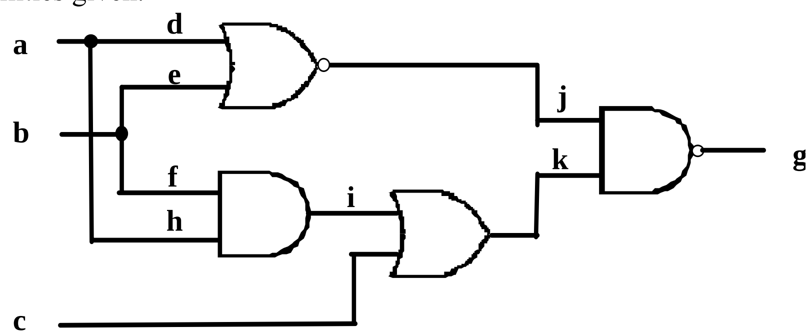
The University of Alabama in Huntsville
ECE Department
CPE 628 01
Test 1 Solution
Fall 2008

1. (10 points) For the circuit shown, calculate the probability-based observabilities given the controllabilities given.



Line 0-C/1-C/O

Line	0-C/1-C/O
a	0.5/0.5/_0.25_
b	0.5/0.5/_0.25_
c	0.5/0.5/_0.03125_
d	0.5/0.5/_0.25_
e	0.5/0.5/_0.25_
f	0.5/0.5/_0.0625_
h	0.5/0.5/_0.0625_
i	0.125/0.5/_0.125_
j	0.5/0.25/_0.5_
k	0.25/0.5/_0.25_
g	0.125/0.5/_1

O(g) =1 O(j) = O(g)*C1(k) = 1*0.5 = 0.5
O(k) = O(g)*C1(j) = 1*0.25 = 0.25
O(i) = O(k)*C1(c) = 0.25*0.5 = 0.125
O(c) = O(k)*C1(i) = 0.25*0.125 = 0.03125
O(h) = O(i)*C1(f) = 0.125*0.5 = 0.0625
O(f) = O(i)*C1(h) = 0.125*0.5 = 0.0625
O(e) = O(j)*C1(d) = 0.5*0.5 = 0.25
O(d) = O(j)*C1(e) = 0.5*0.5 = 0.25
O(a) = max{O(d), O(h) = max{0.25, 0.0625} = 0.25
O(b) = max{O(e), O(f) = max{0.25, 0.0625} = 0.25

2. (5 points) The number of failures in 10^9 hours is a unit (abbreviated FITS) that is often used in reliability calculations. Calculate the MTBF for a system with 10 components where each component has a failure rate of 3000 FITS.

$$\lambda = \sum_{i=1}^{k} \lambda_i \,, \quad \lambda_i = \frac{3000}{10^9}. \text{ Thus, } \lambda = \frac{3000}{10^9} * 10 = 3*10^{-5}$$

$$\text{MTBF} = \frac{1}{\lambda} = 1/3*10^5 \text{ hours} = 33{,}333 \text{ hours}$$

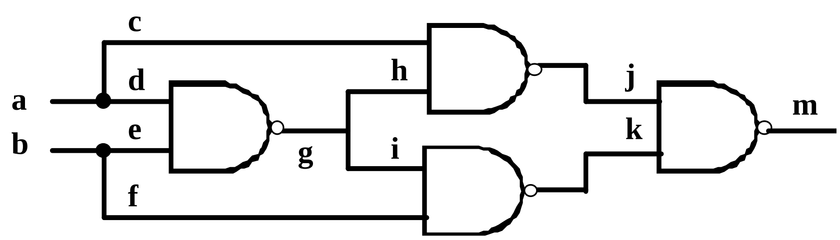
3. (10 points) Generate a minimum set of test vectors to completely test an n-input XOR gate under the single stuck-at fault model. How many test vectors are needed? at most 3

There are two cases, n odd and n even

For n odd, two patterns are required. The test pattern 111…1 will detect all s-a-0 faults on inputs and the test pattern 000…0 will detect all s-a-a faults on inputs. The s-a-0 fault on the output is detected by the all 1s pattern and the s-a-1 fault on the output is detected by the all 0s pattern.

For n even, a third pattern is required to detect the s-a-0 fault on the output. This pattern must have an odd number of 1s.

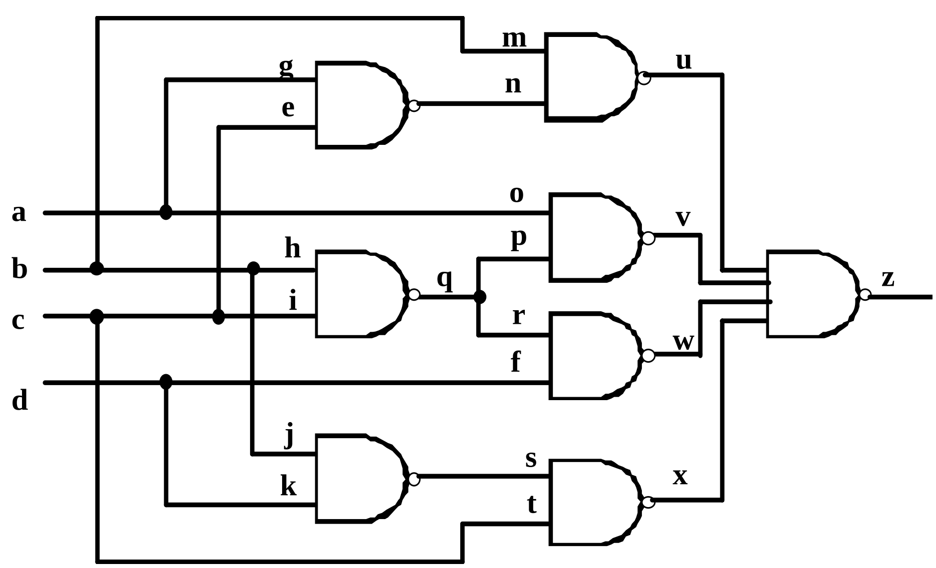
4. (15 points) For the circuit given, calculate the SCOAP controllability measures.



CO(a) = CO(b) = 1 C1(a) = C1(b) = 1 C0(c) = C0(d) = C0(e) = C0(f) = 1
C1(c) = C1(d) = C1(e) = C1(f) = 1 C0(g) = C1(d) + C1(e) + 1 = 1 + 1 + 1 = 3
C1(g) = min{C0(d), C0(e)} + 1 = min{1, 1} + 1 = 1 + 1 = 2 C0(h) = C0(i) = C0(g) = 3
C1(h) = C1(i) = C1(g) = 2 C0(j) = C1(c) + C1(h) + 1 = 1 + 2 + 1 = 4
C1(j) = min{C0(c), C0(h)} + 1 = min{1, 3} + 1 = 1 + 1 = 2
C0(k) = C1(i) + C1(f) + 1 = 2 + 1 + 1 = 4
C1(k) = min{C0(i), C0(f)} + 1 = min{3, 1} + 1 = 1 + 1 = 2
C0(m) = C1(j) + C1(k) + 1 = 2 + 2 + 1 = 5
C1(m) = min{C0(j), C0(k)} + 1 = min{4, 4} + 1 = 4 + 1 = 5

5. (1 point) The symbol _u_ represents the logic value unknown.

6. (10 points) For the circuit shown and the two faults α = e/0, β = f/1, use the parallel-pattern single-fault propagation technique to identify which faults can be detected by the test patterns (a, b, c, d) = (0, 1, 0, 1), (1, 1, 0, 1).



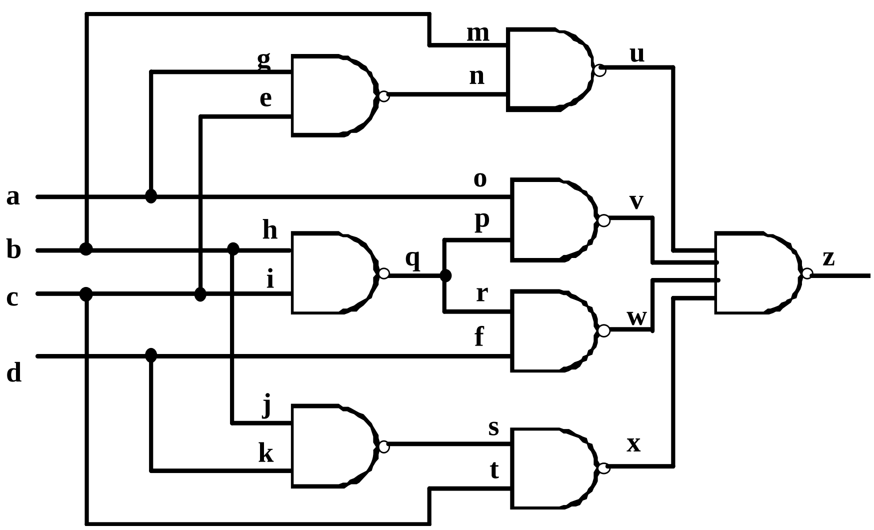
PPSFP		input				internal																			output
fault	*P*	*a*	*b*	*c*	*d*	*e*	*f*	*g*	*h*	*i*	*j*	*k*	*m*	*n*	*o*	*p*	*q*	*r*	*s*	*t*	*u*	*v*	*w*	*x*	*z*
fault-free	P1	0	1	0	1	0	1	0	1	0	1	1	1	1	0	1	1	1	0	0	0	1	0	1	1
	P2	1	1	0	1	0	1	1	1	0	1	1	1	1	1	1	1	1	0	0	0	0	0	1	1
α	P1	0	1	0	1	0	1	0	1	0	1	1	1	1	0	1	1	1	0	0	0	1	0	1	1
	P2	1	1	0	1	0	1	1	1	0	1	1	1	1	1	1	1	1	0	0	0	0	0	1	1
β	P1	0	1	0	1	0	1	0	1	0	1	1	1	1	0	1	1	1	0	0	0	1	0	1	1
	P2	1	1	0	1	0	1	1	1	0	1	1	1	1	1	1	1	1	0	0	0	0	0	1	1

Neither of the faults are detected.

7. (1 point) A _defect_ is a flaw or physical imperfection that may lead to a fault.

8. (1 point) The goal of _test generation_ is to find an efficient set of test vectors that detects all faults considered for a circuit.

9. (10 points) Use the circuit, faults and patterns of problem 6 to do parallel fault simulation.



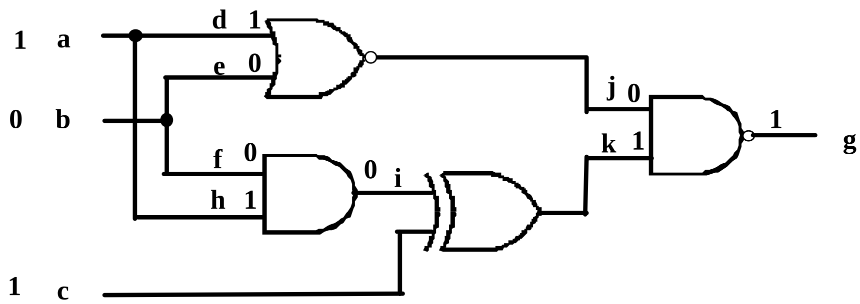
PPSFP		input				internal																			output
fault	*P*	*a*	*b*	*c*	*d*	*e*	*f*	*g*	*h*	*i*	*j*	*k*	*m*	*n*	*o*	*p*	*q*	*r*	*s*	*t*	*u*	*v*	*w*	*x*	*z*
ff	P1	0	1	0	1	0	1	0	1	0	1	1	1	1	0	1	1	1	0	0	0	1	0	1	1
α	P1	0	1	0	1	0	1	0	1	0	1	1	1	1	0	1	1	1	0	0	0	1	0	1	1
β	P1	0	1	0	1	0	1	0	1	0	1	1	1	1	0	1	1	1	0	0	0	1	0	1	1
ff	P2	1	1	0	1	0	1	1	1	0	1	1	1	1	1	1	1	1	0	0	0	0	0	1	1
α	P2	1	1	0	1	0	1	1	1	0	1	1	1	1	1	1	1	1	0	0	0	0	0	1	1
β	P2	1	1	0	1	0	1	1	1	0	1	1	1	1	1	1	1	1	0	0	0	0	0	1	1

Neither of the faults are detected.

10. (1 point) The most widely used structured DFT methodology is _scan design_.

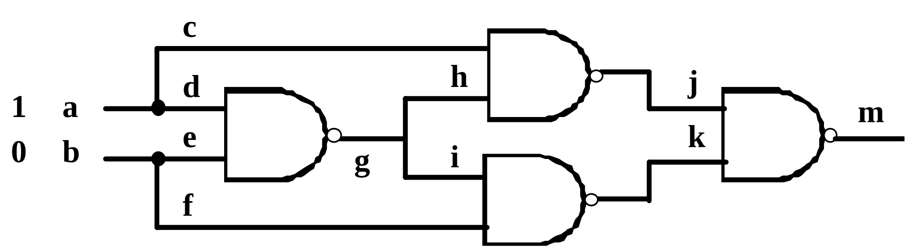
11. (1 point) _Logic simulation_ helps the designer verify that a design conforms to the functional specifications.

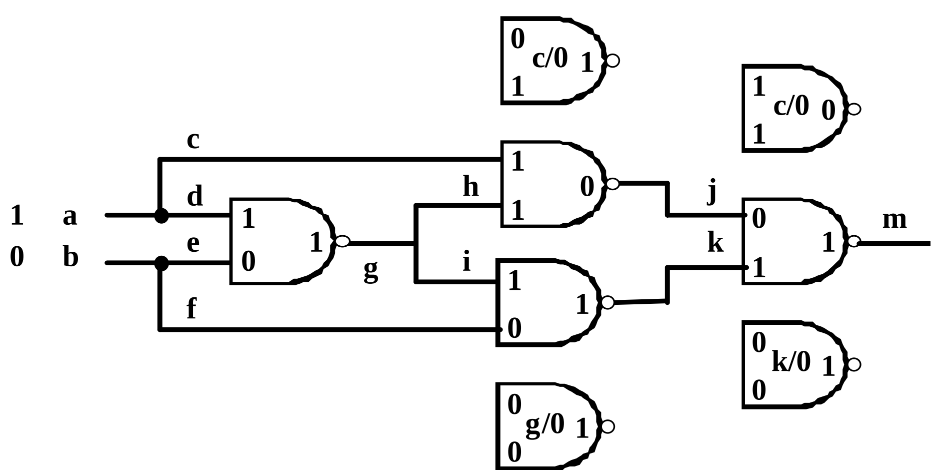
12. (15 points) For the circuit shown, use deductive fault simulation to determine the faults detected by the pattern shown.



L_a = {a/0} L_b = {b/1} L_c = {c/0} L_d = {a/0, d/0} L_e = {b/1, e/1}
L_f = {b/1, f/1} L_h = {a/0, h/0} L_i = {b/1, f/1, i/1}
L_j = {a/0, d/0, j/1} L_k = {b/1, c/0, f/1, i/1, k/0} L_g = {a/0, d/0, j/1, g/0}

13. (15 points) For the circuit shown, use concurrent fault simulation to determine whether the faults g/0, c/0, k/0 are detectable for the pattern given.





Only c/0 is detectable.