

If a circuit output is wrong for some set of input values, this may be due to several possible causes:

1. Incorrect design
2. Gates connected wrong
3. Wrong input signals to the circuit

If the circuit is built in lab, other possible causes include

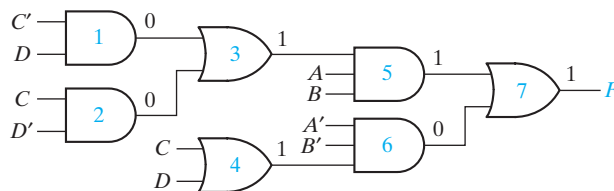
4. Defective gates
5. Defective connecting wires

Fortunately, if the output of a combinational logic circuit is wrong, it is very easy to locate the problem systematically by starting at the output and working back through the circuit until the trouble is located. For example, if the output gate has the wrong output and its inputs are correct, this indicates that the gate is defective. On the other hand, if one of the inputs is wrong, then either the gate is connected wrong, the gate driving this input has the wrong output, or the input connection is defective.

Example

FIGURE 8-14
Logic Circuit with
Incorrect Output

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A student builds the circuit in a lab and finds that when $A = B = C = D = 1$, the output F has the wrong value, and that the gate outputs are as shown in Figure 8-14. The reason for the incorrect value of F can be determined as follows:

1. The output of gate 7 (F) is wrong, but this wrong output is consistent with the inputs to gate 7, that is, $1 + 0 = 1$. Therefore, one of the inputs to gate 7 must be wrong.
2. In order for gate 7 to have the correct output ($F = 0$), both inputs must be 0. Therefore, the output of gate 5 is wrong. However, the output of gate 5 is consistent with its inputs because $1 \cdot 1 \cdot 1 = 1$. Therefore, one of the inputs to gate 5 must be wrong.
3. Either the output of gate 3 is wrong, or the A or B input to gate 5 is wrong. Because $C'D + CD' = 0$, the output of gate 3 is wrong.
4. The output of gate 3 is not consistent with the outputs of gates 1 and 2 because $0 + 0 \neq 1$. Therefore, either one of the inputs to gate 3 is connected wrong, gate 3 is defective, or one of the input connections to gate 3 is defective.

This example illustrates how to troubleshoot a logic circuit by starting at the output gate and working back until the wrong connection or defective gate is located.