Chapter 7: Graph Coverage Criteria

1. Consider the following fragment of Java code:

```
1  public int mystery(int max) {
2      int a = 0;
3      while (a < 10) {
4          for (int i = 0; i <= max; i++) {
5              if (i % 2 == 0) {
6                  a = a + i;
7              }
8          }
9      }
10     return a;
11 }
```

Using the code above, answer the following questions

a. Draw the control flow graph that represents abstraction of its execution. Label edges and nodes in the graph with the corresponding code fragments. Do not forget to indicate initial and end node.
b. List the test requirements for Node Coverage
c. List the test requirements for Edge Coverage
d. List the test requirements for Edge-Pair Coverage
e. List all simple paths
f. List the prime paths
g. Extend the prime paths to create a set of test paths TR that provide Prime Path Coverage (PPC)
h. Give a set of test cases for the requirements in questions b
i. Give a set of test cases for the requirements in questions c
j. Give a set of test cases for the requirements in questions d
k. Give a set of test cases for the requirements in questions g

Homework - 4

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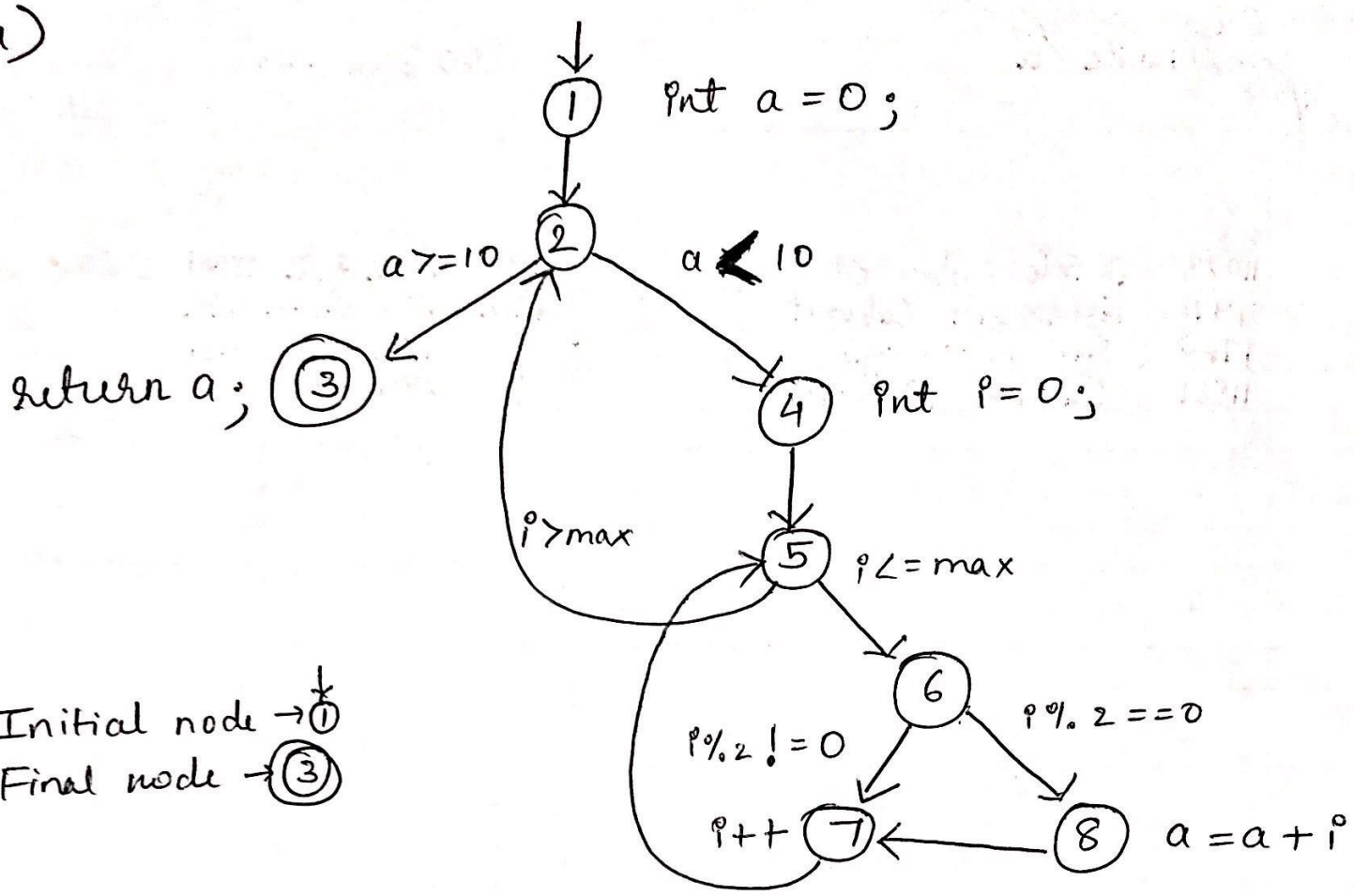
a)



b) Node coverage

[1]
[2]
[3]
[4]
[5]
[6]
[7]
[8]

c) Edge coverage

[1, 2]
[2, 3]
[2, 4]
[4, 5]
[5, 6]
[5, 2]
[6, 7]
[6, 8]
[7, 5]
[8, 7]

d) Edge Pair coverage

[1,2,3] !
[1,2,4]
[2,4,5]
[4,5,2]
[4,5,6]
[5,2,4]
[5,2,3]!
[5,6,8]
[5,6,7]
[6,7,5]
[6,8,7]
[7,5,6]
[7,5,2]
[8,7,5]

e) Simple path

len 0

[1]
[2]
[3]!
[4]
[5]
[6]
[7]
[8]

len 1

[1,2]
[2,3]!
[2,4]
[4,5]
[5,6]
[5,2]
[6,7]
[6,8]
[7,5]
[8,7]

len 2

[1,2,3]!
[1,2,4]
[2,4,5]
[4,5,2]
[4,5,6]
[5,2,4]
[5,2,3]!
[5,6,8]
[5,6,7]
[6,7,5]
[6,8,7]
[7,5,6]
[7,5,2]
[8,7,5]

len 3

[1,2,4,5]
[2,4,5,2]*
[4,5,2,4]*
[4,5,6,8]
[4,5,6,7]
[5,2,4,5]*
[5,6,8,7]
[5,6,7,5]*
[6,7,5,6]*
[6,7,5,2]
[6,8,7,5]
[7,5,6,7]*
[7,5,6,8]
[7,5,2,3]!
[7,5,2,4]
[8,7,5,6]
[8,7,5,2]
[2,4,5,6]
[4,5,2,3]!

Len 4

[1,2,4,5,6]

[2,4,5,6,7]

[2,4,5,6,8]

[4,5,6,8,7]

[5,6,8,7,5]*

[6,7,5,2,3]!

[6,7,5,2,4]

[6,8,7,5,6]*

[6,8,7,5,2]

[7,5,6,8,7]*

[8,7,5,6,8]*

[8,7,5,2,3]!

[8,7,5,2,4]

Len 5

[1,2,4,5,6,7]

[1,2,4,5,6,8]

[2,4,5,6,8,7]

[6,8,7,5,2,3]!

[6,8,7,5,2,4]

Len 6

[1,2,4,5,6,8,7]

f) Prime paths.

[1,2,3]!

[4,5,2,3]!

[7,5,6,7]*

[5,6,7,5]*

[6,7,5,6]*

[5,2,4,5]*

[4,5,2,4]*

[2,4,5,2]*

[8,7,5,6,8]*

[7,5,6,8,7]*

[6,8,7,5,6]*

[6,7,5,2,4]

[6,7,5,2,3]!

[5,6,8,7,5]*

[6,8,7,5,2,4]

[6,8,7,5,2,3]!

[1,2,4,5,6,7]

[1,2,4,5,6,8,7]

g) PPC

	TP	TR
t_1	[1,2,3]	[1,2,3]
t_2	[1,2,4,5,6,8,7,5,6,8,7,5,2,3]	[1,2,4,5,6,8,7], [6,8,7,5,2,3], [5,6,8,7,5], [6,8,7,5,6], [7,5,6,8,7], [8,7,5,6,8],
t_3	[1,2,4,5,2,4,5,6,7,5,6,7,5,2,3]	[6,7,5,2,3], [2,4,5,2], [4,5,2,4], [5,2,4,5], [5,6,7,5], [6,7,5,6], [7,5,6,7]
t_4	[1,2,4,5,6,7,5,2,4,5,6,8,7,5,2,4,5,2,3]	[1,2,4,5,6,7], [6,8,7,5,2,4], [6,7,5,2,4], [4,5,2,3]

h) TR = {1,2,3,4,5,6,7,8}

TP

t_1 = [1,2,3]

t_2 = [1,2,4,5,6,8,7,5,2,3]

Test case value

t_1 → impossible.

t_2 → impossible.

[1,2,4,5,6,8,7,5,2,3]

a=0 (5,6,8,7) 07=10 ✗ (5,2,3)

① a = 0

② 07=10 ✗

One possible Test path

t_3 → [1,2,4,5,6,8,7,5,6,7,5,6,8,7,5,6,7,5,6,8,7,5,6,7,5,6,8,7,5,6,7,5,2,3]

Test value

t_3 → max = 6 expected 12

For brief explanation refer question (i)

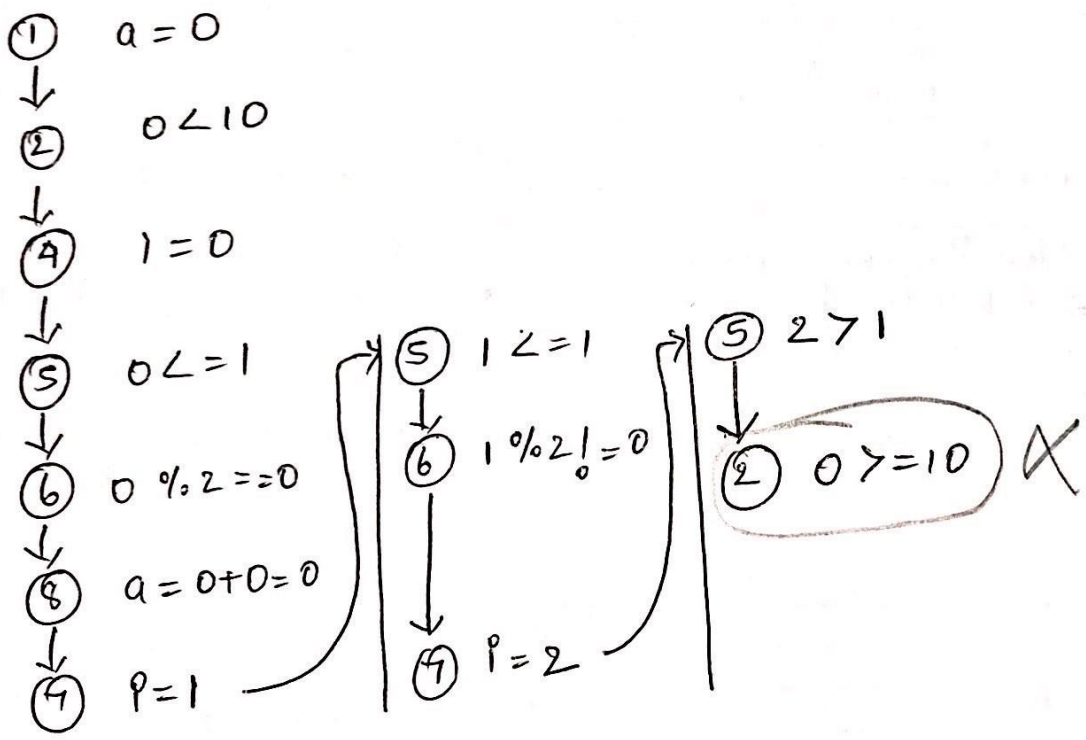
9) TR = {(1,2), (2,3), (2,4), (4,5), (5,6), (5,2), (6,7), (6,8), (7,5), (8,7)}

TP

t_1 = [1, 2, 4, 5, 6, 8, 7, 5, 6, 7, 5, 2, 4, 5, 2, 3]

* Test case values (max)

t_1 → Impossible to design a test case.
i.e. max = 1



So, TR [2, 3] can't be covered.

* One possible test case can be designed if Test path is as follows :-

In order to cover TR [2,3] a should be ≥ 10 or greater than 10. So we design test path in which value of a becomes ∨ 10.
greater than

TP (max = 6)

[1, 2, 4, 5, 6, 8, 7, 5, 6, 7,

a = 0, i = 1 (5, 6, 8, 7)

i = 2 (5, 6, 7)

5, 6, 8, 7, 5, 6, 7,

a = 2, i = 3 (5, 6, 8, 7)

i = 4 (5, 6, 7)

5, 6, 8, 7, 5, 6, 7,

a = 6, i = 5 (5, 6, 8, 7)

i = 6 (5, 6, 7)

5, 6, 8, 7, 5, 2, 3]

a = 12, i = 7 (5, 6, 8, 7)

Test Path is

[1, 2, 4, 5, 6, 8, 7, 5, 6, 7, 5, 6, 8, 7, 5, 6, 7,
5, 6, 8, 7, 5, 6, 7, 5, 6, 8, 7, 5, 2, 3]

Test value

max = 6 expected 12.

j)

TR = { (1,2,3), (1,2,4), (2,4,5), (4,5,2), (4,5,6), (5,2,4), (5,2,3), (5,6,8), (5,6,7), (6,7,5), (6,8,7), (7,5,6), (7,5,2), (8,7,5) }

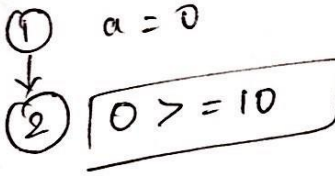
Test paths

t_1 = [1,2,3]

t_2 = [1,2,4,5,6,8,7,5,6,7,5,2,4,5,2,3]

Test case values.

t_1 → Impossible to design a test case.



so, TR [1,2,3] can't be covered.

t_2 → Impossible to design a test case.

Test case is possible for following test path

t_3 = [1,2,4,5,6,8,7,5,6,7,5,6,8,7,5,6,7,5,6,8,7,5,6,7,5,6,8,7,5,2,3]

Test value

t_3 → max = 6 expected 12

" For brief explanation of t_2 & t_3 refer Question (i) ".

k) TP

$t_1 \rightarrow [1,2,3]$

$t_2 \rightarrow [1,2,4,5,6,8,7,5,6,8,7,5,2,3]$

$t_3 \rightarrow [1,2,4,5,2,4,5,6,7,5,6,7,5,2,3]$

$t_4 \rightarrow [1,2,4,5,6,7,5,2,4,5,6,8,7,5,2,4,5,2,3]$

Test case value

$t_1 \rightarrow$ Impossible to design a test case.

$t_2 \rightarrow$ Impossible.

[1,2,4,5,6,8,7,5,6,8,7,5,2,3] ✗

a=0, i=1

i%2

1%2 != 0

$t_3 \rightarrow$ Impossible.

i.e. max = -1

[1,2,4,5,2,4,5,6,7,5,6,7,5,2,3]

i=0

0<=-1 ✗

$t_4 \rightarrow$ Impossible.

[1,2,4,5,6,7,5,2,4,5,6,8,7,5,2,4,5,2,3] ✗

i=0

i%2==0

0%2==0

Test case is possible with following test path.

t_5 = [1,2,4, 5,6,8,7, 5,6,7,5,6,8,7, 5,6,7 5,6,8,7, 5,6,7, 5,6,8,7, 5,2,3]

Test value

t_5 → max = 6 expected 12

" for brief explanation refer question (i°) "