Indian Institute of Technology Bombay
Department of Electrical Engineering
EE-709 Testing and Verification of VLSI Circuits

Assignment 1

Submission Deadline: March 12, 2012 (Monday), 5:00 pm

Question 1: A given machine is known to be either M_1 in state S_i or M_2 in state S_j, where S_i is not equivalent to S_j. Suppose you are given the state table of M_1 and M_2 and assume that M_1 has n_1 states and M_2 has n_2 states. Prove that the given machine and its initial state can always be identified by means of input sequence whose length is bounded by

$L \leq n_1 + n_2 - 1$.

Question 2: Show that for a fractional increase Δ in the area *A* of a VLSI chip when hardware for design for testability is added, the cost increase is given by

$$\left[(1+\Delta)\left(1+\frac{Ad\Delta}{\alpha+Ad}\right)^2-1\right]\times 100 \text{ percent}$$

where *d* is the defect density and *α* is the defect clustering parameter.

Question 3: Let M_1 and M_2 be strongly connected and completely specified machines, and suppose that a state S_i of M_1 is equivalent to a state S_j of M_2. Prove that M_1 is equivalent to M_2.

Question 4: Give a procedure that can be used to determine two incompletely specified machines M1 and M2 are related so that either M1 contains M2 or vice-versa.

Question 5: Define double Boolean difference of *f* as

$$\frac{\partial f}{\partial(xixj)} = \frac{\partial^2 f}{\partial xi \partial xj} \oplus \frac{\partial f}{\partial xi} \oplus \frac{\partial f}{\partial xj}$$

When $$\frac{\partial^2 f}{\partial(xixj)} = \frac{\partial}{\partial xi}\frac{\partial f}{\partial xj} = \frac{\partial}{\partial xj}\frac{\partial f}{\partial xi}$$

Question 6: Prove the following relations for Boolean difference

(a) $$\frac{\partial(f.g)}{\partial x} = f.\frac{\partial g}{\partial x} \oplus g.\frac{\partial f}{\partial x} \oplus \frac{\partial f}{\partial x}.\frac{\partial g}{\partial x}$$

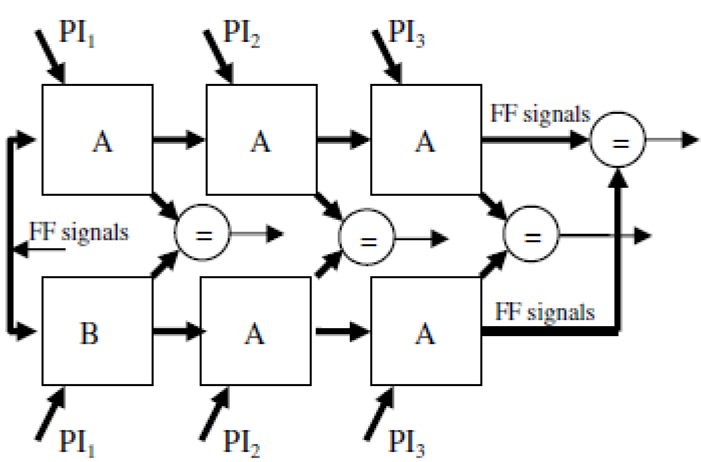
(b) $$\frac{\partial(f+g)}{\partial x} = \overline{f}.\frac{\partial g}{\partial x} \oplus \overline{g}.\frac{\partial f}{\partial x} \oplus \frac{\partial f}{\partial x}.\frac{\partial g}{\partial x}$$

Question 7: Show that combinational test generation is an NP-Complete problem.

(Hint: Transform this problem to 3-SAT problem which is known NP-Complete problem)

Question 8: Let A be a sequential circuit and A^1 denote the combinational part of A. Let A^n denote the combinational circuit obtained by connecting ***n*** copies of the A^1 at the FF inputs and outputs.

Suppose two sequential circuits A and B have the same PIs and POs, and the same number of FFs. (B^n , A^k) denotes the combinational circuit where the outputs corresponding to the final FF inputs of B^n are connected to the inputs corresponding to the initial FF outputs of A^n. The connection is done using some 1-1 mapping between the FF of *A* and *B*.
Using some 1-1 mapping between the FFs of A and B to form (B^n, A^k), suppose that (B^m, A^k) = A^{n+k}. *Then prove that A=B for any common initial state.*



Question 9: Statically compact the following test vectors, first in forward order then in the reverse order. Which order is superior?

Test Vector	PI_1	PI_2	PI_3	PI_4
V_1	1	1	0	0
V_2	X	1	0	0
V_3	0	X	X	0
V_4	1	X	X	0
V_5	X	0	1	0