CSE435 Introduction to EDA & Testing - Spring 2022

Homework Assignment #5

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1. (20%) A circuit has the truth table of Table 1. When there is a fault (faults) on the circuit, the faulty truth table becomes Table 2. Try to derive tests to detect the fault (faults).

CD \ AB	00	01	11	10
00	1			
01		1	1	
11				1
10			1	1

Table 1

CD \ AB	00	01	11	10
00				
01		1	1	
11				
10	1		1	1

Table 2

Solution: Compare two truth tables, we can tell the circuit has stuck-at-0 fault at output when input (A, B, C, D) equals (0, 0, 0, 0) or (1, 0, 1, 1). The circuit also has stuck-at-1 fault at output when the input equals (0, 0, 1, 0).

Answers: {(0, 0, 0, 0), (1, 0, 1, 1), (0, 0, 1, 0)}

2. (80%) Generate a test for the fault f-sa1 in Figure 1 by the following FOUR methods. Be sure to give the **key steps to show the features of every algorithm**, and also **draw the decision trees** for each case.

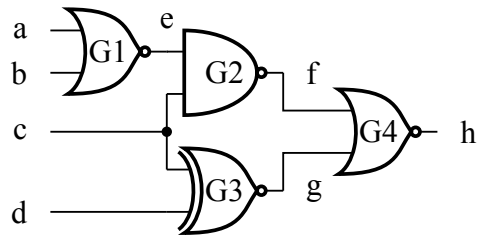

Figure 1

(a) (20%) Use the **Boolean difference method** to derive all the test patterns to detect the fault f-sa1.

Solution: To test the stuck-at-1 fault at f, f must equal 0 to activate the fault. In addition, the fault has to be observable at the output, meaning that the boolean difference of the logic function F w.r.t. f should be 1, i.e., $F_f(0) \oplus F_f(1) = 1$.

$$
\begin{aligned}
f &= 0 \\
f' &= 1 \\
F_f(0) \oplus F_f(1) &= 1 \\
(f')(F_f(0) \oplus F_f(1)) &= 1 \\
(f')(0 + (c \oplus d)')' \oplus (1 + (c \oplus d)')' &= 1 \\
(f')(c \oplus d \oplus 0) &= 1 \\
(f')(c \oplus d) &= 1 \\
((a + b)'c)''(c \oplus d) &= 1 \\
((a + b)'c)(c \oplus d) &= 1 \\
a'b'c(c \oplus d) &= 1 \\
a'b'c(cd' + c'd) &= 1 \\
a'b'ccd' + a'b'cc'd &= 1 \\
a'b'cd' &= 1
\end{aligned}
$$

Answer: {(a, b, c, d) | a'b'cd' = 1} = {(0, 0, 1, 0)}.

(b) (20%) Generate a test for the fault f-sa1 by using **D-algorithm**.

Solution:

Step	Decision	Implication	Comment
1	f = D'	e = c = 1	Activate f-sa1
		a = b = 0	(ce)' = 0
			(a+b)' = 1
2	g = 0	h = D	Propagate via h
		d = 0	c⊕d = 1, and c = 1 (from step 1)

Answer: (a, b, c, d) = (0, 0, 1, 0).

(c) (20%) Generate a test for the fault f-sa1 by using **9-V Algorithm**.

Solution: Same as 2(b) above.

(d) (20%) Generate a test for the fault f-sa1 by using **PODEM algorithm**.

Solution:

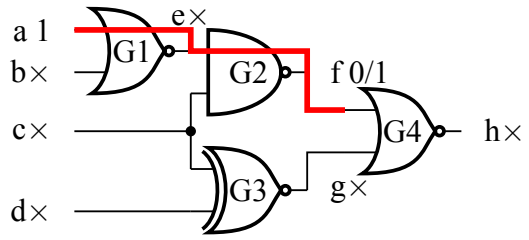

Figure 2: Activate f-sa1, so f = 0. Objective = (f, 0), inversion parity = even. Therefore, a = f = 0.

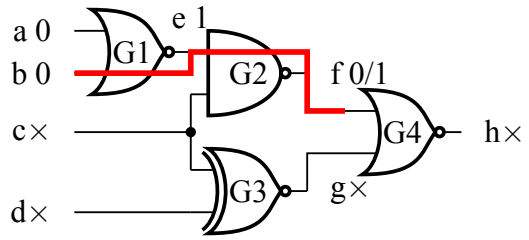

Figure 3: Objective = (f, 0), inversion parity = even. Therefore, b = f = 0, e = 1.

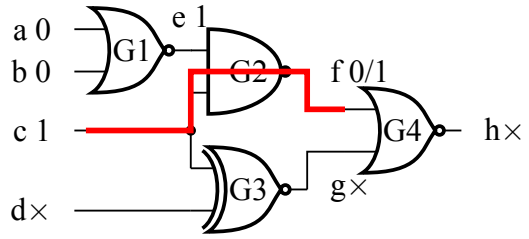

Figure 4: Objective = (f, 0), inversion parity = odd. Therefore, c = f' = 1

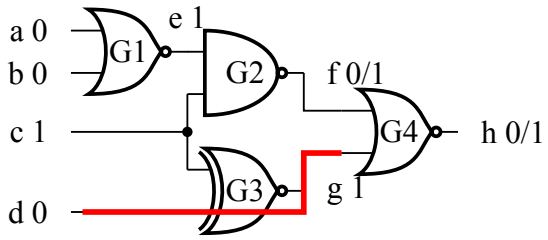

Figure 5: To propagate to h, g = 1. Objective = (g, 1), inversion parity = odd. Therefore, d = g' = 0. f-sa1 is now observable at h, thus complete.

Answer: (a, b, c, d) = (0, 0, 1, 0).