Department of Electrical and Computer Engineering
Utah State University

ECE 5930/6930: VLSI Testing and Verification
Created By: Shayan (Sean) Taheri

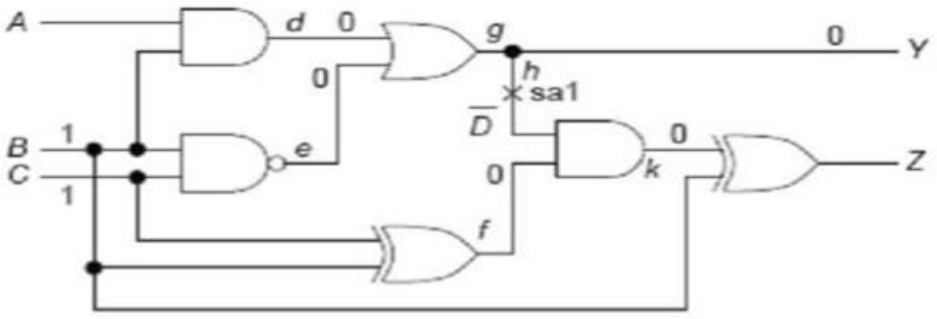
Homework 03
Solution Outline

Answer 1.

We level order the signals and proceed as follows:

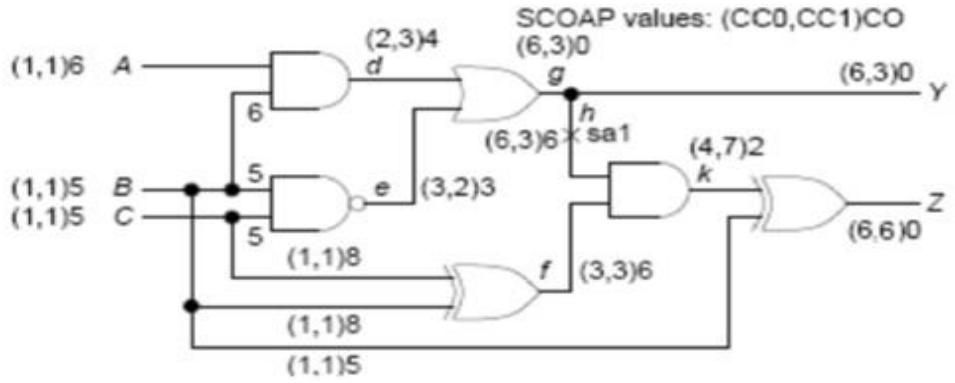
Step no.	Action	Signals A B C d e f g Y h k Z	D front.	Impl. stack
1	Fault Activation	0 0 $\overline{D}$	k	$g=0$
	Immediate impl.	0 0 0 0 $\overline{D}$	k	$g=0$
	Immediate impl.	1 1 0 0 0 0 $\overline{D}$	k	$g=0$
	Immediate impl.	1 1 0 0 0 0 0 $\overline{D}$	k	$g=0$
	Immediate impl.	1 1 0 0 0 0 0 $\overline{D}$ 0	ϕ	$g=0$
	Immediate impl.	1 1 0 0 0 0 0 $\overline{D}$ 0 1	ϕ	$g=0$

The fault is redundant because the D-frontier disappeared and there is no backtracks. Signals are shown in the following figure:



Answer 2.

The figure below shows the SCOAP testability measures used for guiding PODEM.



The steps of the PODEM algorithms are recorded in the following table:

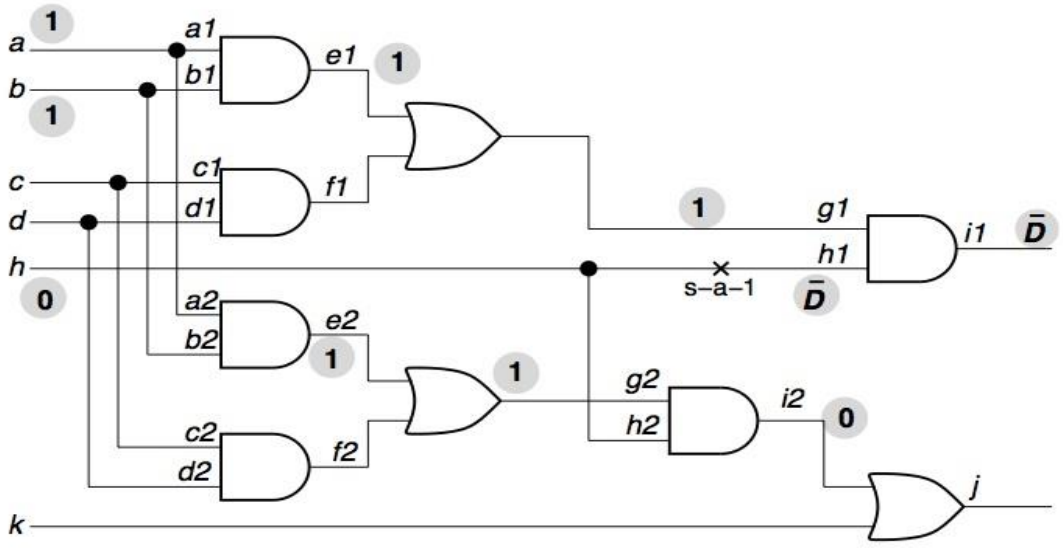
Step No.	Objec-tive	Action	Imp. stack	Implied signal values $A\ B\ C\ d\ e\ f\ g\ h\ k\ Y\ Z$	D front.	X path
1	$g=0$	Backtrace	$B=1$	1	ϕ	ok
2	$g=0$	Backtrace	$C=1$ $B=1$	1 1 0 0 0 1	ϕ	none
3	$g=0$	Backtrack	$C=0$ $B=1$	1 0 1 1 1 1 1 1 0	ϕ	none
4	$g=0$	Backtrack	$B=0$	0 0 1 1 1 1	ϕ	none
5	$g=0$	Backtrack	Empty			
Algorithm termination: Objective g=0 is impossible; fault h s-a-1 is redundant.						

Explanation: an X-path is a path from the fault site to a PO, such that the signals on it are either faulty states or undetermined. An ”OK” for X-path in the table means that one or more such paths exist. Having no X-path is a reason for backtracks because its existence is a necessary condition for the detection of the fault. When a series of backtracks leads to an empty stack, it indicates that the objective g = 0 is impossible. As a result, **the fault h (stuck-at-1) cannot be activated and, hence, it is redundant**. Meanwhile, there is three backtracks.

Answer 3.

Step	Action	Impl. stack	Forward implications	D-frontier
1	Fault act.	$h=0$	$h=0, h1=\overline{D}, i2=0$	$i1$
2	D-prop.	$g1=1, h=0$	$g1=1, h=0, h1=\overline{D}$ $i1=\overline{D}, i2=0$	PO
3	Justify	$e1=1, g1=1$ $h=0$	$e1=1, g1=1, h=0$ $h1=\overline{D}, i1=\overline{D}, i2=0$	PO
4	Justify	$a=1, b=1$ $e1=1, g1=1$ $h=0$	$a=1, b=1, e1=1, g1=1$ $e2=1, g1=1, g2=1$ $h=0, h1=\overline{D}, i1=\overline{D}$ $i2=0$	PO
Test found: $(a,b,c,d,h,k)=(1,1,X,X,0,X)$; $i1=\overline{D}$				

The following figure shows the circuit and the signal values specified by D-algorithm.



Answer 4.

The following table gives the steps of PODEM algorithm:

Step No.	Objective	Action	Imp. stack	Implied signal values $ABCDEFghklmpqsruwZ$	D front.	X path
1	$g = 0(\overline{D})$	Backtrace	$C = 0$	$C = 0, h = 0$	ϕ	ok
2	$g = 0(\overline{D})$	Backtrace	$D = 0$ $C = 0$	$C = 0, D = 0, g = 0(\overline{D})$ $h = 0, k = 0, m = 0, u = 0$	ϕ	none
3	$g = 0(\overline{D})$	Backtrack	$D = 1$ $C = 0$	$C = 0, D = 1, g = 1, h = 0$ $k = 1, m = 1, p = 0, q = 1, r = 0$	ϕ	none
4	$g = 0(\overline{D})$	Backtrack	$C = 1$	$C = 1, g = 1, h = 1, m = 1$ $p = 0, q = 1, r = 0$	ϕ	none
5	$g = 0(\overline{D})$	Backtrack	Empty			
Algorithm termination: $g = 0(\overline{D})$ with X-path impossible; fault g s-a-1 is redundant. 3 backtracks.						