PRACTICE FINAL SOLUTIONS

FINAL EXAM: ECE 6140 FALL 2011
NAME:
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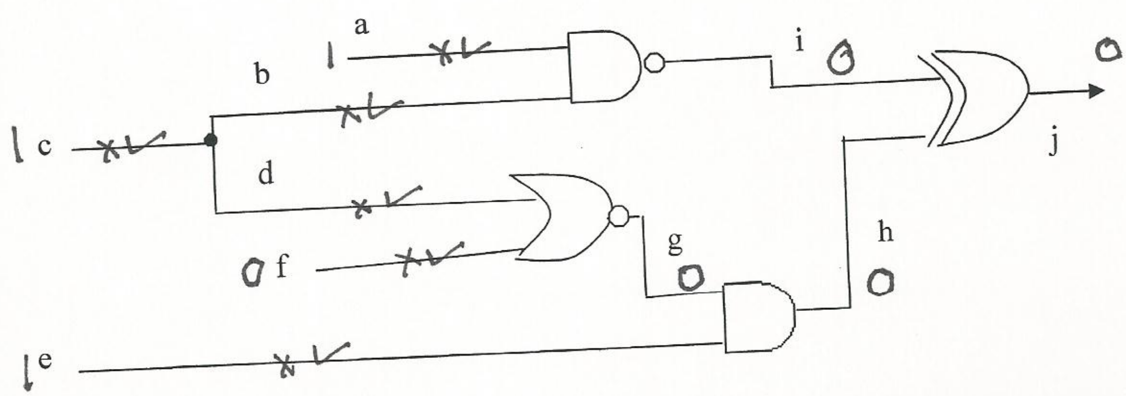


Figure 1. Test Ckt.

Prob 1 (10 points): For the fault set {a0, a1, b0, b1, c0, c1, d0, d1, e0, e1, f0, f1} in Figure 1, perform deductive fault simulation with the input vector acfe = [1,1,0,1]. Give all the fault lists below.

La = $\{a_0\}$

Lb = $\{c_0, b_0\}$

Lc = $\{c_0\}$

Ld = $\{c_0, d_0\}$

Le = $\{e_0\}$

Lf = $\{f_1\}$

Lg = $L_d - L_f = \{c_0, d_0\}$

Lh = $L_g - L_e = \{c_0, d_0\}$

Li = $L_a \cup L_b = \{a_0, b_0, c_0\}$

Lj = $(L_h \cup L_i) - (L_h \cap L_i) = \{a_0, b_0, d_0\}$

The following faults are detected = a_0, b_0, d_0

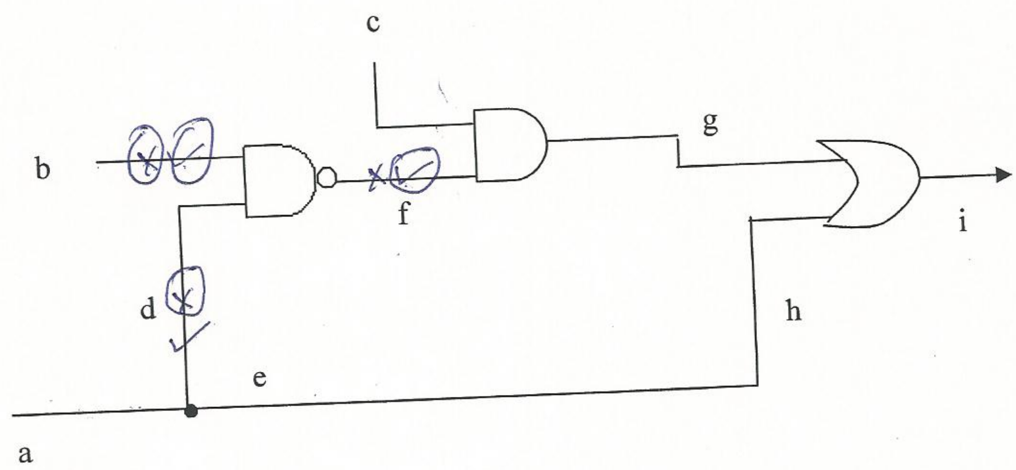


Figure 2. Test Ckt.

Prob 2 (10 points): For the circuit of Figure 2, identify *all* the redundant faults in the circuit if any or say that all faults are detectable.

$$F = (\overline{a \cdot b}) \cdot c + a$$

$$= \bar{a} \cdot c + \bar{b} \cdot c + a = a + c + \bar{b} \cdot c$$

$$= a + c(1 + \bar{b})$$

$$= a + c$$

$\{b_0, b_1, f_1, d_0\}$

Prob 3 (10 points): For the circuit of Figure 3:

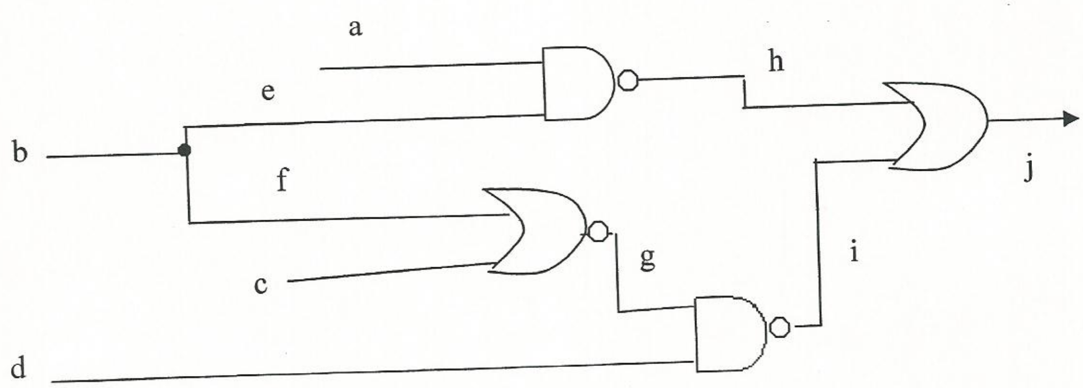


Figure 3. Test Ckt.

There are 20 stuck-at faults in the circuit of Figure 3, 2 in each of the lines a thru j. Starting with all 20 faults, reduce the fault set using equivalent and dominant fault collapsing as follows (*read carefully*).

Using crosses (stuck at 0) and ticks (stuck at 1), show the set of faults in the Figure below *after only equivalent fault collapsing*:

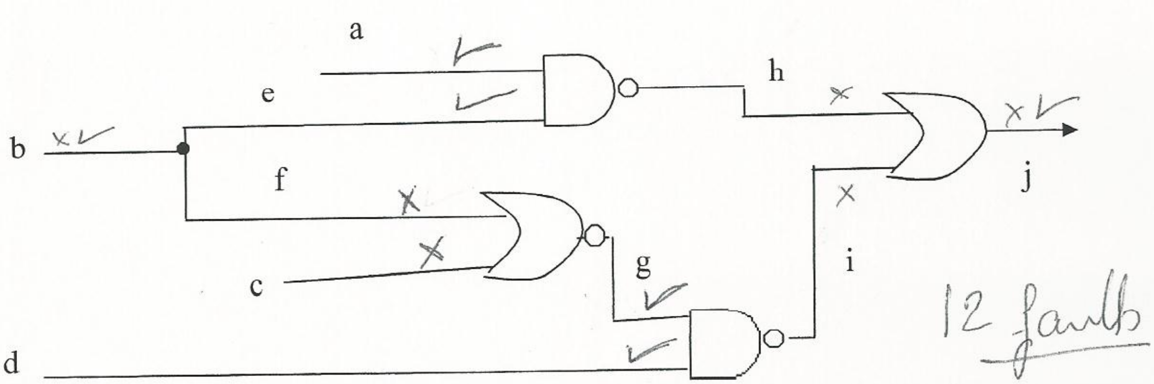


Figure 3a. Test Ckt after Equivalent fault collapsing

Now, using crosses (stuck at 0) and ticks (stuck at 1) again, show the set of faults remaining after performing equivalent *and* dominant fault collapsing in Figure 3b (i.e. perform dominant fault collapsing on the faults remaining in Figure 3a).

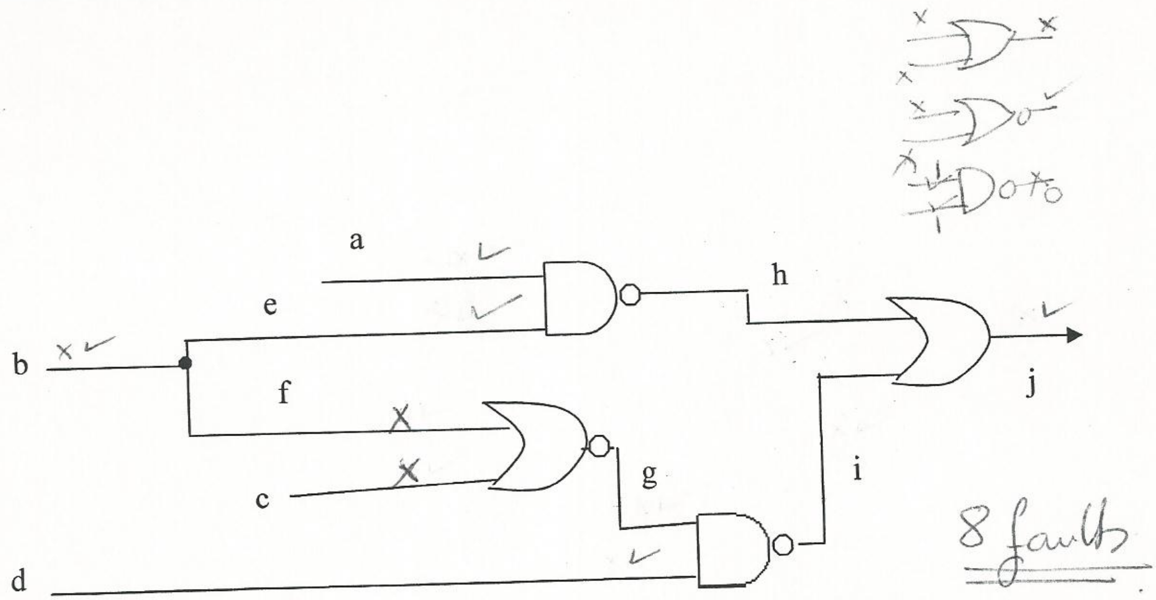
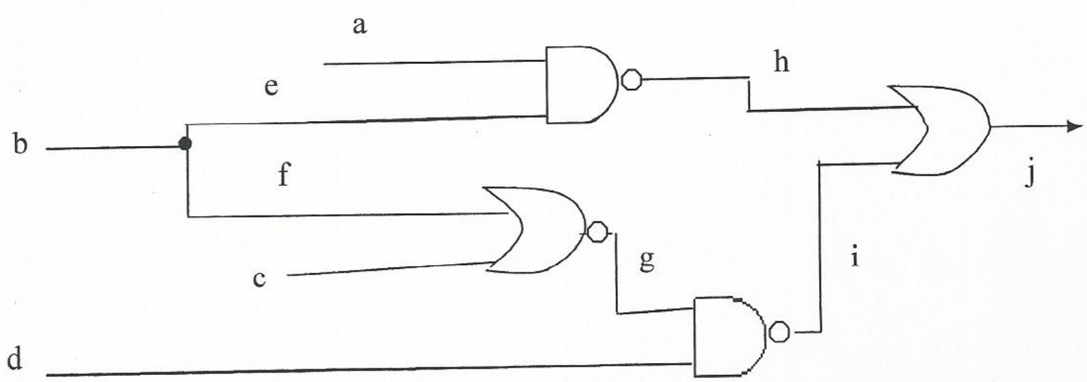
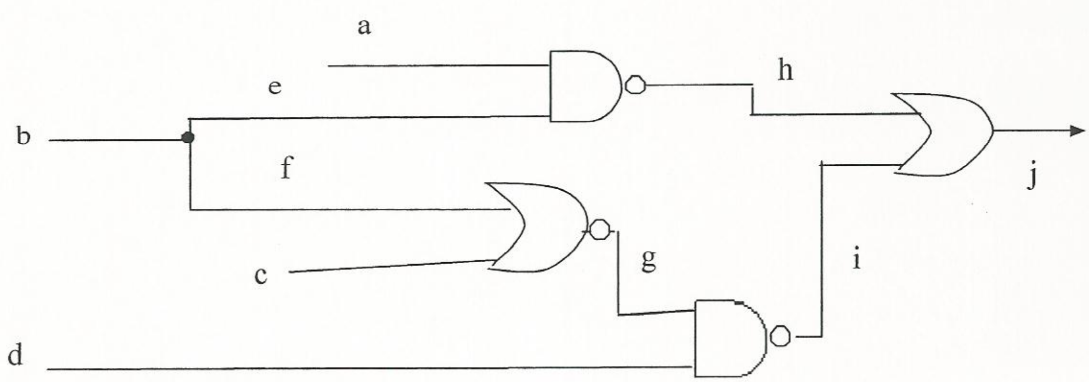


Figure 3b. Test Ckt after Equivalent *and* Dominant fault collapsing

You may use the figures below for rough work:



Rough Work:



Rough Work:

$$g_f = a\cdot d + \overline{\overline{(b+c)} \cdot a\cdot d}$$
$$= a\cdot d + b + c + \bar{a} + \bar{d}$$
$$= d + \bar{a} + \bar{d} + b + c = 1$$

$$g = a + \overline{\overline{(b+c)}\cdot d}$$
$$= a + \overline{\bar{b}\cdot\bar{c}} + \bar{d} = a + b + c + \bar{d}$$

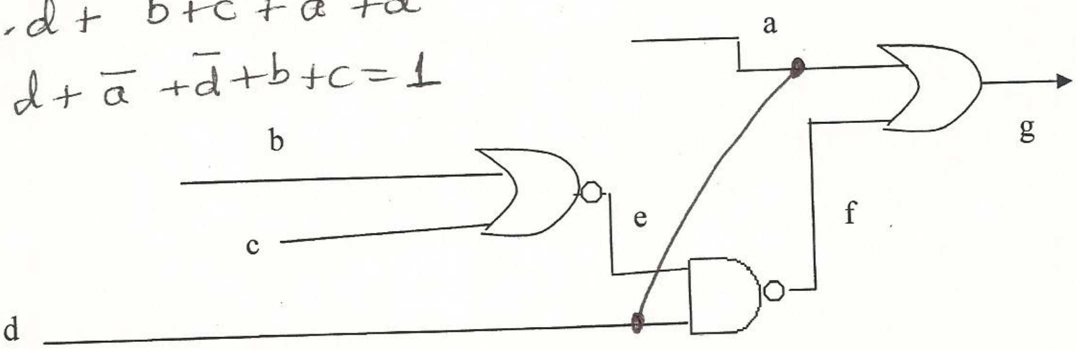


Figure 4. Test Circuit.

Prob 4 (10 points): Give a list of *ALL* the test vectors that detect the AND type bridging fault between lines d and a in Figure 4.

Tests abcd = 0001

So vector is $1 \oplus (a+b+c+\bar{d}) = 1$

or abcd = 0001

Give a list of vectors that distinguish between the above bridging fault and the fault line e stuck-at-1.

Tests abcd =

$1 \oplus (\bar{d}+a) = 1.$

$f_{bridge} = 1$

$a=0, d=1.$

$f_{e-1} = \bar{d} + a$

abcd = $\begin{bmatrix} 0001 \\ 0011 \\ 0101 \\ 0111 \end{bmatrix}$

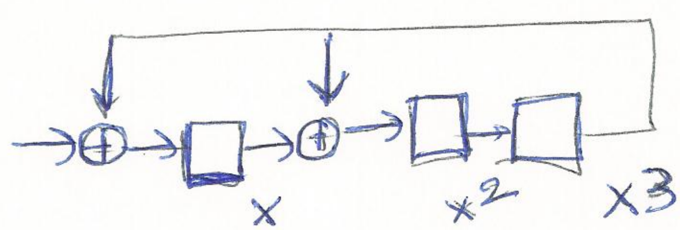
PROB 5 (10 points): Consider an LFSR for which $P^*(x) = x^3+x+1$.

(a) What is the signature (remainder) for a data sequence for which $G(x) = x^6 + x^4+x+1$.

$R(x) =$

$$
\begin{array}{r|l}
 & x^3 \qquad + 1 \\
\hline
x^3+x+1 & x^6 + x^4 + x + 1 \\
 & x^6 + x^4 + x^3 \\
\hline
 & \qquad x^3 + x + 1 \\
 & \qquad x^3 + x + 1 \\
\hline
 & \qquad\qquad 0
\end{array}
$$

(b) Draw the LFSR below.



(c) Give one erroneous data sequence (erroneous generator polynomial for data sequence) that will give the *same* signature as the data sequence in part (a) above.

signature = Rem of $G(x)/P^*(x) = S$

under error $G'(x) = G(x) + E(x)$

so signature under error $S^* = \text{Rem of}\left(\frac{G(x) + E(x)}{P^*(x)}\right)$

By the Chinese Remainder Theorem

$$S^* = \text{Rem}\left(\frac{G(x)}{P^*(x)}\right) + \text{Rem}\left(\frac{E(x)}{P^*(x)}\right)$$

Aliasing occurs when $S^* = S$. This happens when

$\text{Rem}\left(\frac{E(x)}{P^*(x)}\right) = 0$ or $E(x) =$ multiple of $P^*(x)$

So pick any $E(x) = (1 + d_1 x + d_2 x^2 + \cdots)\, P^*(x)$

$d_i = \{0, 1\}$.

Pick $d_1 = 1$, all other $d_i = 0$

$$E(x) = (1+x)(x^3+x+1) = x^4 + x^3 + x^2 + 1$$

$$G'(x) = G(x) + E(x) = x^6 + \cancel{x^4} + x + 1 + \cancel{x^4} + x^3 + x^2 + 1$$

$$= x^6 + x^3 + x^2 + x = \text{ANSWER}.$$

Check that $\text{Rem}\left(\frac{x^6 + x^4 + x + 1}{x^3 + x + 1}\right) = \text{Rem}\left(\frac{x^6 + x^3 + x^2 + x}{x^3 + x + 1}\right)$

Note : you could have picked

$E(x) = (x+x^2)(x^3+x+1)$ as well

(try it and find $g'(x) = g(x) + E(x)$)

PROB 6 (10 points) A FSM has two flip flops with outputs A and B and inputs D(A) and D(B) respectively. The FSM has an input I and one output Z. The equations for the FSM are given below (XOR = Exclusive-OR).

D(A) = A OR B

D(B) = A XOR I

Z = B

(XOR = exclusive OR, OR = logical OR)

Initially, at t=0, A(0) = B(0) = 0.

Starting with the above initial states, find a test sequence of *minimal* length that detects the fault D(A) stuck-at-0.

~~So any $E(x) = (1+\alpha_1 x + \alpha_2 x^2 + \dots)\, p^*(x)$ where $\alpha_i = \{0,1\}$ will give same remainder as~~

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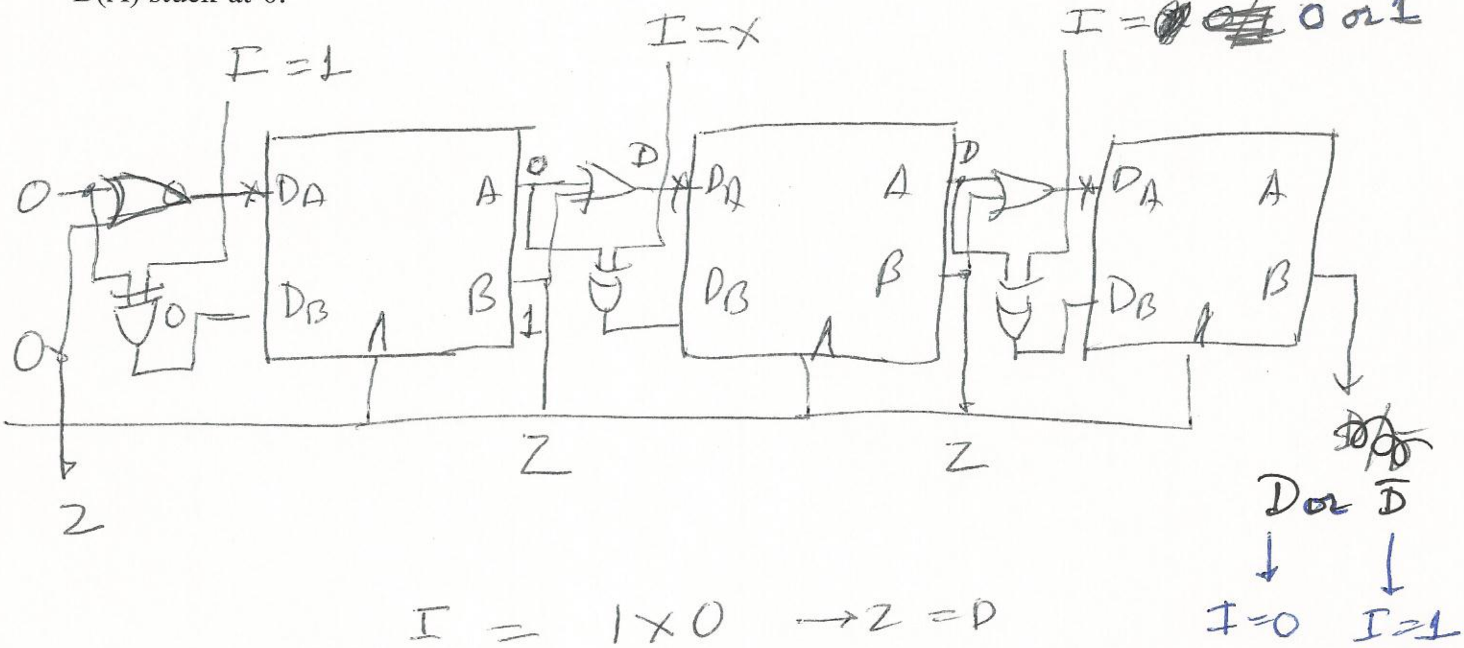

I = 1 X 0 → Z = D

or

1 X 1 → Z = $\bar{D}$