Logic Gates

Example 1:

Draw the circuit diagram to implement the expression $x = (A + B)(\overline{B} + C)$.

Solution

This expression shows that the terms $A + B$ and $\overline{B} + C$ are inputs to an AND gate, and each of these two terms is generated from a separate OR gate. The result is drawn in Figure 3-18.

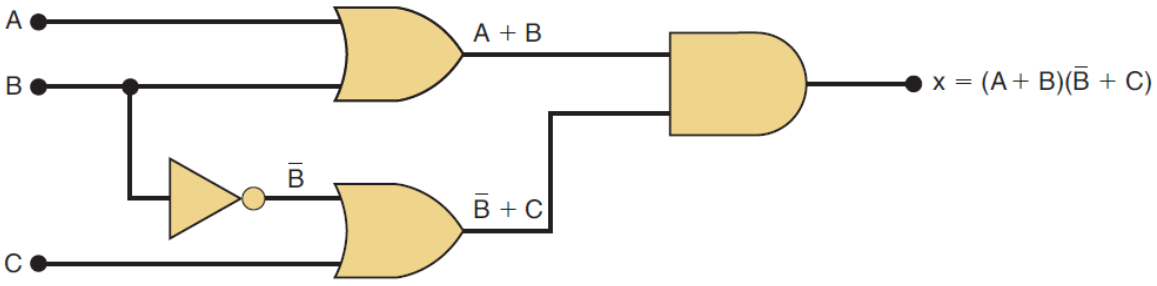


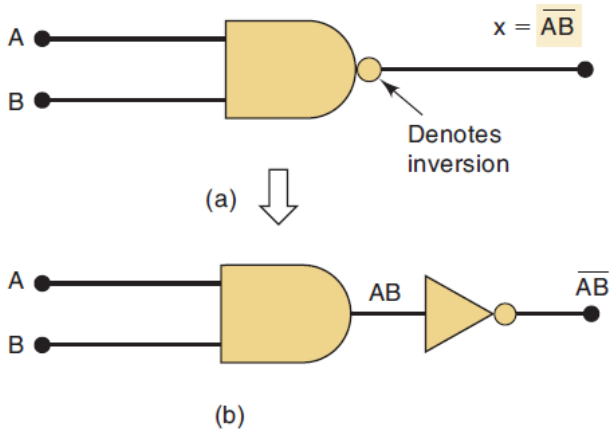
Figure 1: circuit diagram to implement the expression *of* $x = (A + B)(\overline{B} + C)$

H.W

1. Draw the circuit diagram that implements the expression $x = \overline{A}BC(\overline{A + D})$ using gates with no more than three inputs.
2. Draw the circuit diagram for the expression $y = AC + B\overline{C} + \overline{A}BC$.
3. Draw the circuit diagram for $x = [D + (\overline{A + B})C] \cdot E$.

NAND gate

NAND stands for NOT AND. An AND gate followed by a NOT circuit makes it a NAND gate.

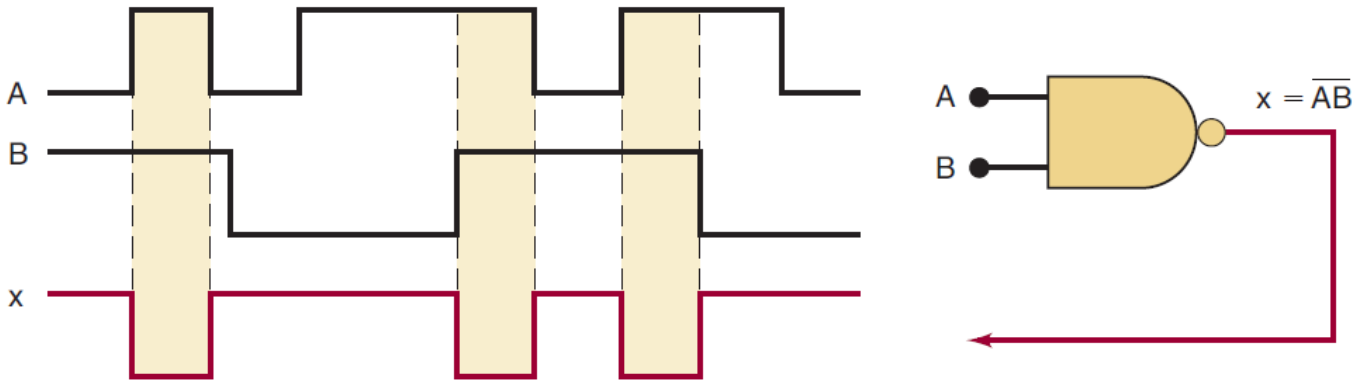


		AND	NAND
A	B	AB	$\overline{AB}$
0	0	0	1
0	1	0	1
1	0	0	1
1	1	1	0

(c)

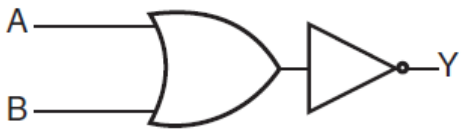
Figure 2 : (a) Two-input NAND implementation using an AND gate and a NOT circuit, (b) the circuit symbol of a two-input NAND gate and (c) the truth table of a two-input NAND gate.

Example 2: Determine the output waveform of a NAND gate having the input waveforms shown in **Figure 2a**:

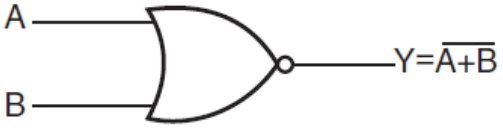


NOR gate

NOR stands for NOT OR. An OR gate followed by a NOT circuit makes it a NOR gate.



(a)



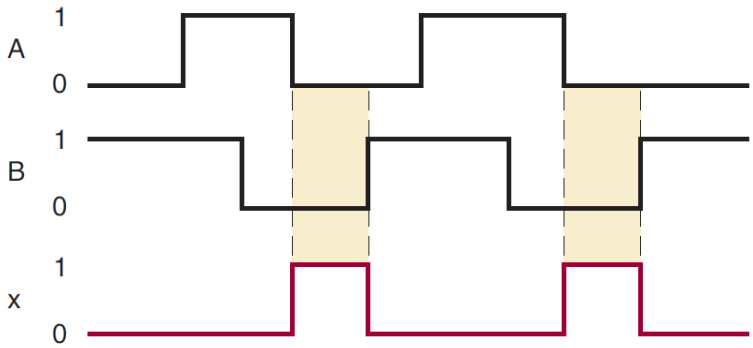
(b)

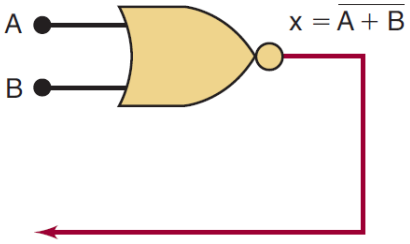
		OR	NOR
A	B	A + B	$\overline{A + B}$
0	0	0	1
0	1	1	0
1	0	1	0
1	1	1	0

(c)

Figure 3: (a) Two-input NOR implementation using an OR gate and a NOT circuit, (b) the circuit symbol of a two-input NOR gate and (c) the truth table of a two-input NOR gate.

Example 3: Determine the waveform at the output of a NOR gate for the input waveforms shown in Figure 3a:





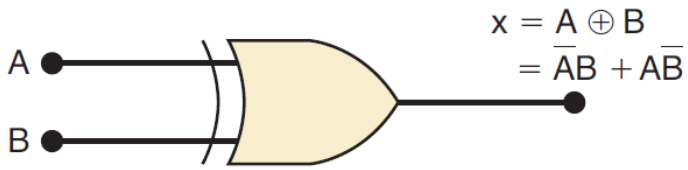
H.W.

Implement the logic circuit that has the expression $x = \overline{AB \cdot (\overline{C + D})}$ using only NOR and NAND gates.

EXCLUSIVE-OR Gate

The EXCLUSIVE-OR gate, commonly written as EX-OR gate, is a two-input, one-output gate.

$$Y = (A \oplus B) = \overline{A}B + A\overline{B}$$



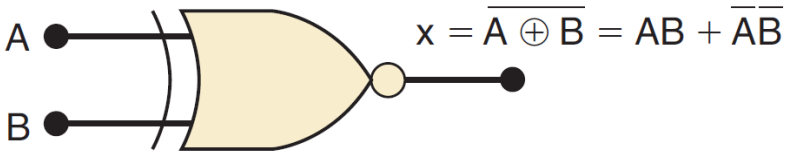
A	B	x
0	0	0
0	1	1
1	0	1
1	1	0

Figure 4: Circuit symbol of a two-input EXCLUSIVE-OR gate, and the truth table of a two-input EXCLUSIVE-OR gate.

EXCLUSIVE-NOR Gate

EXCLUSIVE-NOR (commonly written as EX-NOR) means NOT of EX-OR, i.e. the logic gate that we get by complementing the output of an EX-OR gate.

$$Y = (\overline{A \oplus B}) = (A.B + \overline{A}.\overline{B})$$



A	B	x
0	0	1
0	1	0
1	0	0
1	1	1

Figure 5: Circuit symbol of a two-input EXCLUSIVE-NOR gate and the truth table of a two-input EXCLUSIVE-NOR gate.