

Department of Computer Science
Purdue University, West Lafayette

Spring 2011: CS 49000-ST0 Software Testing
Midterm Examination: Open Textbook

Tuesday March 8, 2011. 1:30-2:45pm STEQ 208

Maximum points: 100 (To be scaled down to 15 during final course grading.)

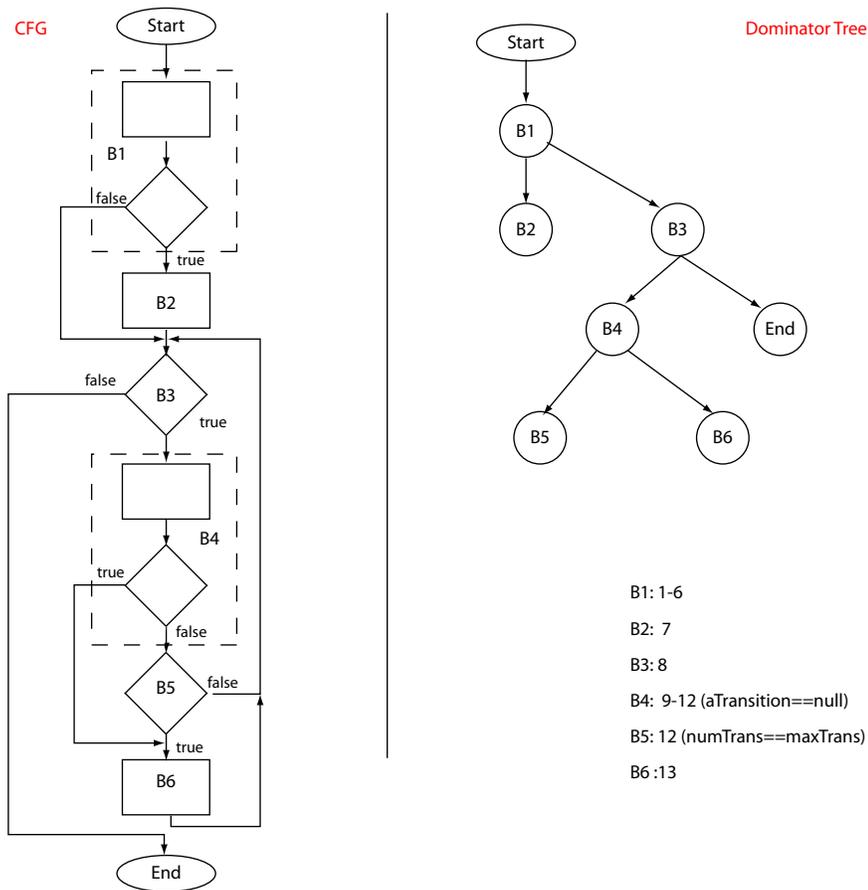
Name: _____

Answer all questions in the space provided. When needed, use the empty space on the back of each sheet.

Q1 Draw the control flow graph (CFG) from the code given below. Indicate basic block numbers, e.g. B_1 , B_2 , and so on, on your CFG. Indicate the contents of each basic block by specifying, in a separate table, the line numbers that fall in each block. Assume that compound conditions may be executed partially. Thus, as an example, in the condition $a \wedge b$, b is not evaluated if a is false.

10 points

```
1 begin
2   int numTrans=0;
3   BR fsmFile= new BR (new FileReader(fsmFilename));
4   aTransition=fsmFile.readLine();
5   boolean done=false;
6   if (aTransition==null)
7     done=true;
8   while (!done){
9     numTrans++;
10    splitTransition(aTransition);
11    aTransition=fsmFile.readLine();
12    if ((aTransition==null) || (numTrans==maxTrans))
13      done=true;
14  }
15 end
```



(b) Draw the dominator tree from the CFG you have drawn in (a). 10 points

Q2 An application `App` takes the following inputs:

- An integer $-4 \leq x \leq 3$.
- A string `s` that consists of digits 0 through 9 and characters drawn from the set `{+, *}`.
- An enum variable `switch` that may assume values from the set `{ON, OFF, FAULTY}`.

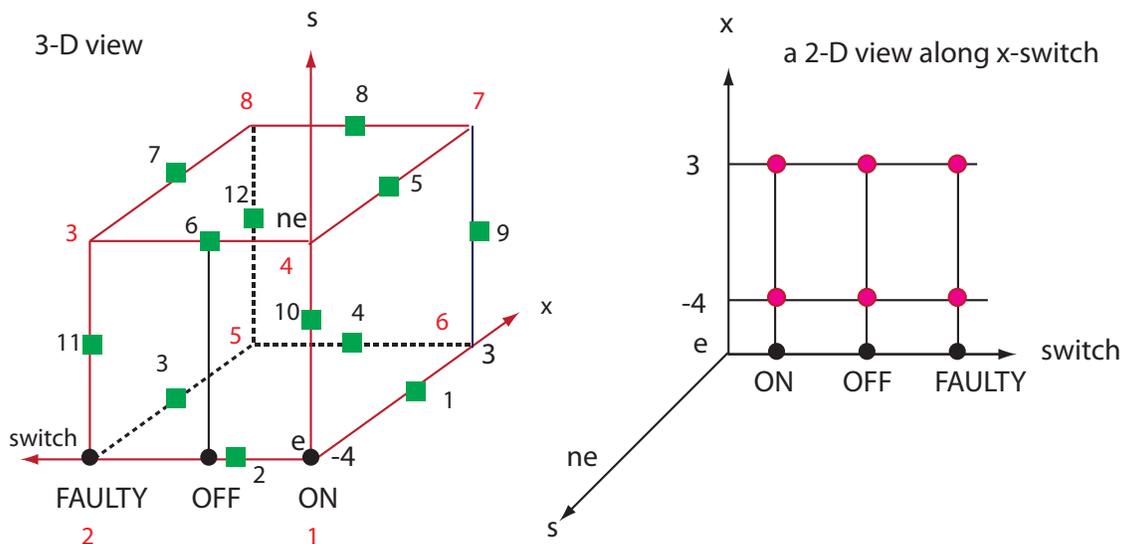
Below are two sample inputs.

(2, 3**1, ON)

(-1, ++87, FAULTY)

Generate a set of test inputs for `App` using boundary value analysis. All tests should be at the boundaries, or at the corners, of the input domain. You will need to determine the boundaries and the corners.

10 points



Corners are labeled red as 1–8 ● values of switch ■ Boundary tests

Each test is a triple, the first element of the triple is the value of x , second is the value of s and the third is the value of $switch$. e denotes an empty string, and ne a non-empty string.

Corner tests=

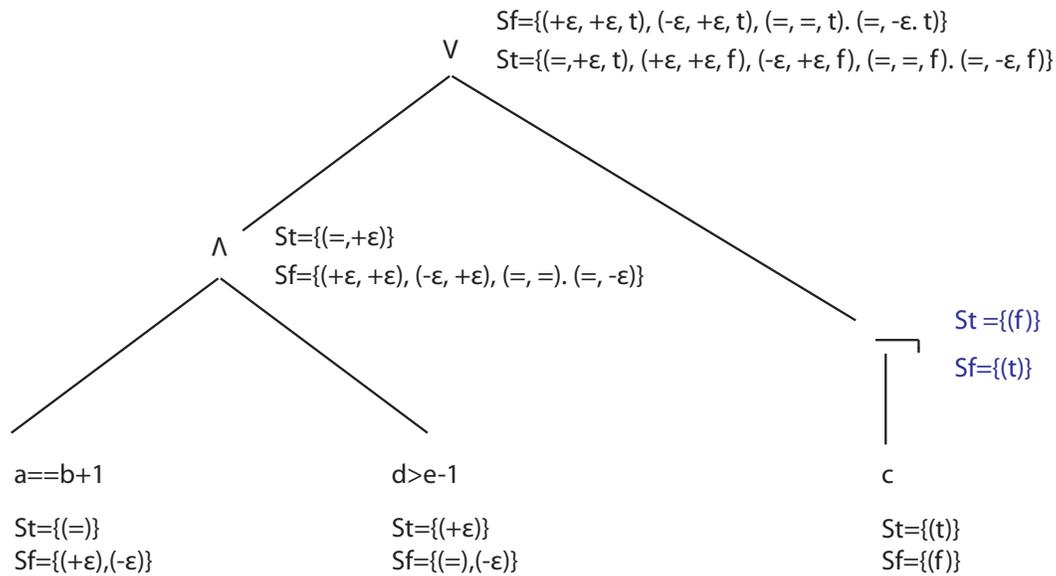
- $\{(-4, e, ON), (-4, e, FAULTY), (-4, ne, FAULTY), (-4, ne, ON), (3, e, FAULTY), (3, e, ON), (3, ne, ON), (3, ne, FAULTY)\}$

Boundary tests=

- $\{1: (0, e, ON), (2: 0, e, OFF), (3: 0, e, FAULTY), (4: 3, e, OFF), (5: 0, ne, ON), (6: -4, ne, OFF), (7: 3, ne, OFF), (8: 3, ne, OFF), (9: 3, ne, ON), (10: -4, ne, ON), (11: -4, ne, FAULTY), (12: 3, ne, FAULTY)\}$

Q3(a) Let $p : a == b + 1 \wedge d > e - 1 \vee \neg c$, where a, b, d, e are integers and c is a Boolean. Derive a BRE constraint set S for predicate p . Precedence of Boolean operators (from high to low) is: \neg, \wedge , and \vee . Show the syntax tree used in deriving S .

20 points



(b) Use only S_f to derive a sample set T of test inputs.

5 points

Test ID	Constraint	Test	p	p_1	p_2
T1	$(+\epsilon, +\epsilon, t)$	$(a = 2, b = 0, d = 1, e = 1, c = \text{true})$	false	false	true
T2	$(-\epsilon, +\epsilon, t)$	$(a = 2, b = 2, d = 1, e = 1, c = \text{true})$	false	false	true
T3	$(=, =, t)$	$(a = 2, b = 0, d = 2, e = 3, c = \text{true})$	false	false	true
T4	$(=, -\epsilon, t)$	$(a = 2, b = 2, d = 2, e = 4, c = \text{true})$	false	false	true

(c) For each of the erroneous versions of p listed below, find a test case from T that reveals the error. Show that indeed the correct and the incorrect predicates to evaluate to different values against the test cases you have selected.

$p_1 : a == b \wedge d > e - 1 \vee \neg c$ [Error not detected by any of the four test cases.]

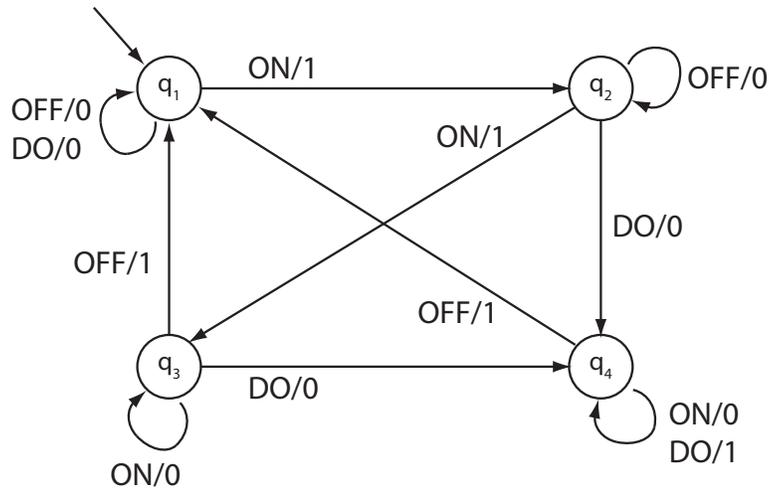
$p_2 : a == b + 1 \wedge d > e \vee c$ [Error detected by all four test cases.]

5 points

Q4 Answer all parts of this question using the FSM given below.

$X=\{ON, OFF, DO\}$ $Y=\{0, 1\}$ Initial state= q_1 $Q=\{q_1, q_2, q_3, q_4\}$

State transition(δ) and output function (O):



(a) Construct the k-equivalence partitions (as many as needed).

15 points

FSM in tabular form:

FSM in tabular form

State	Output	Next State
q_1	1 0 0	q_2 q_1 q_1
q_2	1 0 0	q_3 q_2 q_4
q_3	0 1 0	q_3 q_1 q_4
q_4	0 1 0	q_4 q_1 q_1

P_1 table

Σ	State	Next State
1	q_1	q_{21} q_{11} q_{11}
	q_2	q_{32} q_{21} q_{42}
2	q_3	q_{32} q_{11} q_{42}
	q_4	q_{42} q_{11} q_{11}

P_2 table

Σ	State	Next State
1	q_1	q_{22} q_{11} q_{11}
2	q_2	q_{33} q_{22} q_{44}
3	q_3	q_{33} q_{11} q_{44}
4	q_4	q_{44} q_{11} q_{11}

(b) Construct the characterization set W.

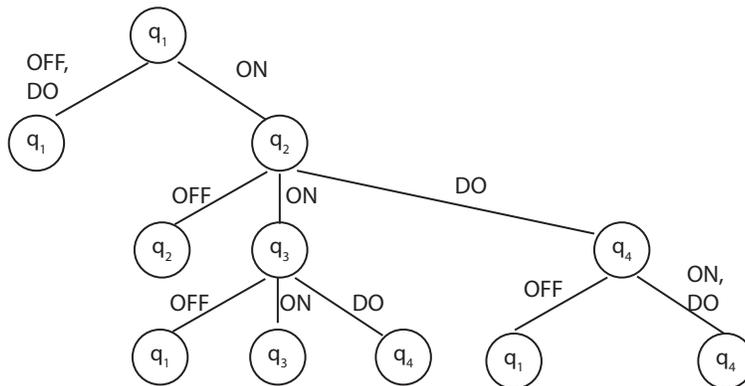
10 points

State pair	Distinguishing string
q_1-q_2	ON OFF
q_1-q_3	OFF
q_1-q_4	OFF
q_2-q_3	OFF
q_2-q_4	OFF
q_3-q_4	ON DO

$W = \{ON\ OFF, OFF, ON\ DO\}$

(c) Construct the testing tree for the FSM give above.

5 points



(c) Derive the transition cover set.

5 points

Transition cover set=

$\{\epsilon, OFF, DO, ON, ON\ OFF, ON\ ON, ON\ ON\ OFF, ON\ ON\ ON, ON\ ON\ DO, ON\ DO, ON\ DO\ OFF, ON\ DO\ ON, ON\ DO\ DO\}$

(d) Assuming that the FSM and the implementation have the same number of states, use the W set and the transition cover set that you have derived to construct four test inputs to be used to test whether or not the implementation conforms to the FSM above.

5 points

Test #	Test
t_1	ON OFF
t_2	OFF
t_3	ON DO
t_4	ON OFF OFF

Q5 Extra credit question: An application App takes n inputs. Each input is in a range given as $l \leq x \leq h$ where x is an input variable and l and h , denote, respectively, its minimum and maximum values. How many tests will be generated?

Corner tests: 2^n (=8 for 3-dimensional input domain)

Tests on the boundary: $2n^2 - 2n$ (=12 for 3-dimensional input domain)

Tests off the boundary outside the region: n (=3 for 3-dimensional input domain)

Tests off the boundary inside the region: n (=3 for 3-dimensional input domain)

Test far from the region the region: 1

Test far inside the region: 1

Total tests: $2^n + 2n^2 - 2n + 2n + 2 = 2^n + 2n^2 + 2$ (=28 for 3-dimensional input domain)

_____ End of Questions. _____