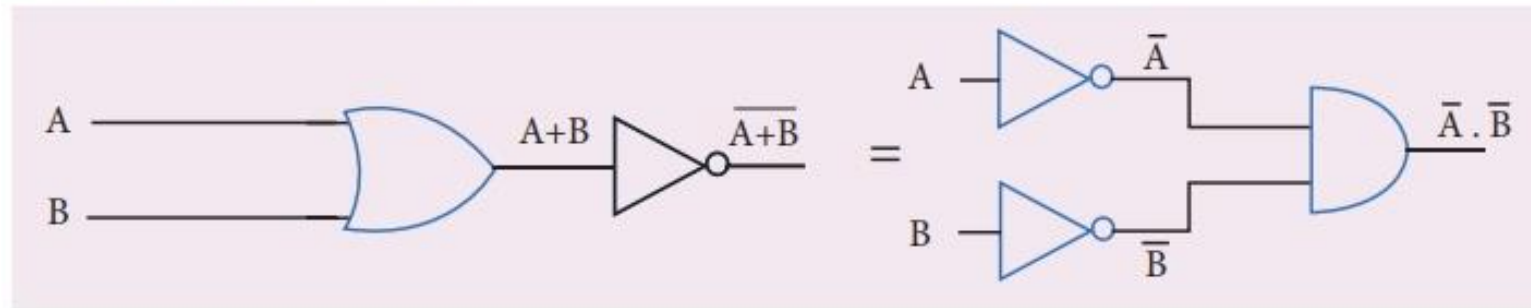
The second De Morgan's theorem:

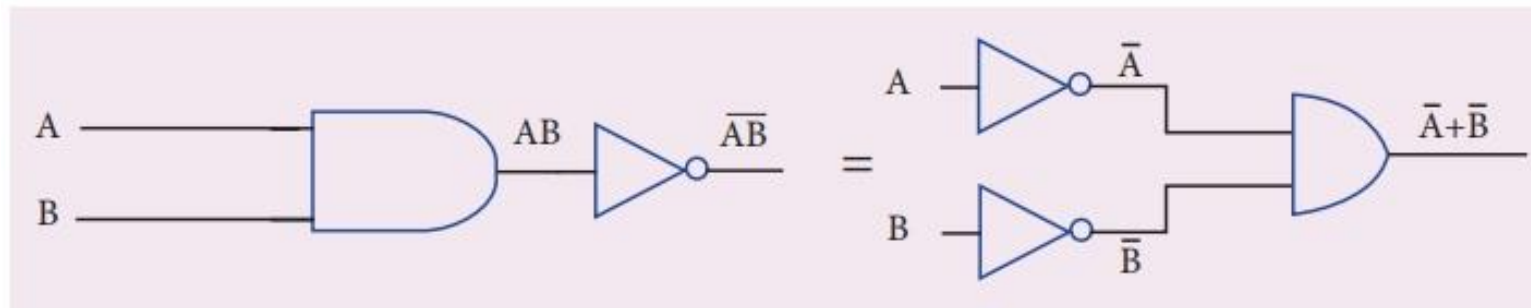$$\overline{A + B} = \overline{A} \cdot \overline{B}$$

For three variables:

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

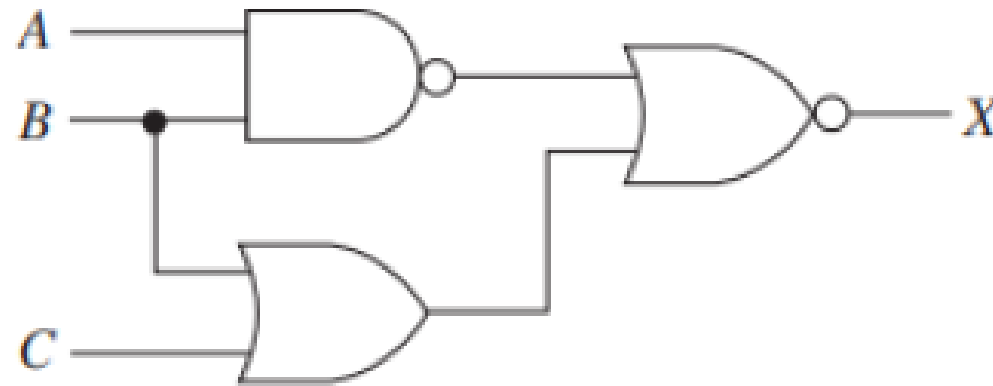# Implementation of De Morgan's theorem:

De Morgan's first theorem

$$A + B \quad \overline{A+B} \quad = \quad \overline{A} . \overline{B}$$

De Morgan's second theorem

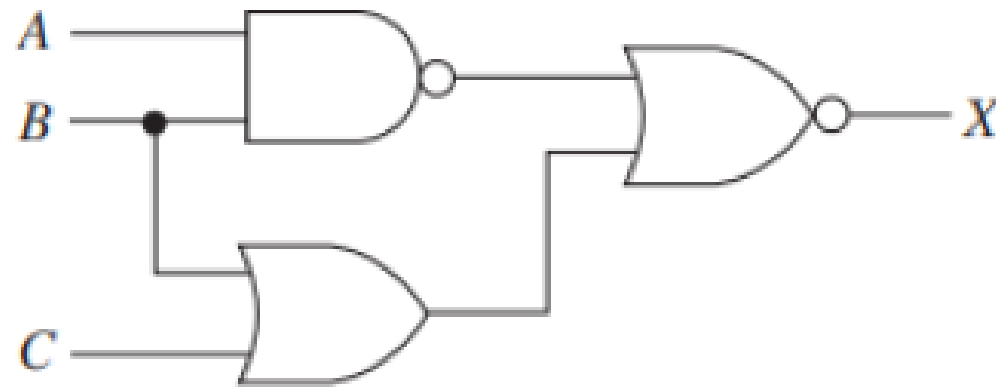$$AB \quad \overline{AB} \quad = \quad \overline{A} + \overline{B}$$

Q1:

Write the Boolean equation for the credit show in the following figure. Then, use De Morgan's theorem and then Boolean algebra rules to simplify the equation. Draw the simplified circuit
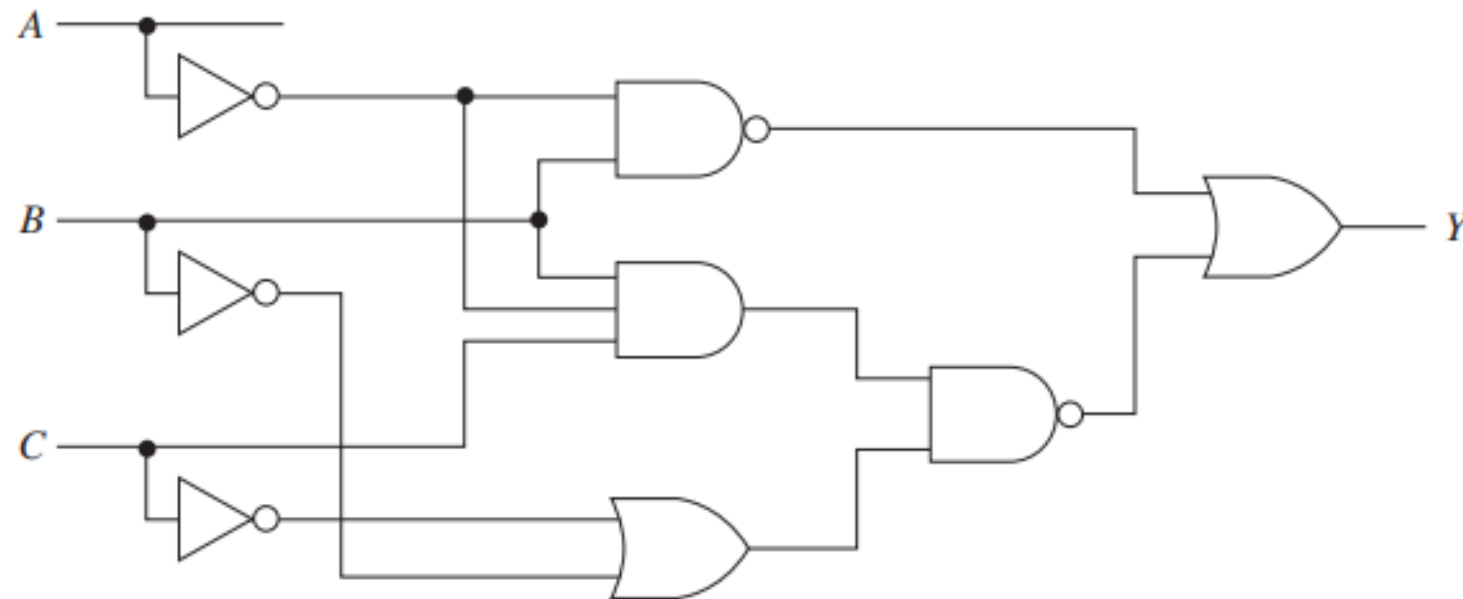

$$x = ??$$

Q1:

Answer:

$$x = \overline{\overline{A\,B} + (B + C)}$$
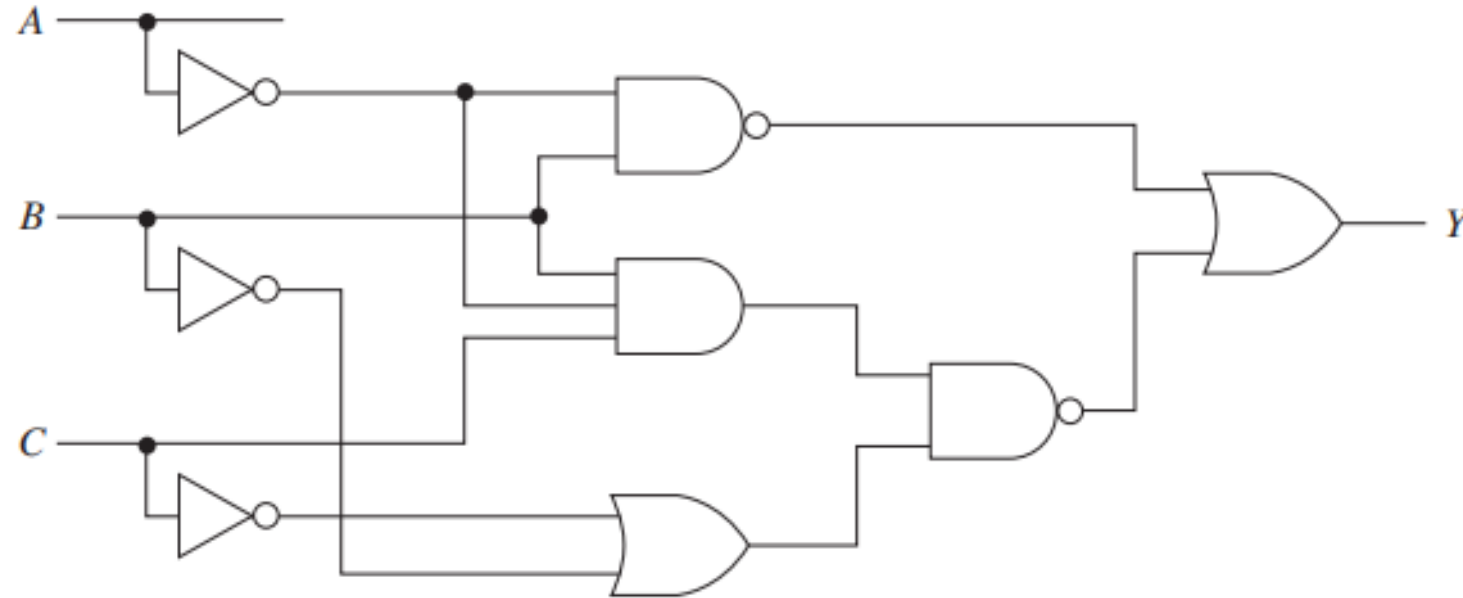
Simplified equation $x = 0$

Q2:

Write the Boolean equation for the credit show in the following figure. Then, use De Morgan's theorem and then Boolean algebra rules to simplify the equation. Draw the simplified circuit
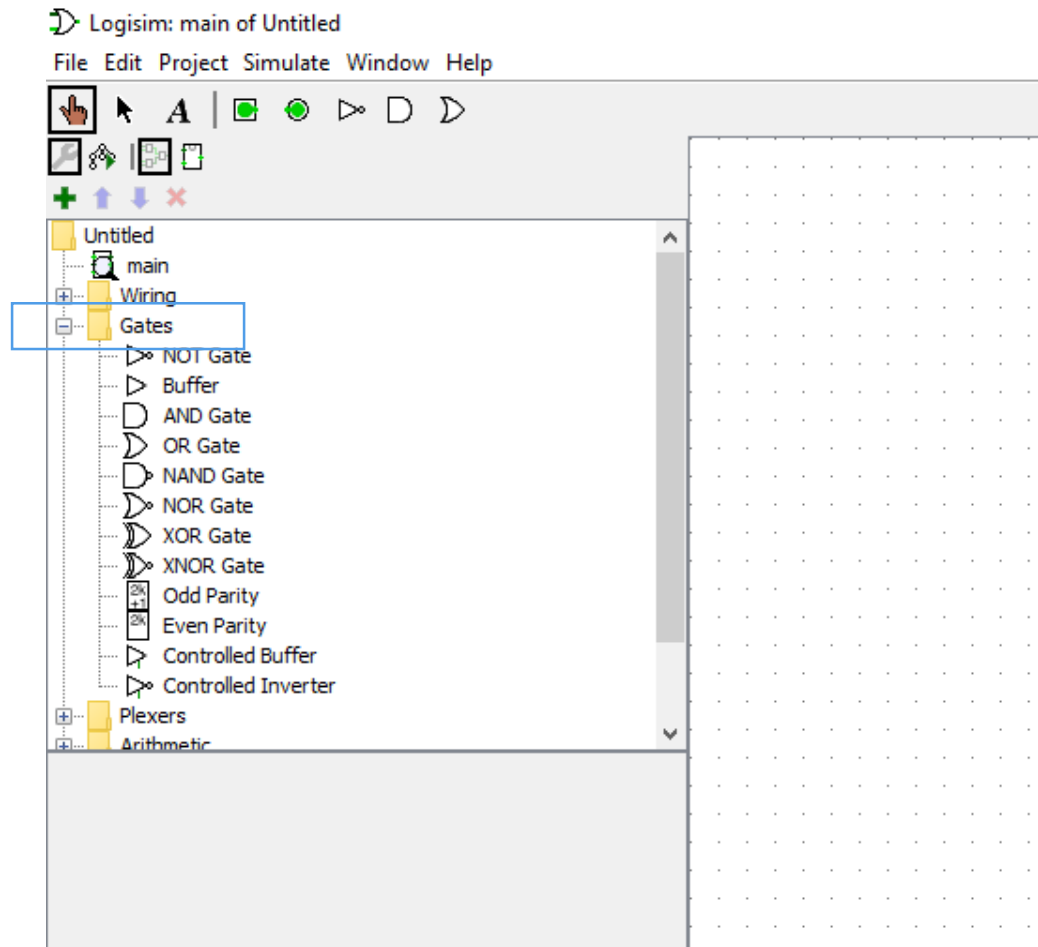

$$x = ???$$

Q2:

Answer:

$$x = \overline{(\overline{A}\,B)} + \overline{\overline{A}\,B\,C}.(\overline{B} + \overline{C})$$
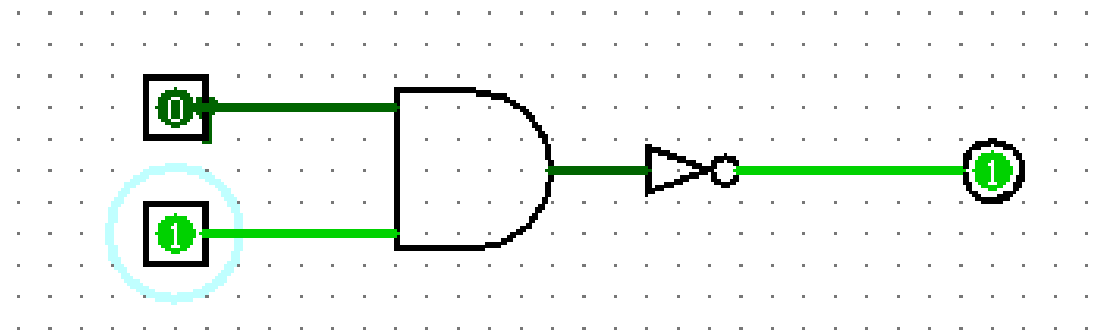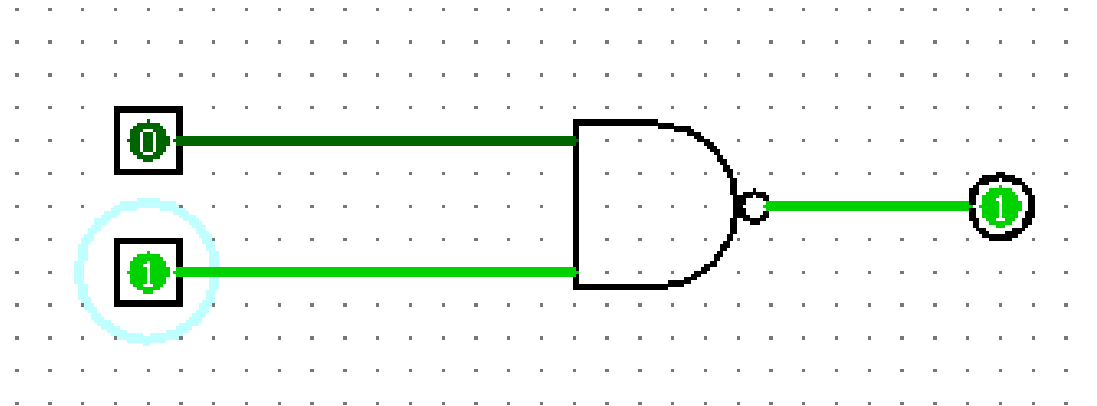
<div style="background-color:pink">

Simplified equation $x = 1$

</div>

Logisim

Logisim

1. NAND gate

a	b	x
0	0	1
0	1	1
1	0	1
1	1	0

Logisim

2. NOR gate

a	b	x
0	0	1
0	1	0
1	0	0
1	1	0