CSC4001 Software Engineering

Assignment 1

Due – 23:59, 8th March, 2023 (Saturday)

Note: Late submission will have grade of 0!!!

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1. Multiple Choice (35 points) Each question might have *one or more* correct answers.

1.1 (15 points) Consider the following buggy program, which aims to return a sorted array via bubble sort.

```
1 int[] BubbleSort(int[] arr) {
2       int n = arr.size();
3       for (int i = 0; i < n-1; i++) {
4             for (int j = 0; j < n-i-1; j++) {
5                   if (arr[j] >= arr[j+1]) {
6                         arr[j] = arr[j+1];
7                         j = j+1;
8                   }
9             }
10      }
11      return arr;
12 }
```

(a) (5 points) Identify the bug in this program.

A. line 2
B. line 3 and 4
C. line 6 and 7
D. line 11

(b) (5 points) Which test case/cases can achieve 100% statement coverage?

A. {3, 2, 1, 0}
B. {8, 15, 2, 10}
C. {1, 2, 3, 4}
D. {0, 0}; {10, 5}

(c) (5 points) Which test case can reveal the bug?

A. {1, 2, 3, 4}
B. {1, 1, 2, 3}
C. {4, 3, 2, 1}
D. {1, 1, 3, 2}

1.2 (20 points) Consider the following program:

```
1 void foo(int a, int b){
2     int x = 1, y = 0;
3     if (a != 0) {
4         y = 3 + x;
5         if (b == 0) {
6             x = 2 * (a + b);
7         }
8         if (x < 0) {
9             x = 0
10        }
11    }
12    if (x  -  y == 0)
13        ERROR;
14 }
```

(a) (5 points) In this program, there are ___ paths to the statement **ERROR**.

A. 1
B. 3
C. 4
D. 5

(b) (5 points) For test cases {a=0, b=1}; {a=-1, b=1} on this program, which option(s) is/are **correct**?

A. It achieves 100% statement coverage
B. Path coverage is 40%
C. Path coverage is 20%
D. There is no executed path to the statement **ERROR**

(c) (5 points) Which option(s) is/are **correct**?

A. Test cases {a=0, b=1}; {a=-1, b=1}, {a=2, b=0} can achieve 100% branch coverage
B. Test cases {a=0, b=1}; {a=-1, b=1}, {a=-2, b=0} can achieve 100% branch coverage
C. It is impossible to achieve 100% branch coverage if the number of test case is less than 3
D. The number of total paths is 5

(d) (5 points) Which option(s) is/are **correct**?

A. There exist a path include line 6 and line 9
B. There exist a path include line 6 and line 13
C. There exist a path include line 9 and line 13
D. There exist a path include line 9 but do not include line 6

2. Control Flow Analysis (35 points)
Consider the following python program:

```
1 def main(x, y):
2       num1 = x
3       num2 = y
4       sums = num1 + num2
5       product = num1 * num2
6       if sums > 30:
7             print("The sums is greater than 30.")
8       else:
9             print( "The sums is not greater than 30.")
10            for i in range(10):
11                  if i % 2 == 0:
12                        product += 1
13                  else:
14                        product *=2
15      j = 3
16      if product % j ==0:
17            product *= -1
18      return product
```

(a) (15 points) Build control flow graph for program above. (Deduct two points for each mistake)

(b) (10 points) Can we design a test set for 100% statement coverage? (5points) If yes, please give the minimal test set. If no, please give the reason. (5 points)

(c) (10 points) Can we design a test set for 100% path coverage? (5points) If yes, please give the minimal test set and the path of each test case. If no, please give the reason. (5 points)

3. Coverage (30 points)

Consider the following python program:

```
1  def add(x, y):
2      return x + y
3  def subtract(x, y):
4      return x - y
5  def multiply(x, y):
6      return x * y
7  def divide(x, y):
8      if y == 0:
9          raise ValueError("Division by zero is not allowed.")
10     return x / y
11 def calculator(choice, num1, num2):
12     print("Select an operation:")
13     print("1. Add")
14     print("2. Subtract")
15     print("3. Multiply")
16     print("4. Divide")
17     if choice == '1':
18         print(num1, "+", num2, "=", add(num1, num2))
19     elif choice == '2':
20         print(num1, "-", num2, "=", subtract(num1, num2))
21     elif choice == '3':
22         print(num1, "*", num2, "=", multiple(num1, num2))
23     elif choice == '4':
24         try:
25             print(num1, "/", num2, "=", divide(num1, num2))
26         except ValueError as e:
27             print(e)
28     else:
29         print("Invalid input")
```

(a) (15 points) For given test set

{choice='1, num1=1, num2=1};
{choice='2', num1=2, num2=2};
{choice='3', num1=3, num2=3};
{choice='4', num1=4, num2=4},

please provide the statement coverage, branch coverage, path coverage.
(each coverage for 5 points)

(b) (15 points) Please provide three minimal test sets which can achieve 100% statement, branch, and path coverage respectively.
(each coverage for 5 points)