EXAMPLE 3-6

Analyze the operation of Figure 3-15(a) by creating a table showing the logic state at each node of the circuit.

Solution

Fill in the column for t by entering a 1 for all entries where $A = 0$ and $B = 1$ and $C = 1$.

Fill in the column for u by entering a 1 for all entries where $A = 1$ or $D = 1$.

Fill in the column for v by complementing all entries in column u.

Fill in the column for x by entering a 1 for all entries where $t = 1$ and $v = 1$.

A	B	C	D	$t = \overline{A}BC$	$u = A + D$	$v = \overline{A + D}$	$x = tv$
0	0	0	0	0	0	1	0
0	0	0	1	0	1	0	0
0	0	1	0	0	0	1	0
0	0	1	1	0	1	0	0
0	1	0	0	0	0	1	0
0	1	0	1	0	1	0	0
0	1	1	0	1	0	1	1
0	1	1	1	1	1	0	0
1	0	0	0	0	1	0	0
1	0	0	1	0	1	0	0
1	0	1	0	0	1	0	0
1	0	1	1	0	1	0	0
1	1	0	0	0	1	0	0
1	1	0	1	0	1	0	0
1	1	1	0	0	1	0	0
1	1	1	1	0	1	0	0

REVIEW QUESTIONS

1. Use the expression for x to determine the output of the circuit in Figure 3-15(a) for the conditions $A = 0, B = 1, C = 1$, and $D = 0$.
2. Use the expression for x to determine the output of the circuit in Figure 3-15(b) for the conditions $A = B = E = 1, C = D = 0$.
3. Determine the answers to Questions 1 and 2 by finding the logic levels present at each gate output using a table as in Figure 3-16.

3-8 IMPLEMENTING CIRCUITS FROM BOOLEAN EXPRESSIONS

When the operation of a circuit is defined by a Boolean expression, we can draw a logic-circuit diagram directly from that expression. For example, if we needed a circuit that was defined by $x = A \cdot B \cdot C$, we would immediately know that all that was needed was a three-input AND gate. If we needed a circuit that was defined by $x = A + \overline{B}$, we would use a two-input OR gate with an INVERTER on one of the inputs. The same reasoning used for these simple cases can be extended to more complex circuits.

Suppose that we wanted to construct a circuit whose output is $y = AC + B\overline{C} + \overline{A}BC$. This Boolean expression contains three terms (AC, $B\overline{C}$, $\overline{A}BC$), which are ORed together. This tells us that a three-input OR gate is required with inputs that are equal to AC, $B\overline{C}$, and $\overline{A}BC$. This is illustrated in Figure 3-17(a), where a three-input OR gate is drawn with inputs labeled as AC, $B\overline{C}$, and $\overline{A}BC$.

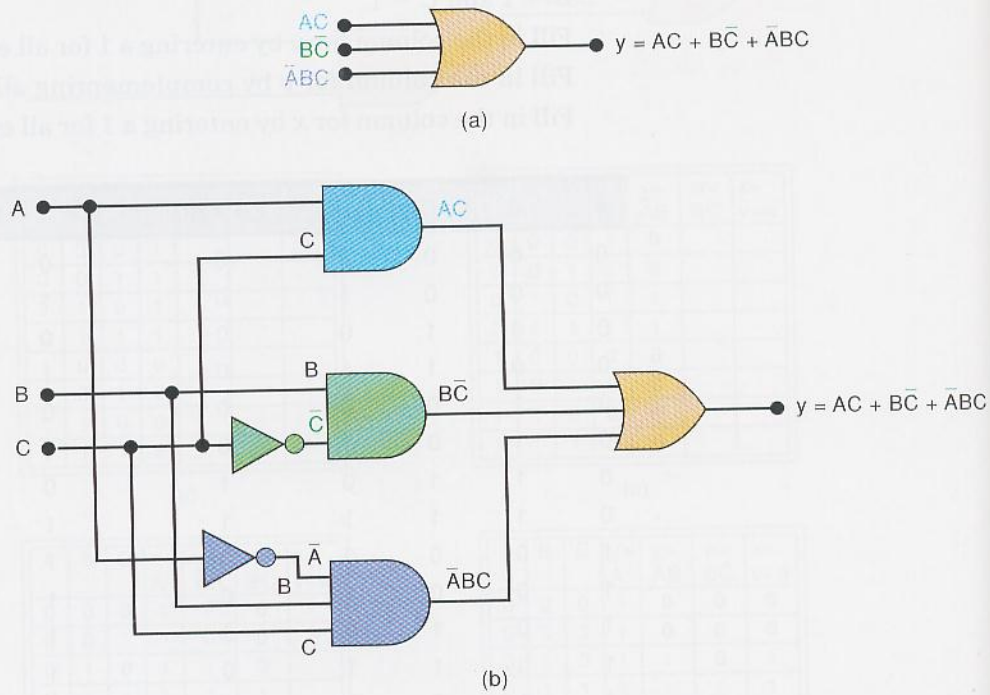

FIGURE 3-17 Constructing a logic circuit from a Boolean expression.

Each OR gate input is an AND product term, which means that an AND gate with appropriate inputs can be used to generate each of these terms. This is shown in Figure 3-17(b), which is the final circuit diagram. Note the use of INVERTERs to produce the $\overline{A}$ and $\overline{C}$ terms required in the expression.

This same general approach can always be followed, although we shall find that there are some clever, more efficient techniques that can be employed. For now, however, this straightforward method will be used to minimize the number of new items that are to be learned.

EXAMPLE 3-7

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.

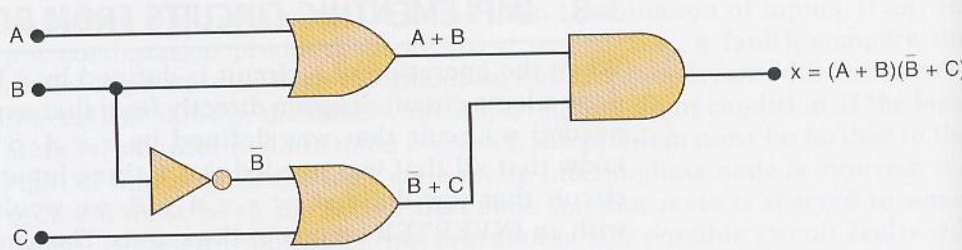

FIGURE 3-18 Example 3-7.