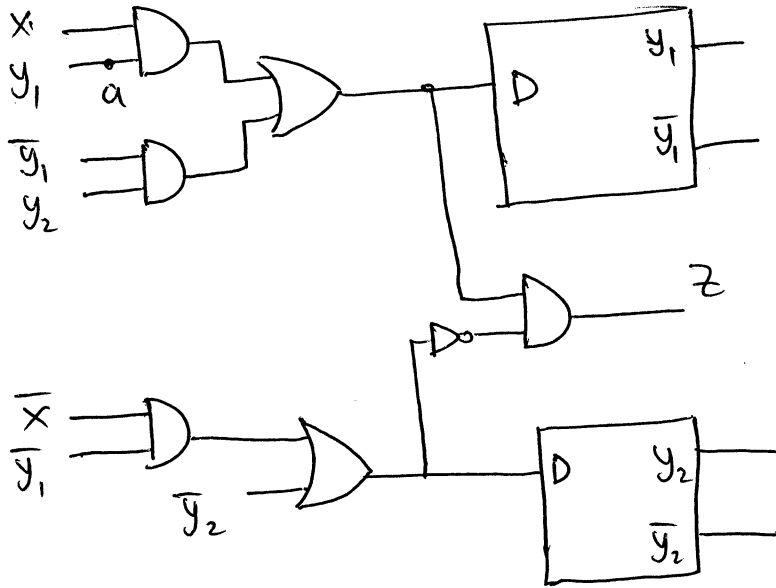


CSE 244 A

HW #3

1. Problem 3.4



Initial state $(y_1, y_2) = (0, 0)$ Fault a s-a-1

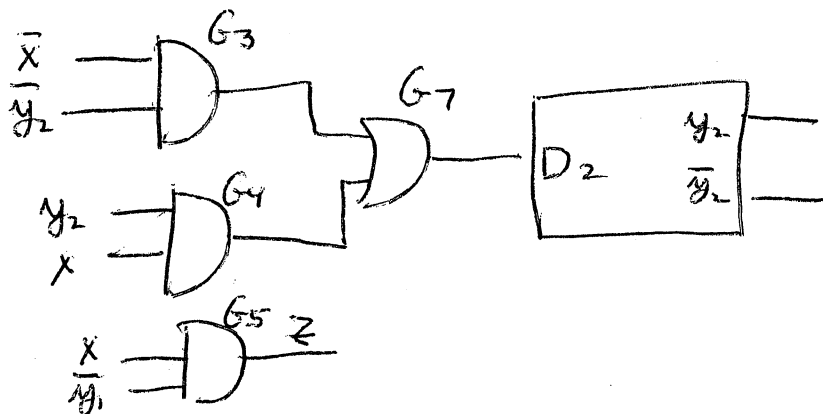
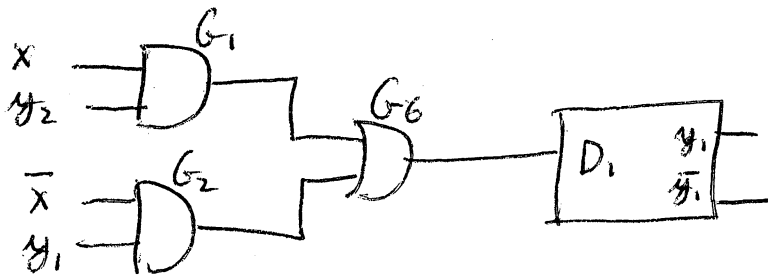
$$(0, 0) \xrightarrow{x=1^*} y_1 = \bar{D}, y_2 = 1 \\ z = 0$$

$$(\bar{D}, 1) \xrightarrow{x=0^*} y_1 = D, y_2 = D \\ z = 0$$

$$(D, D) \xrightarrow{x=1^*} y_1 = 1, y_2 = \bar{D} \\ z = D$$

$$T = 101, z = 00D$$

2. Problem 3.5



Fault z s-a-0

(a) Initial state $(1, 1) = (y_1, y_2)$. To test for z s-a-0, goal state is $\bar{y}_1 = 1, y_1 = 0$.

$$(1, 1) \xrightarrow{x=0} (1, 0), z=0$$

$$(1, 0) \xrightarrow{x=1} (0, 0), z=0$$

$$(0, 0) \xrightarrow{x=1} (0, 0), z=0$$

$$T = 011, z = 000$$

(b) Fault z s-a-0. Initial state $(y_1, y_2) = (u, u)$

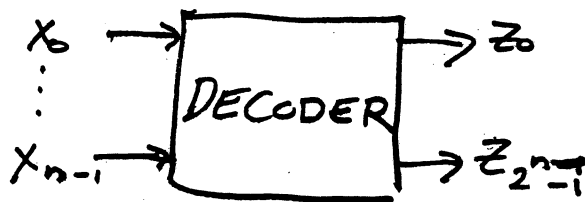
$$(u, u) \xrightarrow{x=0} (u, u), z=u$$

$$\xrightarrow{x=1} (u, u), z=u$$

No test exists.

Circuit can not be initialized

- 2.18 A decoder is a combinational circuit containing n inputs and 2^n outputs, labeled respectively $(x_0, x_1, \dots, x_{n-1})$, and $(z_0, z_1, \dots, z_{2^n-1})$. The circuit functions as follows: If $(a_0, a_1, \dots, a_{n-1})$ is a binary input vector, representing the integer k , then $z_k = 1$ and $z_j = 0$ for all $j \neq k$. Based upon the functional operation of this device, determine a minimal set of tests which will detect any single fault on an input or output line of this device.



To detect z_k s-a-0 must apply input corresponding to integer k .
 Doing this for all k $0 \leq k \leq 2^n - 1$
 requires 2^n tests
 (exhaustive testing - all possible inputs must be applied).

2.19 A multiplexer is a combinational circuit C having the structure shown in Figure 2.60.

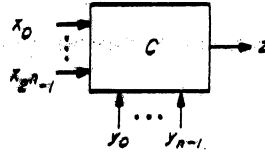


Figure 2.60

If $(a_0, a_1, \dots, a_{n-1})$ is an input vector, representing the integer k , applied to $(y_0, y_1, \dots, y_{n-1})$, then $z = x_k$, where $0 \leq k \leq 2^n - 1$. That is, input line x_k is connected to the output z . Based upon the functional operation of this device, determine a minimal set of tests which will detect any single stuck fault on an input or output line of this device.

4. Problem # 2.19

For each of the 2^n values of $(y_0, \dots, y_{n-1})$ corresponding to x_k input apply 2 tests, one with $x_k=0, x_j=1$ for all $j \neq k$ the other with $x_k=1, x_j=0$ for all $j \neq k$.

These $2 \times 2^n = 2^{n+1}$ tests detect any s-a-fault on x inputs, y inputs or z output.

This requires 2^{n+1} tests out of a possible $2^{(n+2^n)}$ input combinations

$$\left(2^{n+1} / 2^{(n+2^n)} \right) = 1/2^{2^n-1}$$

For $n=2$ this is $1/8$.

For $n=2$ there are 6 inputs $(x_0, x_1, x_2, x_3, y_0, y_1)$

The 8 tests are

x_0	x_1	x_2	x_3	y_0	y_1	x_0	x_1	x_2	x_3	y_0	y_1
0	1	1	1	0	0	1	1	0	1	1	0
1	0	0	0	0	0	0	0	1	0	1	0
1	0	1	1	0	1	1	1	0	1	1	1
0	1	0	0	0	1	0	0	0	1	1	1

3. Problem 3.20

3 state machine

t:	1	2	3	4	5	6	7	8	9	10	11	12	13
X:	0	0	0	0	0	0	1	0	0	1	0	0	0
Z:	0	0	1	0	a_1	1	0	1	a_2	0	1	a_3	a_4

Notice 3 different responses to input sequence 00 at $t=1$, $t=2$, $t=3$. Let state at $t=1$ be A, state at $t=2$ is B, state at $t=3$ is C. Then $N(A, 0) = B$, $Z(A, 0) = 0$, $N(B, 0) = C$, $Z(B, 0) = 0$, $N(C, 0) = A$ or B, $Z(C, 0) = 1$. The state at $t=6$ must be C (since only state C has $Z=1$ for $x=1$). The state at $t=5$ cannot be C since $N(C, 0) \neq C$. Therefore $a_1 = 0$. Therefore the state at $t=4$ is A and $N(C, 0) = A$.

$x \downarrow$

	0	1
A	B, 0	
B	C, 0	
C	A, 1	

Therefore the state at $t=7$ is A and the state at $t=8$ is C. Hence $N(A, 1) = C$, $Z(A, 1) = 0$ and $a_2 = 0$.

$x \downarrow$

	0	1
A	B, 0	C, 0
B	C, 0	
C	A, 1	

$x \downarrow$

	0	1
A	B, 0	
B	C, 0	
C	A, 1	

The state at $t=10$ is B and the state at $t=11$ is C. Hence $N(B, 1) = C$, $Z(B, 1) = 0$.



The values of a_3, a_4 must be $a_3 = a_4 = 0$ and the state at $t=14$ is C. To determine the values of $N(C, 1)$ and $z(C, 1)$ we add the following subsequence.

	x	
	0	1
A	B, 0	C, 0
B	C, 0	C, 0
C	A, 1	

	14	15	16
X	1	0	0
	a_5	a_6	a_7

The values of z at $t=15$ and 16 uniquely determine the state at $t=15$ and hence the value of $N(C, 1)$. The output at $t=14$ is $z(C, 1)$.

$$a_6 a_7 \ 00 \Rightarrow N(C, 1) = A$$

$$a_6 a_7 \ 01 \Rightarrow N(C, 1) = B$$

$$a_6 a_7 \ 10 \Rightarrow N(C, 1) = C$$

$$z(C, 1) = a_5$$