

**EEDG/CE 6303: Testing and Testable Design (Spring'2024)**

**Department of Electrical & Computer Engineering**

**The University of Texas at Dallas**

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**Cover Page for All Submissions**

**(Assignment, Project, Codes/Simulations/CAD, Examinations, etc.)**

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**Submission Materials for (e.g. Homework #, Project #):** \_\_\_\_\_ Homework 4

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## Homework-4

Uday Teja Bandaru

UTB220000.

①

(14.5)

Let us take the following MATSF scheme

$$\{\uparrow(w_0); \uparrow(r_0, w_1); \downarrow(r_1, w_0)\}$$

Expansion B-cell word the following schematic  
is applied

$$\{\uparrow(w_0); \uparrow(r_0, w_0); \downarrow(r_0, w_0)\}$$

where  $b$  is Complement of  $a$ ,  $'a'$  &  $'b'$  are called background words also called as

$$\{\uparrow(w_{00\dots 0}); \uparrow(r_{00\dots 0}, w_{01\dots 0}) \downarrow(r_0, \dots, w_0 \dots 0)\}$$

since SAF is related to single cell,  
since SAF can be detected by

SAFs can be detected by

$$(V_x \dots x \dots w_k \dots x) \text{ and}$$

$(V_{x\dots x} \dots w_{k\dots k} \dots x)$  are satisfied with

$M_1$  &  $M_2$  if can detect AF's

Consider the following

$\langle \uparrow, w_{0000} \rangle; \uparrow(x_{0000}, w_{1111}); \downarrow(r_{1111}, w_{0000})$

These can detect SA0 & SA1

Q.6) Restrictions of march tests are

1. the  $RA \rightarrow WA$  is incremental upon

the completion of read/write operation,  
so  $\uparrow$  is used in march elements

2. march can only contain a single  
Read and/or a single write operation  
i.e., only march elements of the pattern

$\uparrow(r_x), \uparrow(w_x), \uparrow(r_x, w_y), \uparrow(w_y, r_x);$

$$w_x, y = 0/1$$

So not all AFs and not all  
CF's will be detected.

(14.7)

1-bit memory, so if we take following

$$A[0] = 0, A[1] = 1, A[2] = 0 \dots A[256] = 0 \dots \\ , = (1024)A \dots$$

Read  $A[I]$  and write Complement.

$$A[0] = 0, A[1] = 1, A[2] = 0 \dots A[256] = 0 \dots \\ A[1024] = 1$$

Read  $A[I]$

→ To detect linked AFs,  $(r_x, \dots, w_x)$

or  $(\bar{r}_x, \dots, \bar{w}_x)$  is used. If

$(r_0, w_1)$  is used only.

$A[0], A[2]$  were detected. So

All AFs cannot be covered.

→ for stuck at fault:  $S_{A0} : \{\bar{r}w_0; \bar{r}(\bar{w}_0, r_0)\}$

is used and  $S_{A1}$ .

$\{\bar{r}w_1, \bar{r}(w_0, r_0)\}$  is used.

So All SAFs can be detected.

→ since, only 1 transition, All TFS  
cannot be detected.

→ all the CPSs cannot be detected  
by this test. like  $c_0, c_1$  cannot be  
detected.

14.8)

→ linked cells of the form

$\langle \uparrow; \downarrow \rangle \alpha_1 \neq \langle \uparrow; \uparrow \rangle \alpha_2 \vee$

this holds that  $\alpha_1 \in v$  &  $\alpha_2 \in v$ ; also  
this contains  $\alpha_1 \cap \alpha_2$  &  $\alpha_2 \subseteq \alpha_1$ . this

fault is detected by

$\{\uparrow\downarrow(w_0) : \uparrow\uparrow(r_0, w_1); \uparrow\uparrow(r, w_0, w_1)\}$

→  $\langle \uparrow; \downarrow \rangle \neq \langle \uparrow; \uparrow \rangle$  holds that

for  $\langle \uparrow; \downarrow \rangle \neq \langle \uparrow; \uparrow \rangle$  relative - to v-cell,  
the  $\alpha$ -cells take any relative - to v-cell,  
this can be detected by  $(\uparrow(w_0); \uparrow(r_0, w_1); \uparrow(r, w_0, w_1); \downarrow(r, w_0, w_1); \uparrow(w_0) \downarrow(r_0, w_1))$

2)

<u>Faults</u>	<u>Sensitizes</u>	<u>Detected</u>
AF	$M_2$	$M_3$
SAF	$M_1$	$M_4$
TF	$M_0$	$M_1$
$CF_{in} (a < v, \langle \uparrow, \downarrow \rangle)$	$M_1$	$M_2$
$CF_{in} (a > v, \langle \downarrow, \uparrow \rangle)$	$M_2$	$M_3$
$CF_{in} (a > v, \langle \uparrow, \downarrow \rangle)$	$M_3$	$M_4$
$CF_{in} (a > v, \langle \downarrow, \uparrow \rangle)$	$M_4$	$M_1$
$CF_{in} (a < v, \langle \uparrow, o \rangle)$	$M_3$	$M_4$
$CF_{in} (a < v, \langle \uparrow, i \rangle)$	$M_1$	$M_2$
$CF_{in} (a < v, \langle \downarrow, o \rangle)$	$M_2$	$M_5$
$CF_{in} (a > v, \langle \downarrow, i \rangle)$	$M_4$	$M_4$
$CF_{in} (a > v, \langle \uparrow, o \rangle)$	$M_1$	$M_3$
$CF_{in} (a > v, \langle \uparrow, i \rangle)$	$M_5$	$M_4$
$CF_{in} (a > v, \langle \downarrow, o \rangle)$	$M_4$	$M_3$
$CF_{in} (a > v, \langle \downarrow, i \rangle)$	$M_2$	$M_2$

<u>Faults</u>	<u>sensitizes</u>	<u>Detects</u>
$\text{cfst}(\alpha_{\leq v}, \langle 0; 1 \rangle)$	$M_4$	$M_5$
$\text{cfst}(\alpha_{\leq v}, \langle 1; 0 \rangle)$	$M_3$	$M_4$
$\text{cfst}(\alpha_{\leq v}, \langle 1; 1 \rangle)$	$M_1$	$M_1$
$\text{cfst}(\alpha_{> v}, \langle 0; 0 \rangle)$	$M_4$	$M_4$
$\text{cfst}(\alpha_{> v}, \langle 0; 1 \rangle)$	$M_2$	$M_3$
$\text{cfst}(\alpha_{> v}, \langle 1; 0 \rangle)$	$M_1$	$M_2$
$\text{cfst}(\alpha_{> v}, \langle 1; 1 \rangle)$	$M_3$	$M_3$
linked cfst	cannot	cannot

3)

March X

$\{ M_0 : \uparrow(\omega_0); M_1 : \uparrow(r_0, \omega_1, r_1);$   
 $M_2 : \downarrow(r_1, \omega_0, r_0); M_3 : \uparrow(r_0)$

1) AFs:  $(r_x, \omega_x)$  and  $r_x, \omega_x$ ) should be satisfied. Conditions are met by  $M_1$  and  $M_2$ . So faults are detected.

2) SAFs: for SA<sub>0</sub>  $M_1$  satisfies and detect for SA<sub>1</sub>  $M_2$  will satisfies and  $M_3$  will detect.

3) TFS  $\rightarrow \langle \uparrow / \circ \rangle$ :  $\omega_1$  sensitizes and detects.  $M_1$  sensitizes and  $M_2$  detect it and  $\rightarrow \langle \downarrow / \circ \rangle$ :  $\omega_0$  sensitizes it and  $M_2$  detects it  $M_2$  sensitizes and  $M_3$  detect it and TFS detected.

(iv) unlinked CFS:  $\emptyset \subset F''$

$\text{in } \leftarrow; \rightarrow$ : Aggressor goes from 0 to 1  
and its complemented.

Case-1:  $V \triangleright a$

In this case,  $M_1$  sensitizes it ( $w_1$ )  
and  $M_1$  will detect it ( $r_0$ )

Case-2:  $a \triangleright V$

Here, fault will sensitizes  $M_1$  and  
 $M_2$  detects it.

(v)  $\leftarrow; \rightarrow$ : Aggressor has falling  
Condition 1 to 0 and Victim is Complemented

Case-1:  $a \triangleright V$

$M_2$  will sensitizes and detect it  
( $w_0$ ) ( $r_1$ )

Case-2:  $V \triangleright a$

$M_2$  sensitizes and  $M_3$  detect  
All CFS detected

2) CPID

subtypes are

$\langle \uparrow, \uparrow \rangle, \langle \uparrow, \downarrow \rangle, \langle \downarrow, \uparrow \rangle, \langle \downarrow, \downarrow \rangle$

$\langle \uparrow, \uparrow \rangle, \langle \uparrow, \downarrow \rangle, \langle \downarrow, \uparrow \rangle, \langle \downarrow, \downarrow \rangle$  o to 1 ad victim

$\rightarrow \langle \uparrow, \uparrow \rangle = \text{aggressor}$

- also o to 1

① :  $v > a$   
 $M_1$ , sensitize ad detect

② ;  $a > v$   
not detected

$\rightarrow \langle \uparrow, \downarrow \rangle$   
Agg  $\rightarrow$  o to 1 victim  $\rightarrow$  o

$v > a \rightarrow M_1(\text{sens})$  and  $M_2(\text{detect})$

$a > v \rightarrow M_1(\text{sens})$  and  $M_2(\text{detect})$

$\rightarrow \langle \downarrow, \uparrow \rangle$

Agg  $\rightarrow$  1 to o victim  $\rightarrow$  o to 1

$v > a \rightarrow M_2(S) M_3(D)$

$a > v \rightarrow M_2(S) M_3(D)$

$\rightarrow \langle \downarrow; \downarrow \rangle$   
 Ag  $\rightarrow$  i to i      Victim  $\rightarrow$  i to 0  
 $v > a \rightarrow M_2(s)$ , no detect  
 $a > v \rightarrow M_2(s), M_3$  detect

### ③ CFsts:-

for static Coupling fanb, we can use state Validation table.

i  $\rightarrow$  Aggressor      j  $\rightarrow$  Victim.

④  $j > i$

	Match element states $s_{i,j}$ before op	op	state $s_{i,j}$ after op
$M_0$	—	$w_0$ into i $w_0$ into j	$s_{00}$
$M_1$	$s_{00}$ $s_{00}$ $s_{10}$ $s_{00}$	$r_0$ from i $w_1$ into i $r_0$ from j $w_0$ into j	$s_{00}$ $s_{10}$ $s_{00}$ lines $s_{11}$
$M_2$	$s_{11}$ $s_{11}$ $s_{10}$ $s_{10}$	$r_1$ from j $w_0$ into j $r_0$ from i $c_{00}$ into i	$s_{11}$ $s_{10}$ $s_{10}$ $s_{00}$
$M_3$	$s_{00}$ $s_{00}$	$r_0$ from i $r_0$ from j	$s_{00}$ $s_{00}$ L2

$L_{-1}$  detects  $\langle 1; 1 \rangle$   
 $L_{-2}$  detect  $\langle 0; 1 \rangle$   
 $\langle 1; 0 \rangle$  no detect  
 $\langle 0; 0 \rangle$  no detect.

④  $i > j$

$M_0$	-	$w_0$ from $j$	-
	-	$w_0$ into $i$	$s_{00}$
$M_1$	$s_{00}$	$r_0$ from $j$	$s_{00}$
	$s_{00}$	$w_i$ into $j$	$s_{01}$
	$s_{01}$	$r_0$ from $i$	$s_{01}$
	$s_{01}$	$w_i$ from $i$	$s_{11}$
$M_2$	$s_{11}$	$r_i$ from $i$	$s_{11}$
	$s_{11}$	$w_0$ into $i$	$s_{01}$
	$s_{01}$	$r_i$ from $j$	$s_{01}$
	$s_{01}$	$w_0$ from $j$	$s_{00}$
$M_3$	$s_{00}$	$r_0$ from $i$	$s_{00}$
	$s_{00}$	$r_0$ from $j$	$s_{00}$

$\langle 0; 1 \rangle$  will be detected

Few CFST are detected

⑤

linked cfid!

Case - 1 :-  $\langle a_1, v \rangle$

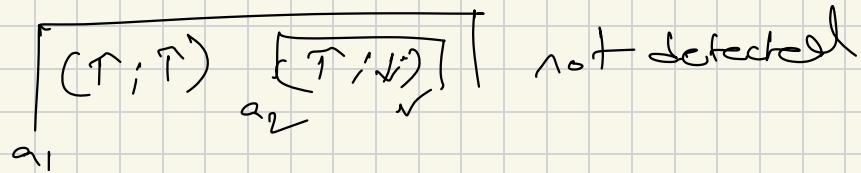
$(\uparrow, \uparrow)$

S-sensitizes  
D-detect

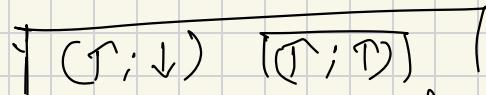
$\langle a_2, v \rangle$

$(\uparrow, \downarrow)$

$\rightarrow a_1 < a_2 < v$

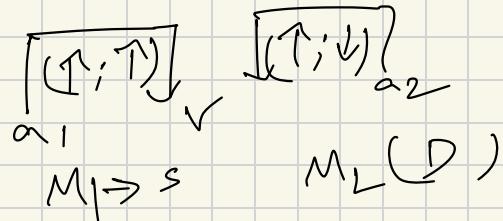


$\rightarrow a_2 < a_1 < v$

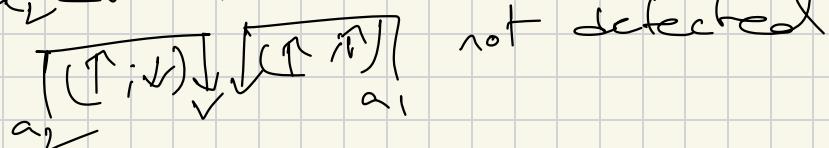


$M_1$  sensitizes and detect-

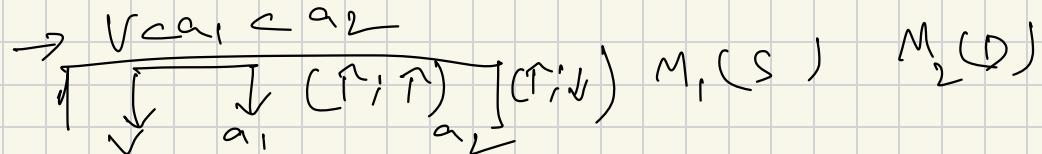
$\rightarrow a_1 < v < a_2$



$\rightarrow a_2 < v < a_1$



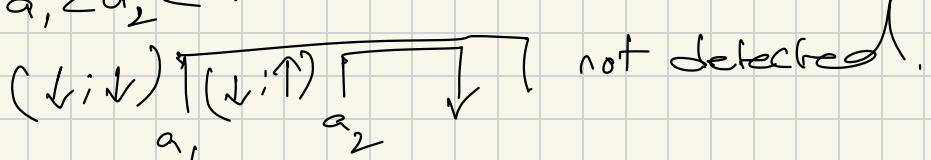
$\rightarrow v < a_1 < a_2$



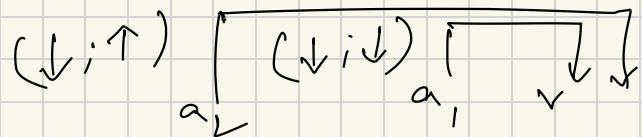
Case-1 :-

$$\begin{array}{ll} (\alpha, \nu) & (\downarrow; \downarrow) \\ (\alpha_2, \nu) & (\downarrow; \uparrow) \end{array}$$

$$\rightarrow \alpha_1 < \alpha_2 < \nu$$

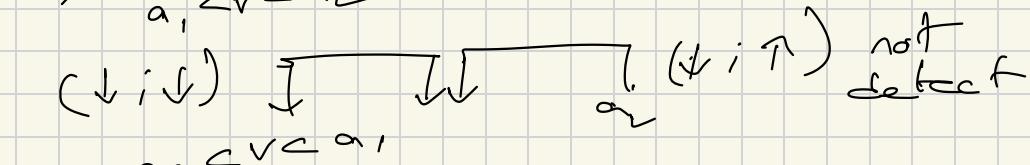


$$\rightarrow \alpha_2 < \alpha_1 < \nu$$

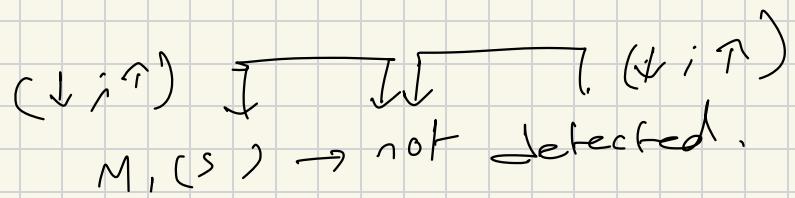


$$M_1(s) \quad M_2, M_3(D)$$

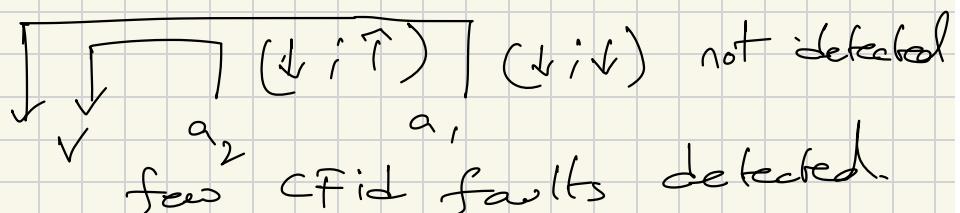
$$\rightarrow \alpha_1 < \nu < \alpha_2$$



$$\rightarrow \alpha_2 < \nu < \alpha_1$$



$$\rightarrow \nu < \alpha_2 < \alpha_1$$



Q4)

This Paper “Memory Test Optimization: An Industrial Evaluation of DRAM Tests” relates to the methodology and application of DRAM chips as this study consists of testing vast range of DRAM chips with 48 vector test combinations of stress and its dependencies. This gives weightage to the perfect stress combination for effective fault coverage. Moreover, tests should be according to the specific technology in usage to nullify the defects. This covers all combinations of march, base cell, repetitive, electric etc. which covers specific types of faults.

Observations reveal that voltage and temperature influence’s fault coverage to some extent, a vast list of base tests are included with their stress condition combinations and percentage of fault coverage that will be turned out. As we are dealing with DRAM majority of faults are caused by the leakage currents at the capacitor and refresh failures, loss of data due to gate level switching, stuck at faults at critical juncture etc. as influenced by high temperatures, so High Temperature (HT) test reveals or covers most of them. Analysis also points out different types of address stresses, timing stresses factor the fault detection in the chips, faults between the cells in the same lines are more likely to show the least effectiveness by address complement stress. After optimization of the stress test times, comparison of results at high and room temperature are noticed, mostly theoretically calculated fault coverage for tests has the highest fault coverage in the actual test result even though there is a clarification needed in modelling the stresses and deduce the fault coverage of that stress test vectors.

To Check in the specific test grouping, 32 DUTs in the HT testing group—which we refer to as single faults—and 37 DUTs in the RT testing category can only be identified by a single test and lots of single tests detect the number of DUTs. Since these tests will be necessary to reach an FC of 100%, it requires us to examine the DUTs identified by a single test.

The study looks to enhance the DRAM testing process through test time savings and ultimately cost savings. This focused on the more challenging uncovering problems, even though some errors might be discovered after multiple tests. Consequently, the plot only contains the problematic DUTs

that were discovered by twelve out of around more than eight hundred tests. It highlights the careful balancing act between comprehensive testing and feasibility, implying that further study be conducted to reduce test durations while reducing the problems if any.