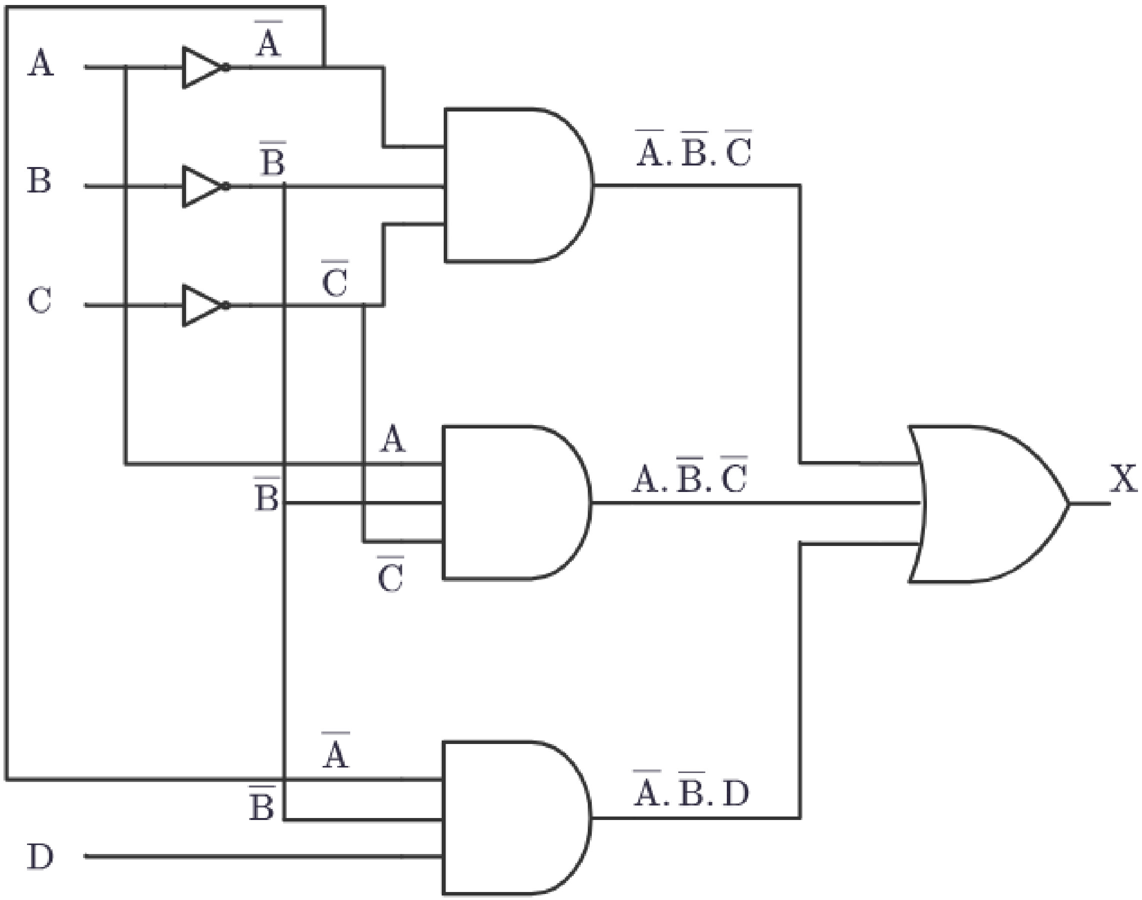
2. Write the Boolean expression for output x in the following figure. Determine the value of x for all possible input conditions, and list the values in a truth table.

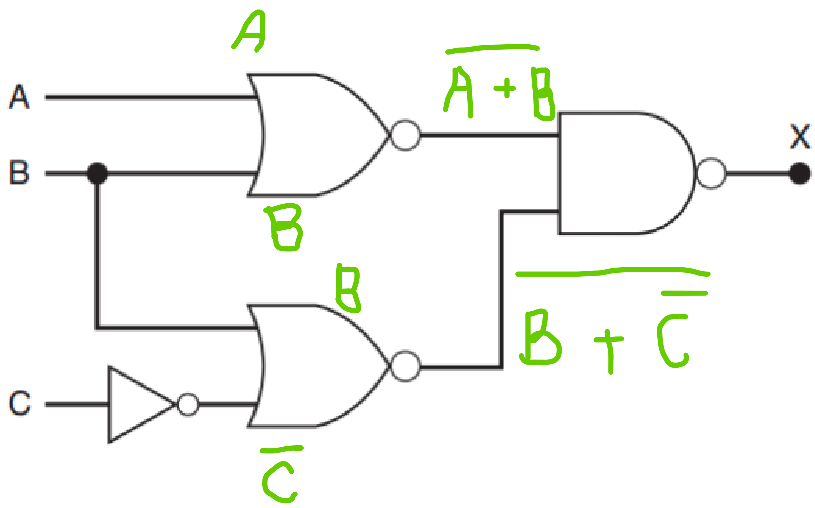


The output expression is,

$$
\begin{aligned}
X &= \left(\overline{A}.\overline{B}.\overline{C}\right) + \left(A.\overline{B}.\overline{C}\right) + \left(\overline{A}.\overline{B}.D\right) \\
&= \overline{B}.\overline{C}\left(A + \overline{A}\right) + \left(\overline{A}.\overline{B}.D\right) \\
&= \overline{B}.\overline{C} + \left(\overline{A}.\overline{B}.D\right)
\end{aligned}
$$

Truth table:

A	B	C	D	X
0	0	0	0	1
0	0	0	1	1
0	0	1	0	0
0	0	1	1	1
0	1	0	0	0
0	1	0	1	0
0	1	1	0	0
0	1	1	1	0
1	0	0	0	1
1	0	0	1	1
1	0	1	0	0
1	0	1	1	0
1	1	0	0	0
1	1	0	1	0
1	1	1	0	0
1	1	1	1	0



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

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

A	B	C	Output
0	0	0	T
0	0	1	F
0	1	0	T
0	1	1	T
1	0	0	T
1	0	1	T
1	1	0	T
1	1	1	T

4. Simplify the following expression using Boolean theorems
    a. The output of Figure 2b
    b. $y = (M + N)(\overline{M} + P)(\overline{N} + \overline{P})$
    c. $z = \overline{A}B\overline{C} + AB\overline{C} + B\overline{C}D$

a.

Start

$\overline{\overline{A+B}\,\overline{B+\overline{C}}}$

Apply: Demorgan Theorm

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

Apply the Involution Law: $\overline{\overline{A}} = A$

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

Apply the Involution Law: $\overline{A} = A$

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

Apply the Idempotent Law: $A+A = A$

$A+B+\overline{C}$

b.

Start
$(M+N)(\overline{M}+P)(\overline{N}+\overline{P})$

Apply: Distribution
$(\overline{M}+P)(\overline{N}+\overline{P})M+(\overline{M}+P)(\overline{N}+\overline{P})N$

Apply: Distribution
$(\overline{N}+\overline{P})M\overline{M}+(\overline{N}+\overline{P})MP+(\overline{M}+P)(\overline{N}+\overline{P})N$

Apply the Complement Law: $A\overline{A} = 0$
$0+(\overline{N}+\overline{P})MP+(\overline{M}+P)(\overline{N}+\overline{P})N$

Apply the Identity Law: $A+0 = A$
$(\overline{N}+\overline{P})MP+(\overline{M}+P)(\overline{N}+\overline{P})N$

Apply: Distribution
$MP\overline{N}+MP\overline{P}+(\overline{M}+P)(\overline{N}+\overline{P})N$

Apply the Complement Law: $A\overline{A} = 0$
$MP\overline{N}+0+(\overline{M}+P)(\overline{N}+\overline{P})N$

Apply the Identity Law: $A+0 = A$
$MP\overline{N}+(\overline{M}+P)(\overline{N}+\overline{P})N$

Apply: Distribution
$MP\overline{N}+(\overline{N}+\overline{P})N\overline{M}+(\overline{N}+\overline{P})NP$

Apply: Distribution
$MP\overline{N}+N\overline{M}\overline{N}+N\overline{M}\overline{P}+(\overline{N}+\overline{P})NP$

Apply the Complement Law: $A\overline{A} = 0$
$MP\overline{N}+0+N\overline{M}\overline{P}+(\overline{N}+\overline{P})NP$

Apply the Identity Law: $A+0 = A$
$MP\overline{N}+N\overline{M}\overline{P}+(\overline{N}+\overline{P})NP$

Apply: Distribution
$MP\overline{N}+N\overline{M}\overline{P}+NP\overline{N}+NP\overline{P}$

Apply the Complement Law: $A\overline{A} = 0$
$MP\overline{N}+N\overline{M}\overline{P}+0+NP\overline{P}$

Apply the Identity Law: $A+0 = A$
$MP\overline{N}+N\overline{M}\overline{P}+NP\overline{P}$

Apply the Complement Law: $A\overline{A} = 0$
$MP\overline{N}+N\overline{M}\overline{P}+0$

Apply the Identity Law: $A+0 = A$
$MP\overline{N}+N\overline{M}\overline{P}$

c.

Start

$\overline{A}B\overline{C}+AB\overline{C}+B\overline{C}D$

Apply the Distributive Law: $AB+AC = A(B+C$

$B\overline{C}(\overline{A}+A)+B\overline{C}D$

Apply the Complement Law: $A+\overline{A} = 1$

$B\overline{C}1+B\overline{C}D$

Apply the Identity Law: $A1 = A$

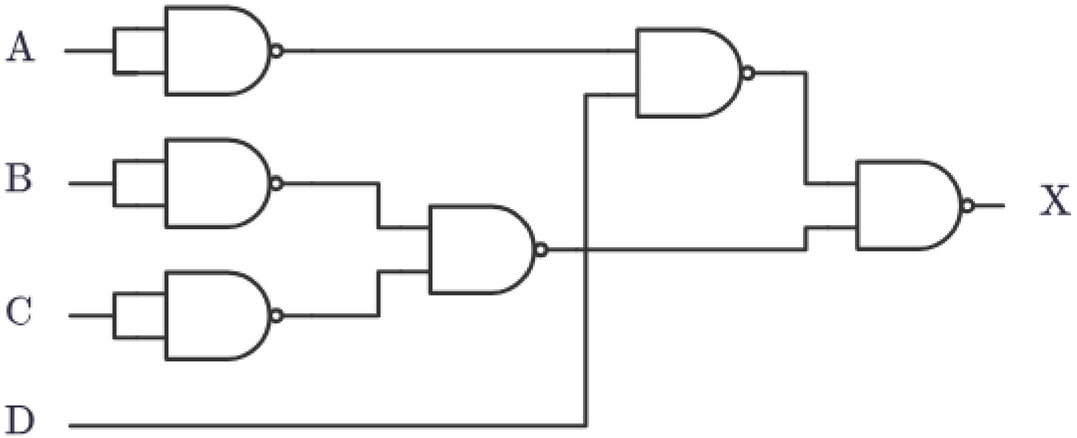
$B\overline{C}+B\overline{C}D$

Apply the Absorption Law: $A+AB = A$

$B\overline{C}$

6.

The logic circuit of the given output expression using NAND gates is,



8.

Here from the given diagram let's write a logic equation $\overline{\mathbf{A.B+\overline{A}.\overline{B}}}$
Therefore from the given diagram let's write the truth tables

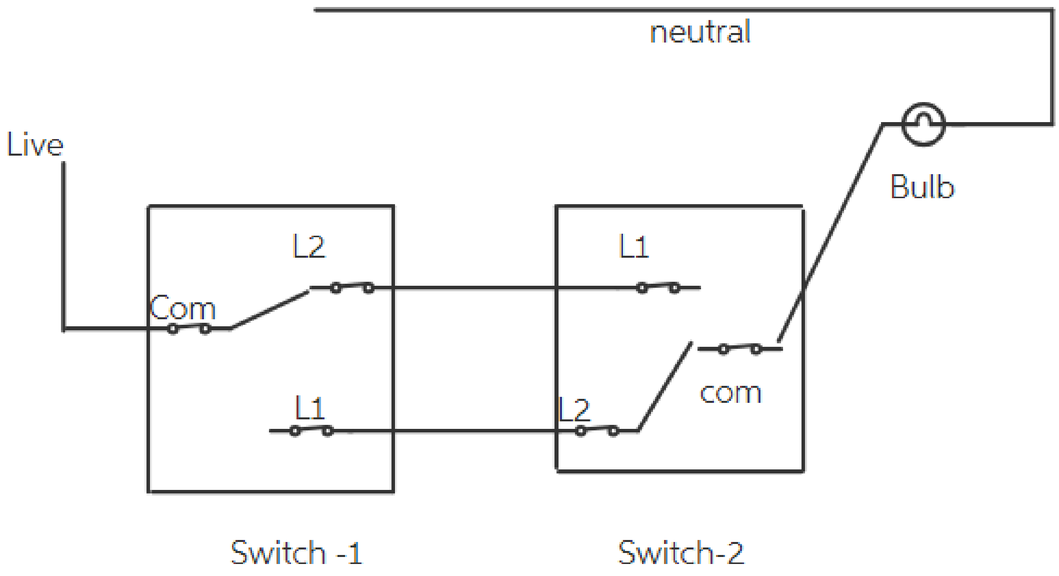
For 00 --> $\overline{\mathbf{0.0+\overline{0}.\overline{0}}} = \overline{\mathbf{0+1}} = \mathbf{0}$

For 01 --> $\overline{\mathbf{0.1+\overline{0}.\overline{1}}} = \overline{\mathbf{0+0}} = \mathbf{1}$

For 10 --> $\overline{\mathbf{1.0+\overline{1}.\overline{0}}} = \overline{\mathbf{0+0}} = \mathbf{1}$

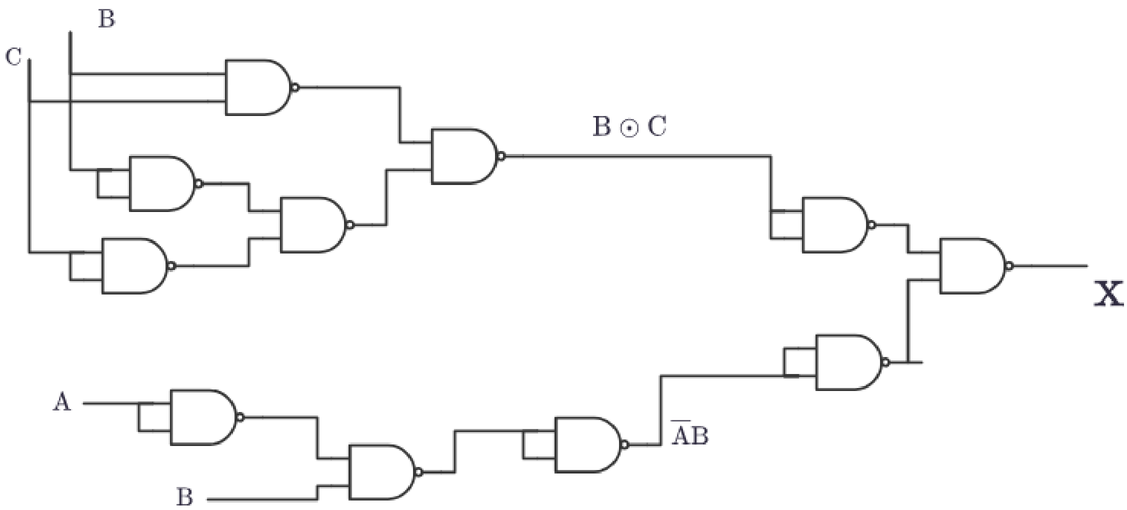
For 11 --> $\overline{\mathbf{1.1+\overline{1}.\overline{1}}} = \overline{\mathbf{1+0}} = \mathbf{0}$

A	B	Y
0	0	0
0	1	1
1	0	1
1	1	0



Here at present condition the switch is in off condition
--> No matter which switch you press the circuit will closed and bulb will glow.
One more press will make the circuit open and bulb will turn off.

10.



B
C
B ⊙ C
X
A
$\overline{A}B$
B