

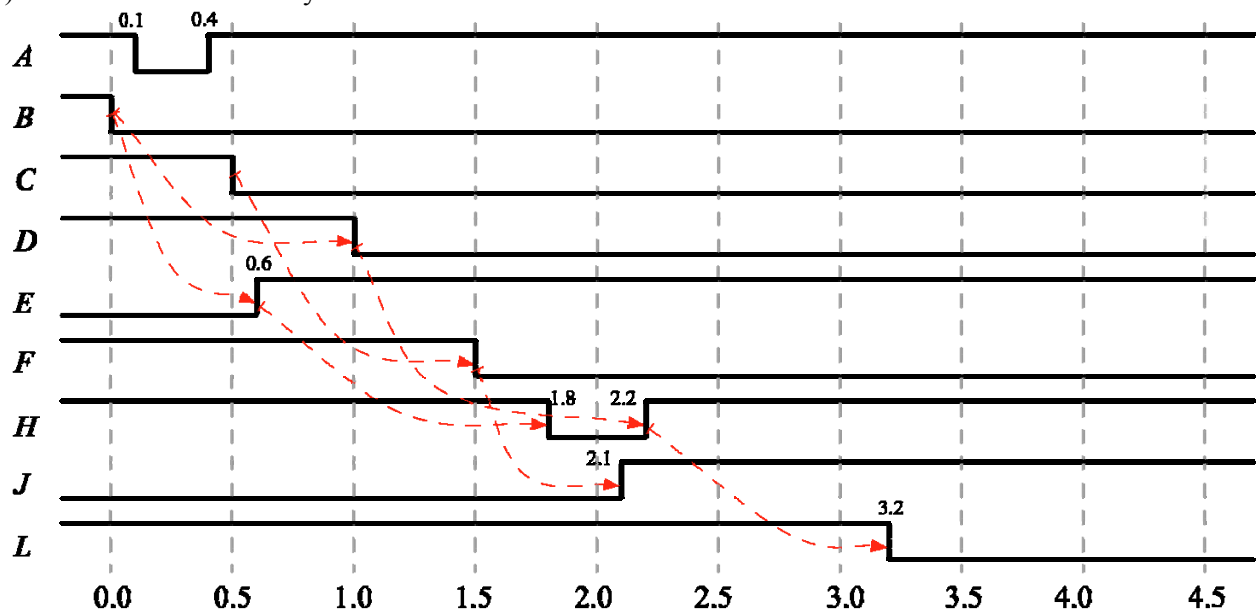
The University of Alabama in Huntsville
ECE Department
CPE 628 01
Fall 2008
Homework #2 Solution

3.2(30 points), 3.4(30 points), 3.7(20 points), 3.8(20 points), Concurrent Fault Simulation Problem(60 points), Deductive Fault Simulation Problem(40 points)

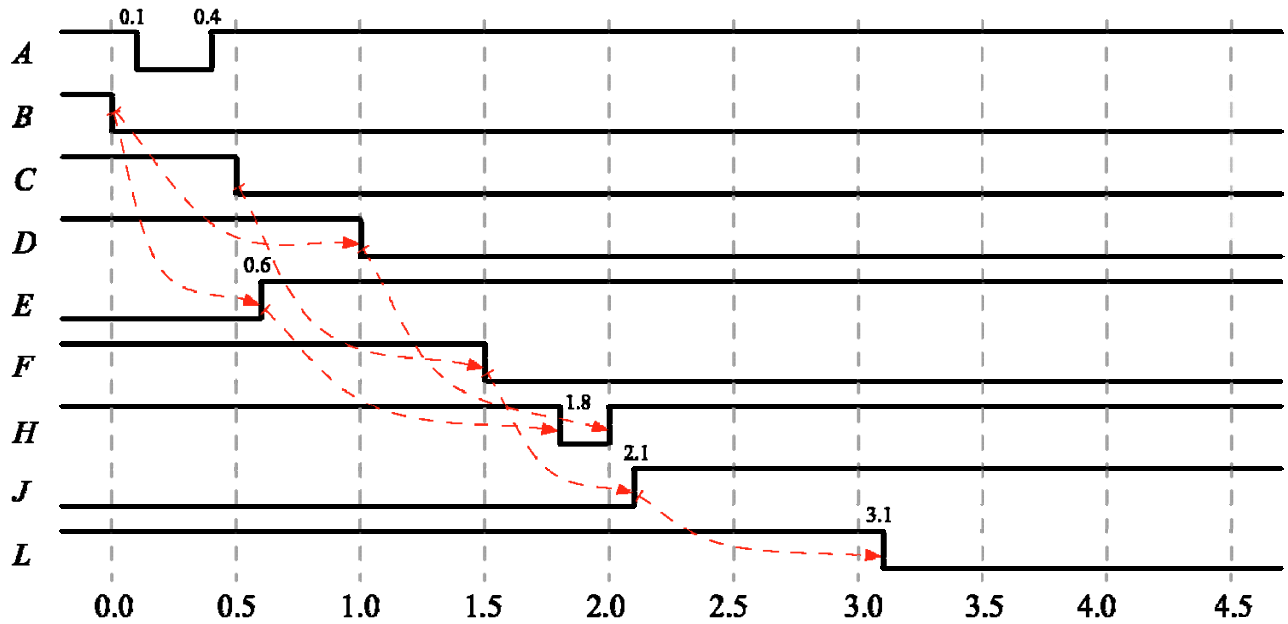
3.2 For the circuit shown, complete the following timing diagram with respect to each timing model given below:

- (a) Nominal delay – Two-input gate, 1 ns; three-input gate, 1.2 ns; inverter, 0.6 ns.
 Inertial delay – All gates, 0.3 ns;
- (b) Rise delay – Two-input gate, 0.8 ns; three-input gate, 1 ns; inverter, 0.6 ns.
 Fall delay – Two-input gate, 1 ns; three-input gate, 1.2 ns; inverter, 0.8 ns.
- (c) Minimum delay – Two-input gate, 0.8 ns; three-input gate, 1 ns; inverter, 0.6 ns.
 Maximum delay – Two-input gate, 1 ns; three-input gate, 1.2 ns; inverter, 0.8 ns.

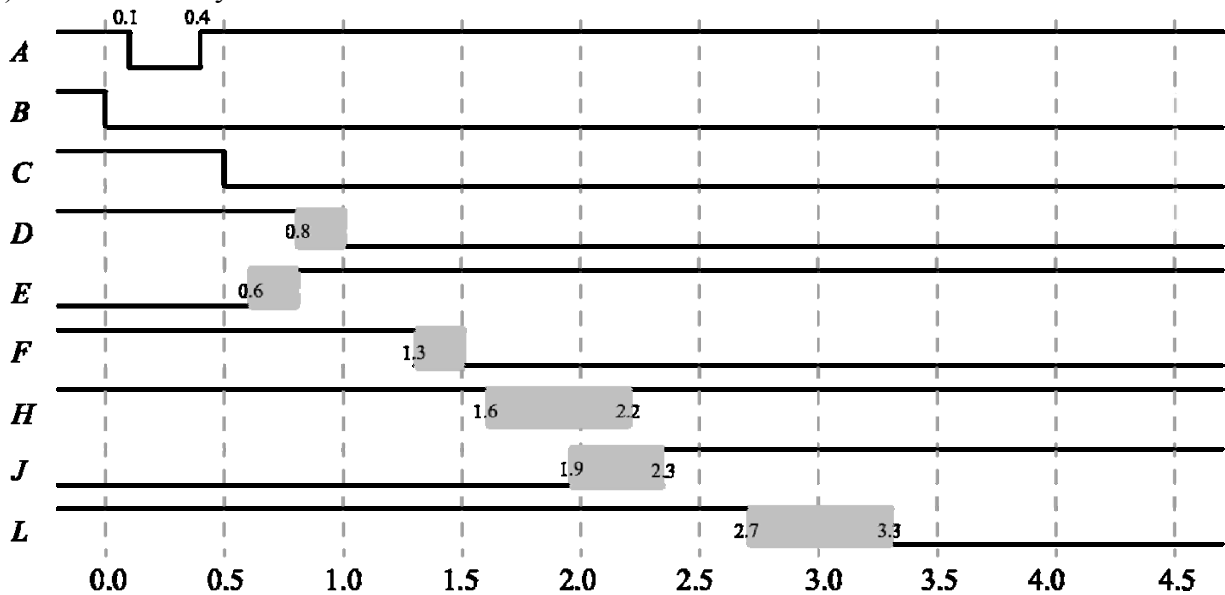
(a) Nominal + Inertial Delays



(b) Rise/Fall Delays



(c) Min-Max Delays

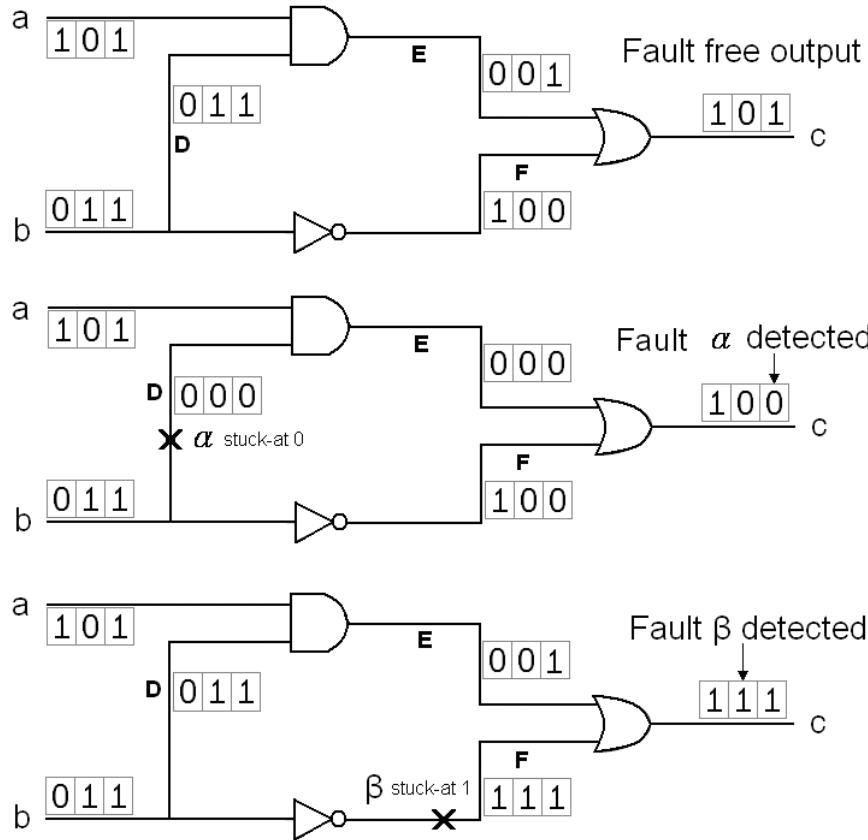


3.4 Redo Problem 3.2a using the nominal-delay event-driven simulation technique. Show all events and activity lists of each time stamp.

Time	L_E	L_A	Scheduled Events
0	$\{(B,0)\}$	$\{D,E,F\}$	$\{(D,0,1),(E,1,0.6),(F,1,1)\}$
0.1	$\{(A,0)\}$	$\{D\}$	$\{(D,0,1.1)\}$
0.4	$\{(A,1)\}$	$\{D\}$	$\{(D,0,1.4)\}$
0.5	$\{(C,0)\}$	$\{F\}$	$\{(F,0,1.5)\}$
0.6	$\{(E,1)\}$	$\{H\}$	$\{(H,0,1.8)\}$
1	$\{(D,0),(F,1)\}$	$\{H\}$	$\{(H,1,2.2)\}$
1.1	$\{(D,0)\}$		
1.4	$\{(D,0)\}$		
1.5	$\{(F,0)\}$	$\{H,J\}$	$\{(H,1,2.7),(J,1,2.1)\}$
1.8	$\{(H,0)\}$	$\{L\}$	$\{(L,1,2.8)\}$

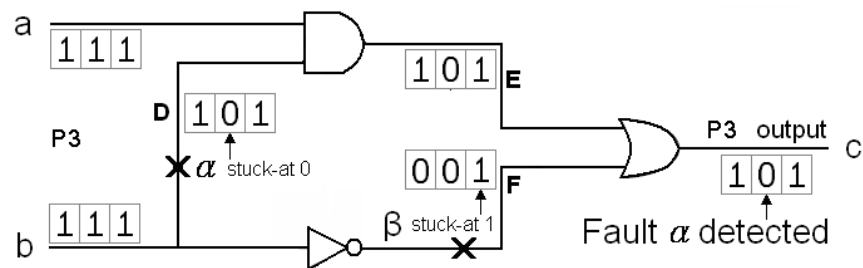
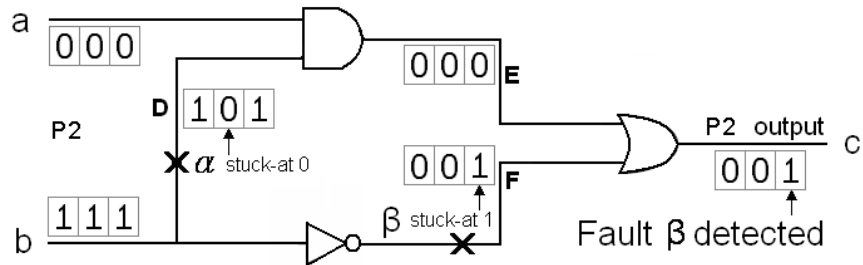
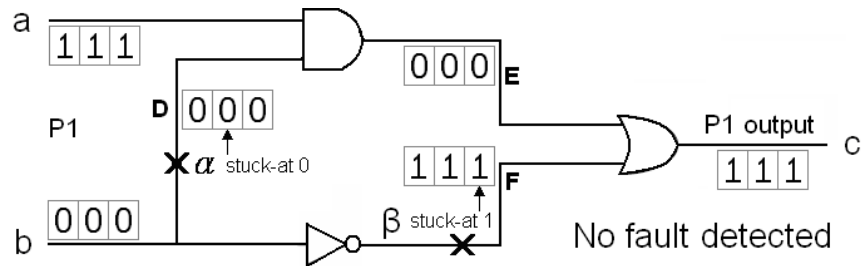
2.1	$\{(J,1)\}$	$\{L\}$	$\{(L,1,3.1)\}$
2.2	$\{(H,1)\}$	$\{L\}$	$\{(L,0,3.2)\}$
2.7	$\{(\overline{H},1)\}$		
2.8	$\{(L,1)\}$		
3.1	$\{(L,1)\}$		
3.2	$\{(L,0)\}$		

3.7 For the circuit and two given stuck-at faults shown, use the parallel-pattern single-fault propagation technique to identify which faults can be detected by the given test patterns.



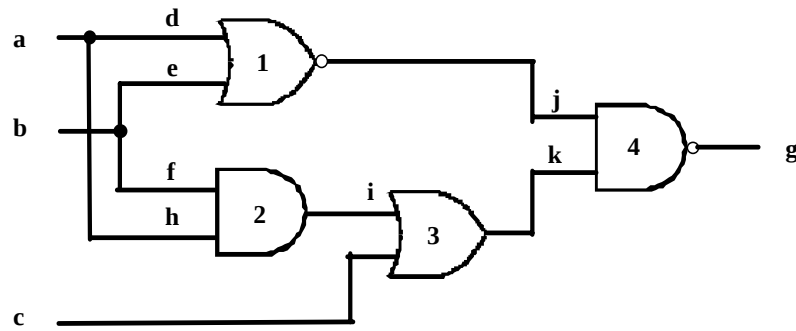
PPSFP		input		internal			output
fault	<i>P</i>	<i>a</i>	<i>b</i>	<i>D</i>	<i>E</i>	<i>F</i>	<i>c</i>
fault-free	P1	1	0	0	0	1	1
	P2	0	1	1	0	0	0
	P3	1	1	1	1	0	1
α	P1	1	0	0	0	1	1
	P2	0	1	<u>0</u>	0	0	0
	P3	1	1	<u>0</u>	<u>0</u>	0	<u>0</u>
β	P1	1	0	0	0	1	1
	P2	0	1	1	0	<u>1</u>	<u>1</u>
	P3	1	1	1	1	<u>1</u>	1

3.8 Repeat Problem 3.7 using parallel fault simulation.

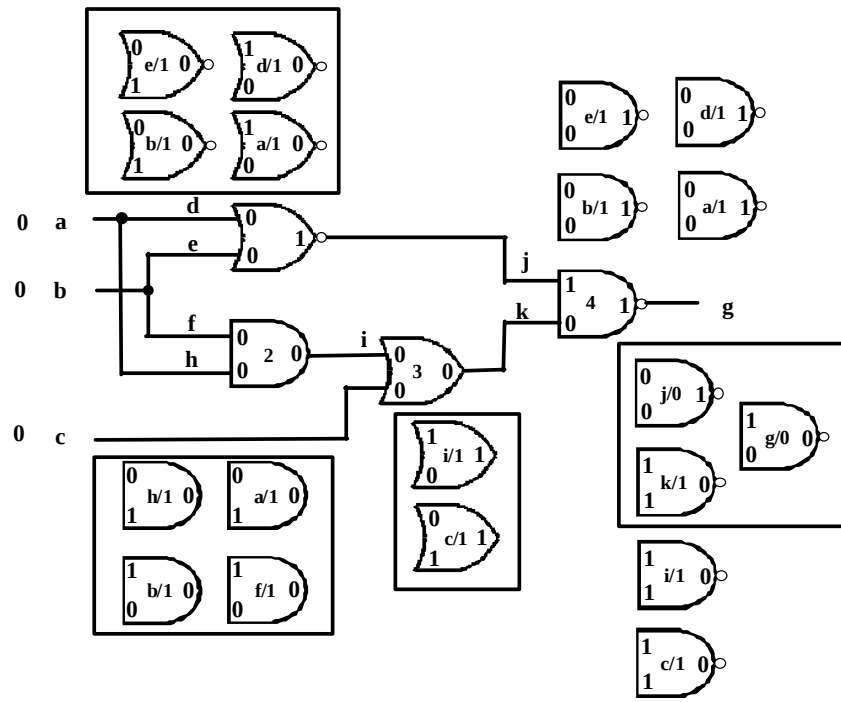


PFS		input		internal			output
Pattern	fault	a	b	D	E	F	c
P1	fault-free	1	0	0	0	1	1
	α	1	0	0	0	1	1
	β	1	0	0	0	1	1
P2	fault-free	0	1	1	0	0	0
	α	0	1	<u>0</u>	0	0	0
	β	0	1	1	0	<u>1</u>	<u>1</u>
P3	fault-free	1	1	1	1	0	1
	α	1	1	<u>0</u>	<u>0</u>	0	<u>0</u>
	β	1	1	1	1	<u>1</u>	1

For the circuit shown, use concurrent fault simulation to determine the faults detected by an exhaustive test set.



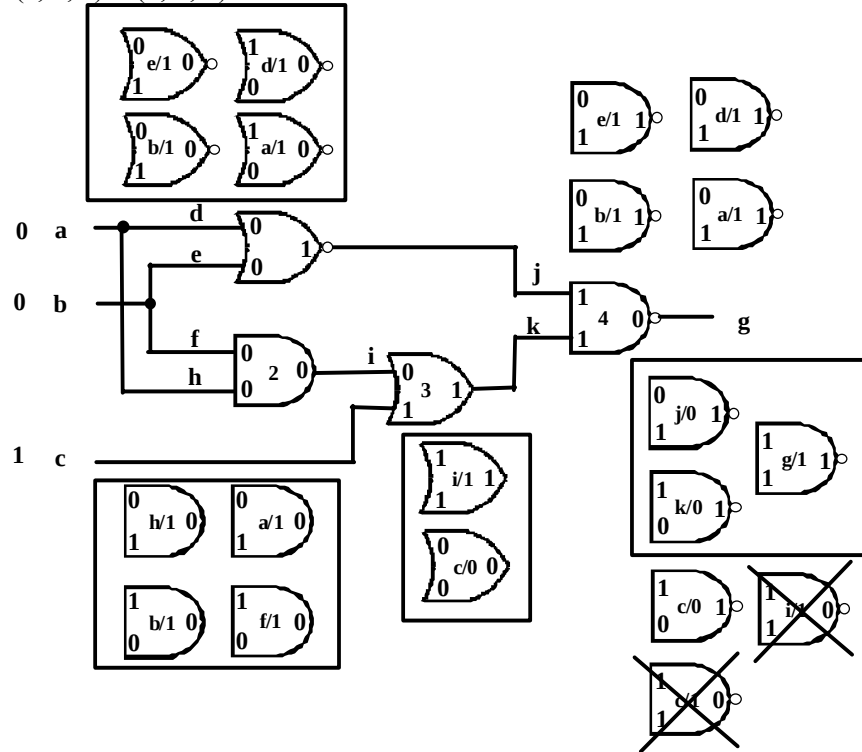
Pattern 1 (a, b, c) = (0, 0, 0)



Faults detected are {c/1, g/0, i/1, k/1}

Pattern 2

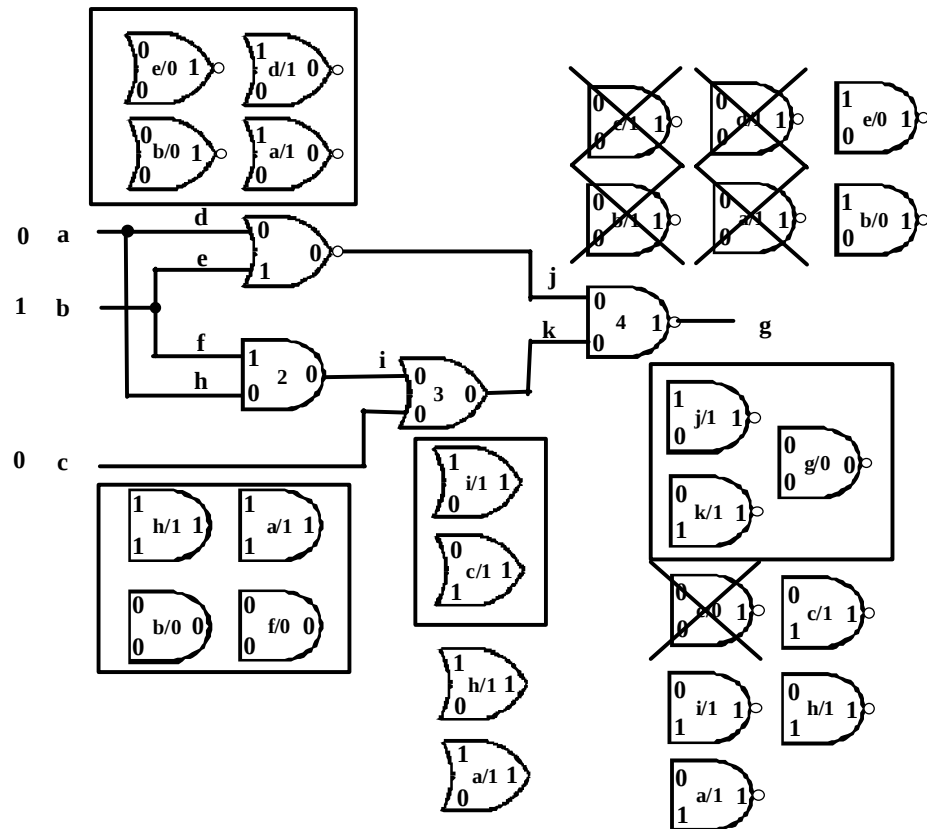
(a, b, c) = (0, 0, 1)



Faults detected are {a/1, b/1, c/0, d/1, e/1, g/1, j/0, k/0}

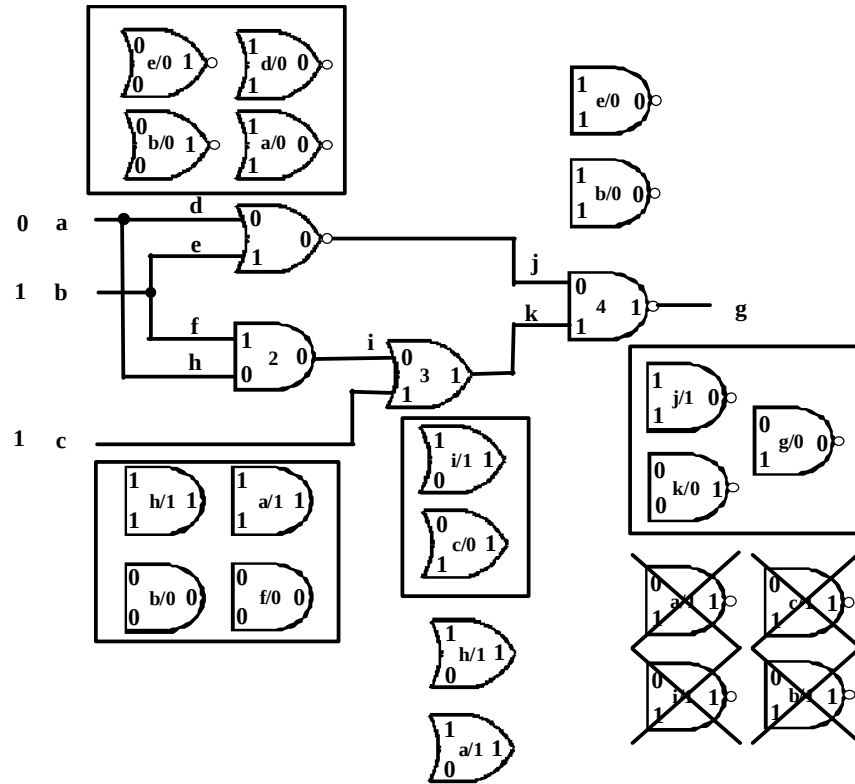
Pattern 3

(a, b, c) = (0, 1, 0)



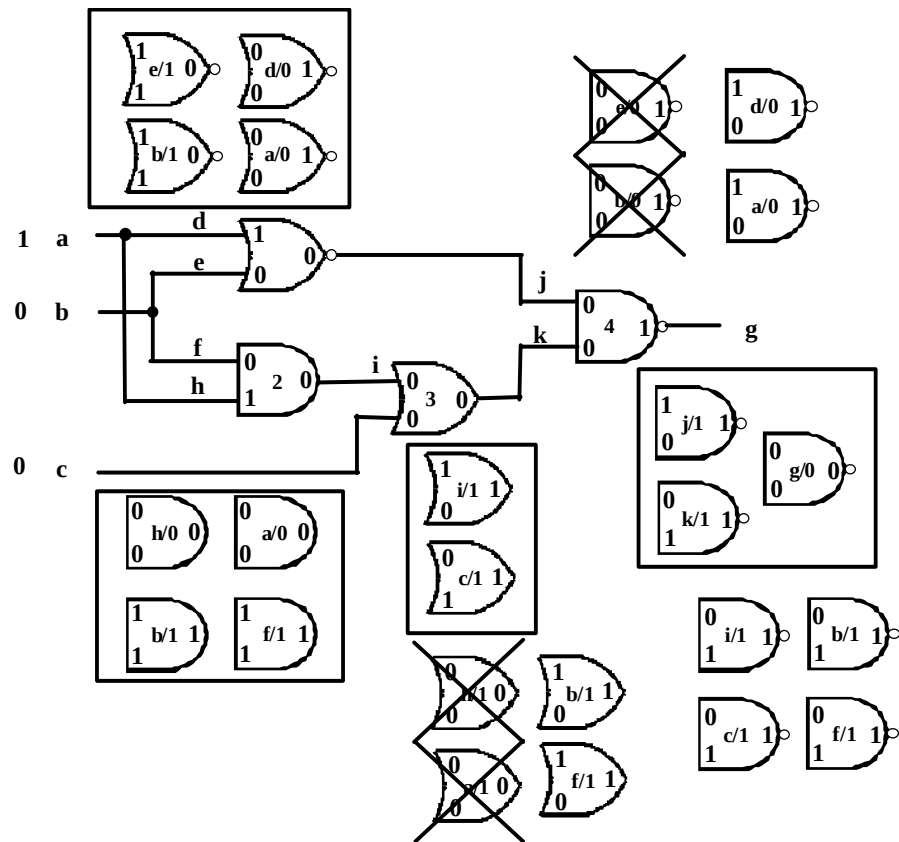
Faults detected are {g/0}

Pattern 4 (a, b, c) = (0, 1, 1)



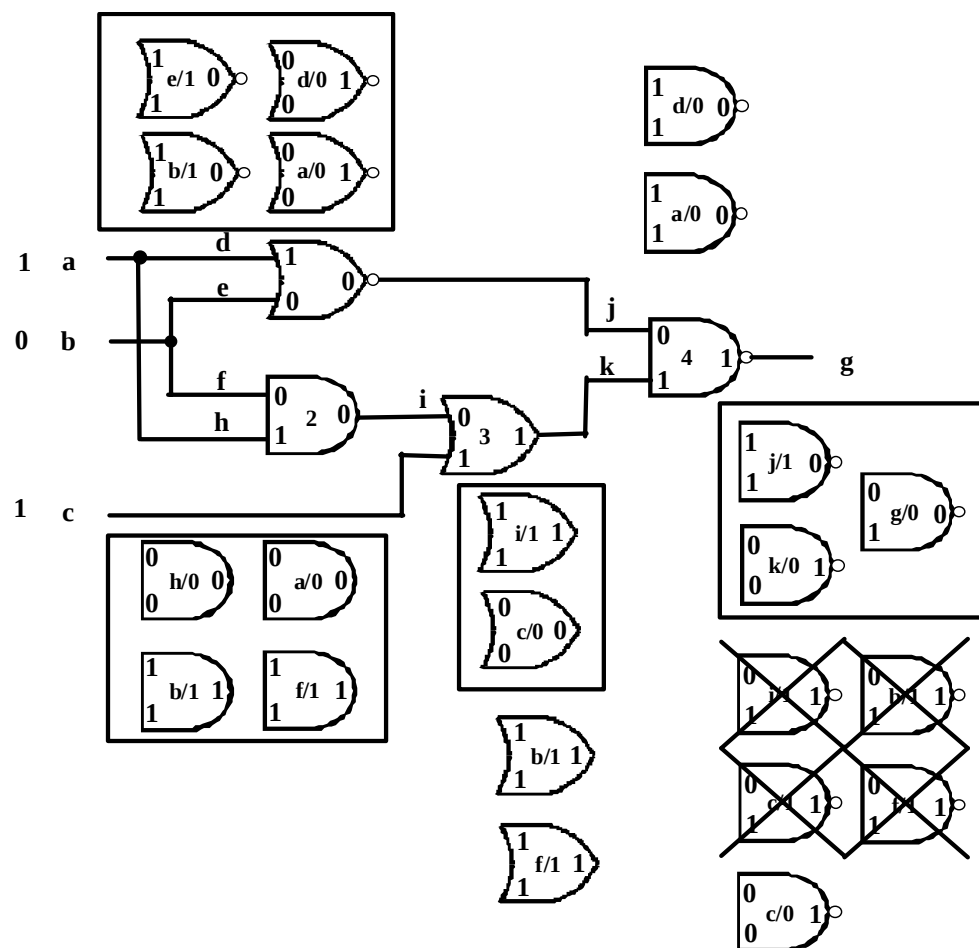
Faults detected are {b/0, e/0, g/0, j/1}

Pattern 5 (a, b, c) = (1, 0, 0)

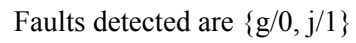


Faults detected are {g/0}

Pattern 6

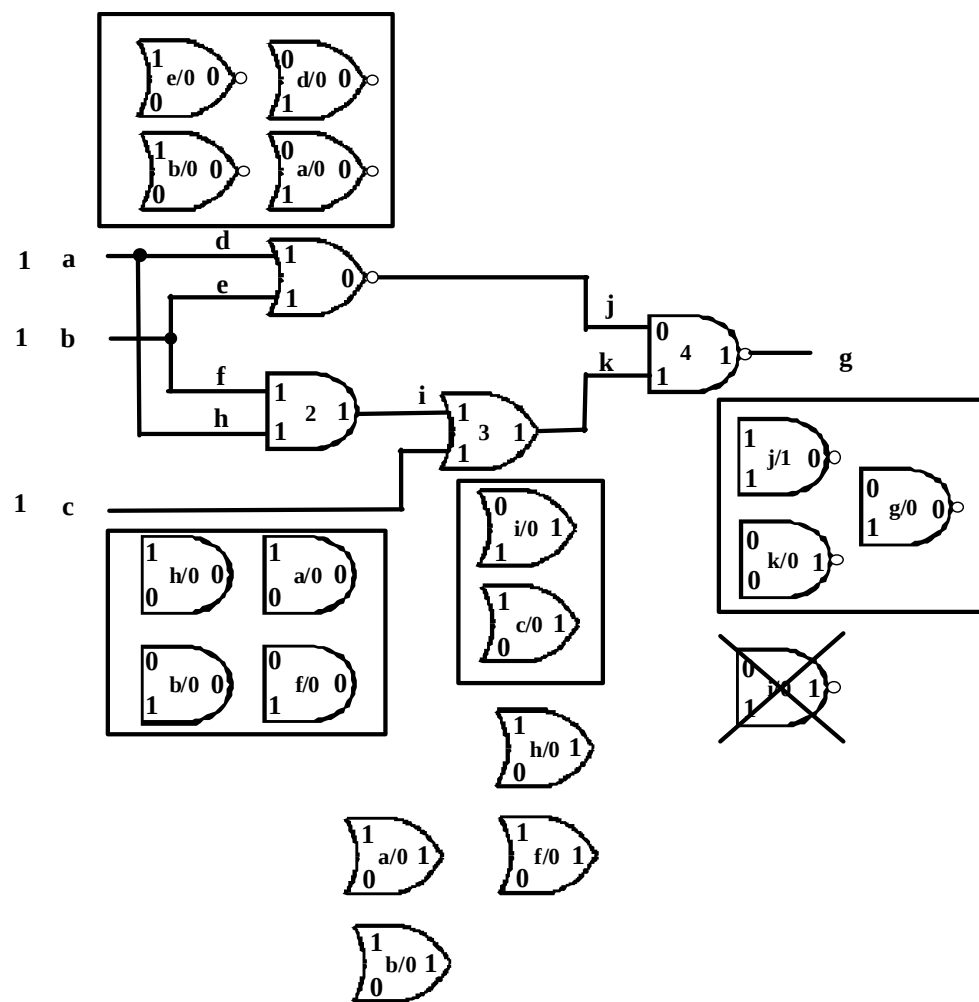
$$(a, b, c) = (1, 0, 1)$$


Faults detected are {a/0, d/0, g/0, j/1}

$$(a, b, c) = (1, 1, 0)$$


Faults detected are $\{g/0, j/1\}$

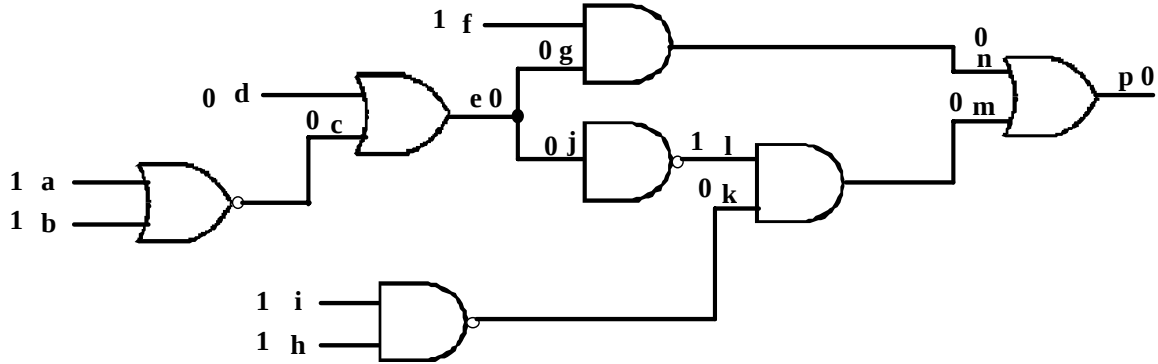
Pattern 8 $abc = (1, 1, 1)$



Faults detected are $\{g/0, j/1\}$

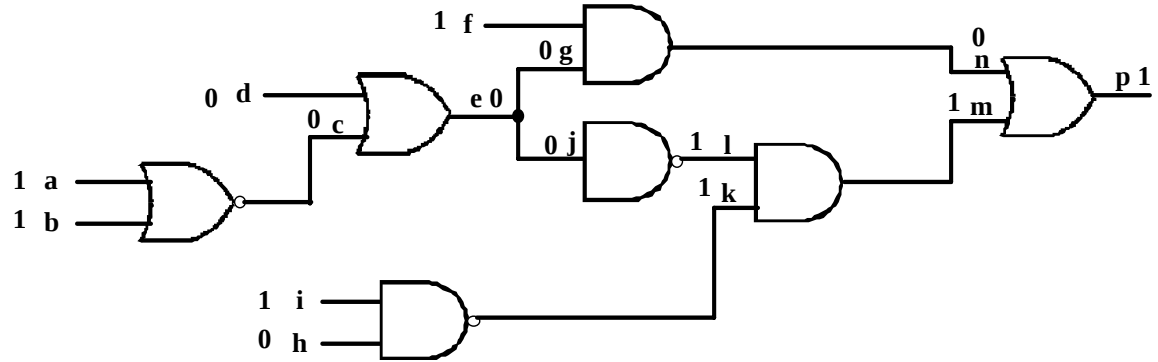
For the circuit shown, use deductive fault simulation to determine the faults detected by the following set of input patterns: (a, b, c, d, f, i, h) = (1, 1, 0, 1, 1, 1), (1, 1, 0, 1, 1, 0), (0, 1, 0, 1, 0, 1), (0, 0, 0, 1, 1, 1), (1, 1, 1, 0, 1, 1), (1, 1, 1, 1, 0, 1).

Pattern 1 (a, b, c, d, f, i, h) = (1, 1, 0, 1, 1, 1, 1)



$L_a = \{a/0\}$ $L_b = \{b/0\}$ $L_c = \{c/1\}$ $L_d = \{d/1\}$ $L_e = \{d/1, c/1, e/1\}$
 $L_f = \{f/0\}$ $L_g = \{d/1, c/1, e/1, g/1\}$ $L_h = \{h/0\}$ $L_i = \{i/0\}$
 $L_j = \{d/1, c/1, e/1, j/1\}$ $L_k = \{h/0, i/0, k/1\}$ $L_l = \{d/1, c/1, e/1, j/1, l/0\}$
 $L_m = \{h/0, i/0, k/1, m/1\}$ $L_n = \{d/1, c/1, e/1, g/1, n/1\}$
 $L_p = \{c/1, d/1, e/1, g/1, h/0, i/0, k/1, m/1, n/1, p/1\}$

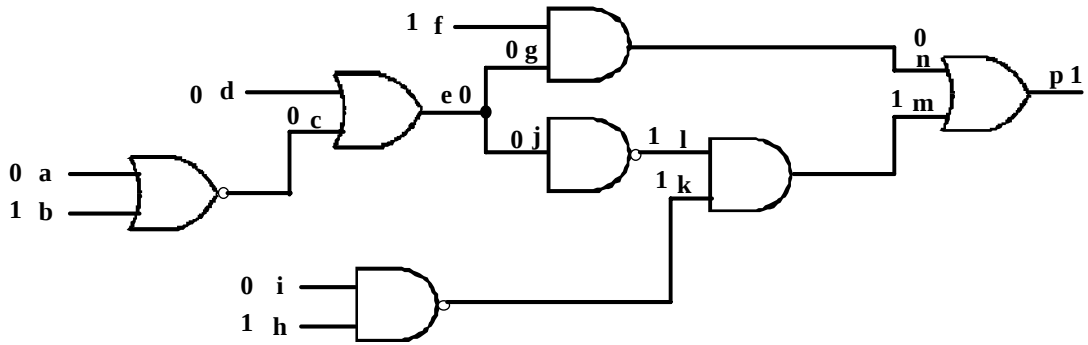
Pattern 2 (a, b, c, d, f, i, h) = (1, 1, 0, 1, 1, 0)



$L_a = \{a/0\}$ $L_b = \{b/0\}$ $L_c = \{c/1\}$ $L_d = \{d/1\}$ $L_e = \{d/1, c/1, e/1\}$
 $L_f = \{f/0\}$ $L_g = \{d/1, c/1, e/1, g/1\}$ $L_h = \{h/1\}$ $L_i = \{i/0\}$
 $L_j = \{d/1, c/1, e/1, j/1\}$ $L_k = \{h/1, k/0\}$ $L_l = \{d/1, c/1, e/1, j/1, l/0\}$
 $L_m = \{h/1, k/0, d/1, c/1, e/1, j/1, l/0, m/0\}$ $L_n = \{d/1, c/1, e/1, g/1, n/1\}$
 $L_p = \{h/1, j/1, k/0, l/0, m/0, p/0\}$

Pattern 3

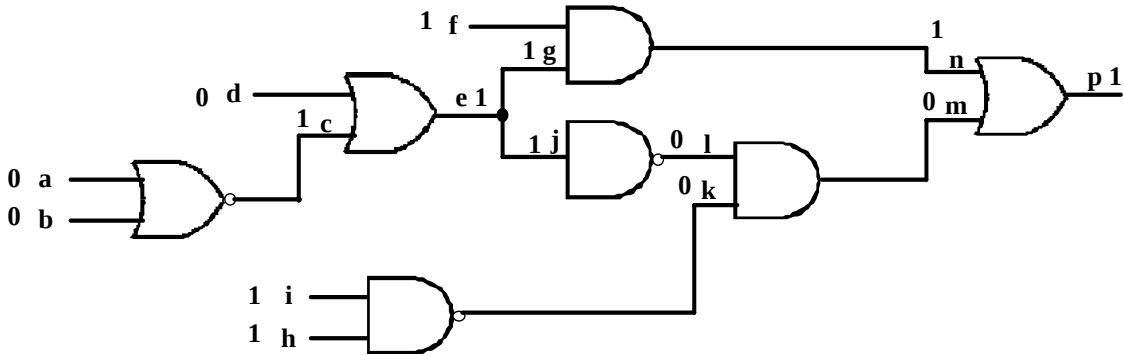
(a, b, c, d, f, i, h) = (0, 1, 0, 1, 0, 1)



$L_a = \{a/1\}$ $L_b = \{b/0\}$ $L_c = \{c/1\}$ $L_d = \{d/1\}$ $L_e = \{d/1, c/1, e/1\}$
 $L_f = \{f/0\}$ $L_g = \{d/1, c/1, e/1, g/1\}$ $L_h = \{h/0\}$ $L_i = \{i/1\}$
 $L_j = \{d/1, c/1, e/1, j/1\}$ $L_k = \{i/1, k/0\}$ $L_l = \{d/1, c/1, e/1, j/1, l/0\}$
 $L_m = \{c/1, d/1, e/1, i/1, j/1, k/0, l/0, m/0\}$ $L_n = \{c/1, d/1, e/1, g/1, n/1\}$
 $L_p = \{i/1, j/1, k/0, l/0, m/0, p/0\}$

Pattern 4

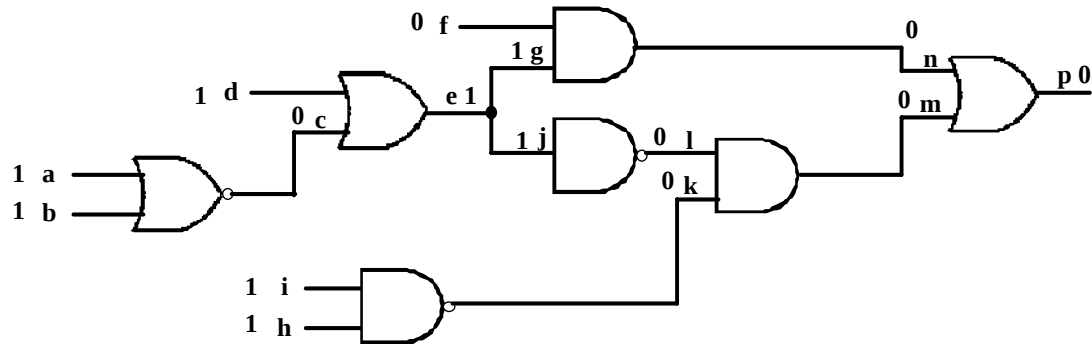
(a, b, c, d, f, i, h) = (0, 0, 0, 1, 1, 1)



$L_a = \{a/1\}$ $L_b = \{b/1\}$ $L_c = \{a/1, b/1, c/0\}$ $L_d = \{d/1\}$ $L_e = \{a/1, b/1, c/0, e/0\}$
 $L_f = \{f/0\}$ $L_g = \{a/1, b/1, c/0, e/0, g/0\}$ $L_h = \{h/0\}$ $L_i = \{i/0\}$
 $L_j = \{a/1, b/1, c/0, e/0, j/0\}$ $L_k = \{h/0, i/0, k/1\}$ $L_l = \{a/1, b/1, c/0, e/0, j/0, l/1\}$
 $L_m = \{m/1\}$ $L_n = \{a/1, b/1, c/0, e/0, f/0, g/0, n/0\}$
 $L_p = \{a/1, b/1, c/0, e/0, f/0, g/0, n/0, p/0\}$

Pattern 5

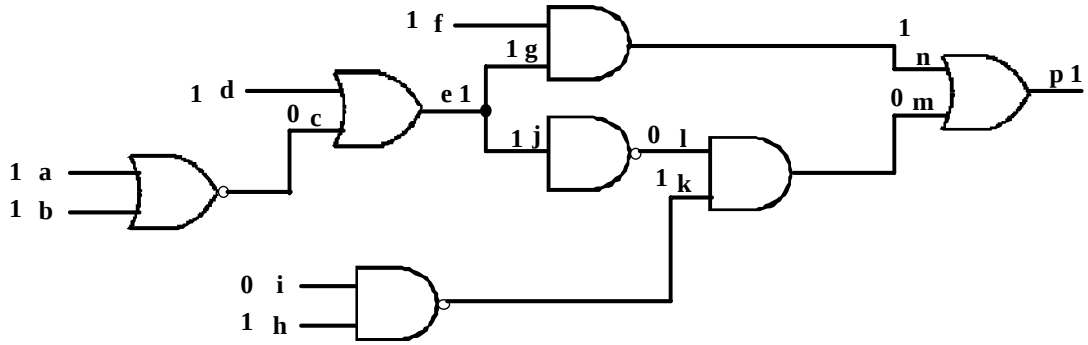
(a, b, c, d, f, i, h) = (1, 1, 1, 0, 1, 1)



$L_a = \{a/0\}$ $L_b = \{b/0\}$ $L_c = \{c/1\}$ $L_d = \{d/0\}$ $L_e = \{d/0, e/0\}$
 $L_f = \{f/1\}$ $L_g = \{d/0, e/0, g/0\}$ $L_h = \{h/0\}$ $L_i = \{i/0\}$
 $L_j = \{d/0, e/0, j/0\}$ $L_k = \{h/0, i/0, k/1\}$ $L_l = \{d/0, e/0, j/0, l/1\}$
 $L_m = \{m/1\}$ $L_n = \{f/1, n/1\}$
 $L_p = \{f/1, m/1, n/1, p/1\}$

Pattern 6

(a, b, c, d, f, i, h) = (1, 1, 1, 1, 0, 1)



$L_a = \{a/0\}$ $L_b = \{b/0\}$ $L_c = \{c/1\}$ $L_d = \{d/0\}$ $L_e = \{d/0, e/0\}$
 $L_f = \{f/0\}$ $L_g = \{d/0, e/0, g/0\}$ $L_h = \{h/0\}$ $L_i = \{i/1\}$
 $L_j = \{d/0, e/0, j/0\}$ $L_k = \{i/1, k/0\}$ $L_l = \{d/0, e/0, j/0, l/1\}$
 $L_m = \{d/0, e/0, j/0, l/1, m/1\}$ $L_n = \{d/0, e/0, f/0, g/0, n/0\}$
 $L_p = \{f/0, g/0, n/0, p/0\}$