4.3 Determine the output function of the circuit of Figure 4.27 for the following faults:

a. AND bridge between inputs of gate G_1

b. The multiple fault $\{x_3$ *s-a*-1, x_2 *s-a*-0$\}$

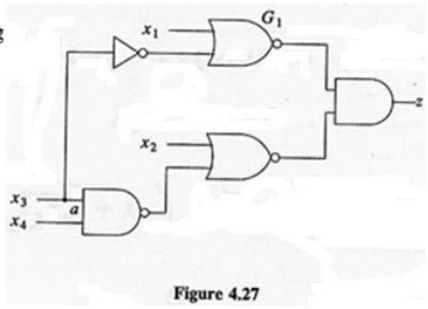
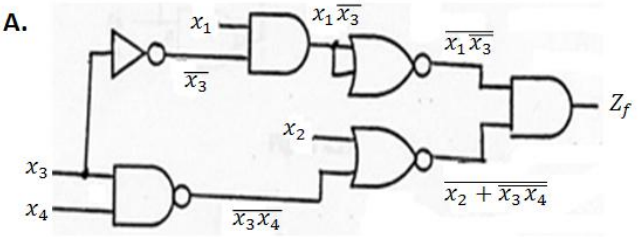


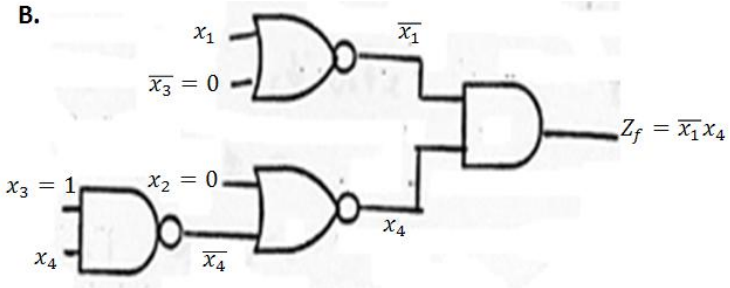
Figure 4.27

A.



$$Z_f = (\overline{x_1\overline{x_3}})(\overline{x_{2+}\overline{x_3x_4}})$$
$$= (\overline{x_1} + x_3)(\overline{x_2} \cdot (x_3x_4))$$

B.



4.4 In the circuit of Figure 4.27 which if any of the following tests detect the fault x_1 *s-a*-0?

a. (0,1,1,1)

b. (1,1,1,1)

c. (1,1,0,1)

d. (1,0,1,0)

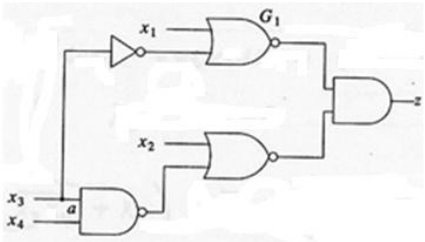


Figure 4.27

	Z(t)	Z_f(t)
a. Does not activate	0	0
b. $X_2 = 1$ ⇨ Z = 0	0	0
c. $X_2 = 1$ ⇨ Z = 0	0	0
d. $X_4 = 0$ ⇨ Z = 0	0	0

4.5 For the circuit of Figure 4.27 find a Boolean expression for the set of all tests that detect the fault:

a. x_3 *s-a-0*

b. x_2 *s-a-0*

c. x_2 *s-a-1*

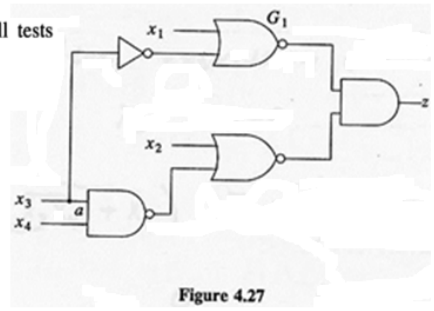


Figure 4.27

A. $Z = (\overline{\overline{x_3x_4} + x_2})(\overline{\overline{x_3} + x_1}) = \overline{x_1}\,\overline{x_2}\,x_3x_4$

$Z_{f(x_3\,s-a-0)} = 0$ *(by substitution)*

- *set* $Z \oplus Z_f = 1$
- $\overline{x_1}\,\overline{x_2}\,x_3x_4 \oplus 0 = 1$
- $\overline{x_1}\,\overline{x_2}\,x_3x_4 = 1$
- $(x_1x_2x_3x_4) = (0011)$ *(only* ***one*** *test)*

B. $Z = \overline{x_1}\,\overline{x_2}\,x_3x_4 \Rightarrow Z_f = \overline{x_1}x_3x_4$

- *set* $Z \oplus Z_f = 1$
- $\overline{x_1}\,\overline{x_2}\,x_3x_4 \oplus \overline{x_1}x_3x_4 = 1$
- $\overline{x_1}x_2x_3x_4 = 1$
- $(x_1x_2x_3x_4) = (0111)$ *(only* ***one*** *test)*

C. $Z = \overline{x_1}\,\overline{x_2}\,x_3x_4$

$Z_{f(x_2\,s-a-1)} = 0$ *(by substitution)*

- *set* $Z \oplus Z_f = 1$
- $\overline{x_1}\,\overline{x_2}\,x_3x_4 \oplus 0 = 1$
- $\overline{x_1}\,\overline{x_2}\,x_3x_4 = 1$
- $(x_1x_2x_3x_4) = (0011)$ *(only* ***one*** *test)*

4.6 For the circuit of Figure 4.28

a. Find the set of all tests that detect the fault *c s-a-1*.

b. Find the set of all tests that detect the fault *a s-a-0*.

c. Find the set of all tests that detect the multiple fault {*c s-a-1*, *a s-a-0*}.

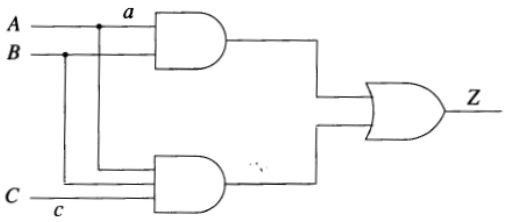


Figure 4.28

A. $Z = AB + ABC = AB \qquad (x + xy = x)$

$Z_f = AB + AB(1) = AB$

- $Z \oplus Z_f = 1$ *has no solution*

B. $Z = AB + ABC = AB$ *(from part* **A.***)*

$Z_f = (0)B + ABC = ABC$

- $Z \oplus Z_f = 1 \Rightarrow AB \oplus ABC = 1$
- $\Rightarrow A = 1, \mathrm{B} = 1, \mathrm{C} = 0$

C. $Z = AB + ABC = AB$ *(from part* **A.***)*

$Z_f = (0)B + AB(1) = 0 + AB = AB$

- $Z \oplus Z_f = 1 \Rightarrow AB \oplus AB = 1$
- $\Rightarrow$ *which has no solution*

4.8 For the circuit of Figure 4.30

a. Find the set of all tests that detect the fault *b* *s-a*-1.

b. Find the set of all tests that distinguish the faults *a* *s-a*-0 and *c* *s-a*-0.

c. Find the set of all tests that distinguish the multiple faults {*a* *s-a*-0, *b* *s-a*-1} and {*c* *s-a*-0, *b* *s-a*-1}.

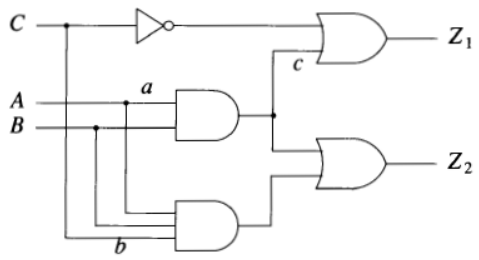


Figure 4.30

A. $Z_1 = \bar{C} + AB$

$Z_2 = AB + ABC = AB$

$Z_{1f(b\,s-a-1)} = \bar{C} + AB \qquad (same\ as\ Z_1)$

$Z_{2f(b\,s-a-1)} = AB + AB(1) = AB \qquad (same\ as\ Z_2)$

♣ b s-a-1 is <u>not</u> detectable

B. For a s-a-0: $Z_{1f} = \bar{C}$ and $Z_{2f} = ABC$

For c s-a-0: $Z_{1f} = \bar{C}$ and $Z_{2f} = AB + ABC = AB$

♣ $Z_f \oplus Z_g = 1$ ➡ $Z_{1f} \oplus Z_{1g} = \bar{C} \oplus \bar{C} = 1 \quad no\ solution$

➡ $Z_{2f} \oplus Z_{2g} = AB \oplus ABC = 1$ ➡ $AB\bar{C} = 1$ ➡ $ABC = 110$

C. ♣ m_1= {a s-a-0, b s-a-1} ♣ m_2= {c s-a-0, b s-a-1}

Under m_1: $Z_{1m_1} = \bar{C}$, $Z_{2m_1} = AB$

Under m_2: $Z_{1m_2} = \bar{C}$, $Z_{2m_2} = AB + AB = AB$

Therefore m_1 and m_2 are <u>indistinguishable</u>