

# Solutions to Homework 8 Problems

## ELEC 7250 VLSI Testing (Spring 2006)

March 18, 2006

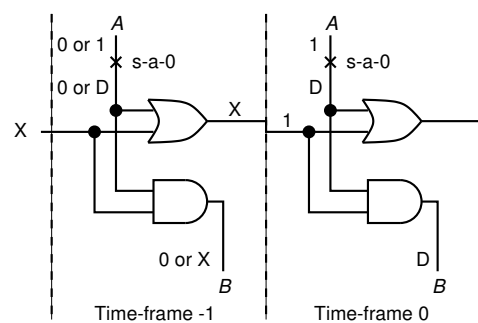
### Problem 8.5

For test generation with the five-valued algebra, we use the following steps (also see the illustration):

**Step 1:** Place a D at the output  $B$  in time-frame 0.

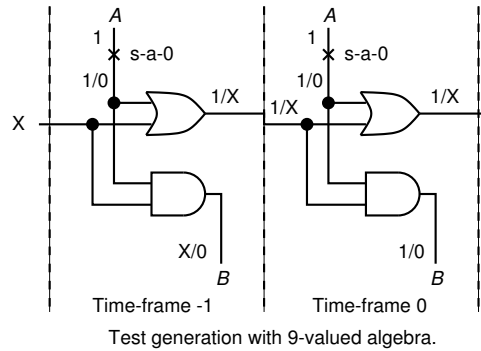
**Step 2:** This can only be justified by either DD or D1 input to the AND gate in time-frame 0. DD is not possible due to the state input being X in the time-frame -1. We place D1 by applying  $A = 1$  and assuming that a state 1 can be justified.

**Step 3:** Any input, 0 or 1, as shown in the figure, produces a state output X from time-frame  $-1$ . Thus, the faulty circuit cannot be initialized to any known state, including the 1 needed for the test. **Hence, it is impossible to find a test by the 5-valued algebra.**



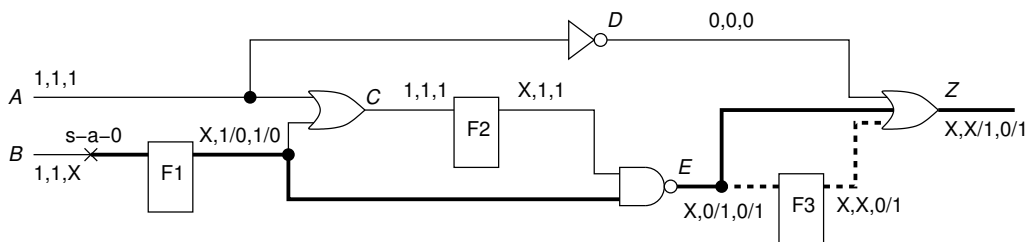
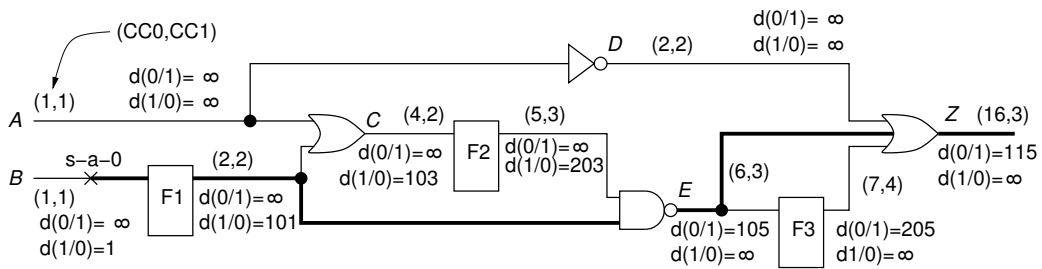
Test generation attempted with 5-valued algebra.

Following similar steps with the nine-valued algebra (see the next illustration), we find that two 1's at  $A$  detect the fault at  $B$  as  $1/0$  in time-frame 0. Notice that the fault is detected although the faulty circuit is never initialized.



### Problem 8.8

The following figure shows the combinational 0 and 1 controllabilities as  $(CC0, CC1)$ . Notice that the output measures for a flip-flops are obtained by just adding 1 to the input measures. This is due to assumptions that the clock has controllabilities  $(1,1)$  and the combinational depth of a flip-flop is 0. The fault site can be driven to  $1/0$  by controlling  $B = 1$  and it cannot be driven to  $0/1$ . Thus, its drivabilities are  $d(0/1) = \infty$  and  $d(1/0) = 1$ , respectively. Drivabilities of all other signals are successively computed by simple path sensitization.



The path shown in bold lines is the least drivability (minimum effort) path. A test obtained by a drivability-based ATPG procedure is shown in the lower figure. This three-vector test,  $(A, B) = (1, 1), (1, 1), (1, X)$ , sensitizes the minimum drivability path and we find that another path, shown by dotted lines, must also be sensitized.