CISC 3115

Test-1

This test consists of 7 questions. Please complete the test and submit it as a plain text email under the subject "CISC 3115 Test-1" to nzhou@brooklyn.cuny.edu by midnight on September 29, 2021.

Question 1

What is the output of the following program?

```
class Q1 {
    public static void main(String[] args){
        Point p = new Point();
        int a[] = {1,2};
        int x, y;

        p.x = 1; p.y = 2;
        x = 1; y = 2;
        f(p, a, --x, y--);

        System.out.println("p.x=" + p.x);
        System.out.println("p.y=" + p.y);
        System.out.println("a[0]=" + a[0]);
        System.out.println("a[1]=" + a[1]);
        System.out.println("x=" + x);
        System.out.println("y=" + y);
    }

    static void f(Point p, int[] a, int x, int y){
        p.x = 3; p.y = 4;
        a[0] = 3; a[1] = 4;
        x = 3; y = 4;
    }
}

class Point {
    int x, y;
}
```

Question 2

Consider the following program:

```
class Q2 {
    public static void main(String[] args){
        System.out.println(f(2,5));
        System.out.println(f(2,10));
    }

    public static long f(long x, long y){
        if (y == 0){
            return 1;
        } else if (y == 1){
            return x;
        } else {
            long z = y/2;
            long e = f(x, z);
            if (y%2 == 0){
                return e*e;
            } else {
                return x*e*e;
            }
        }
    }
}
```

1. What is the output of the program?
2. What does the function `f` return in general?
3. Depict the calls on the run-time stack when `f(2, 1)` is encountered for the *first* time.

Question 3

The following function is supposed to test if a given string is a palindrome. However, it does not work.

```
public static boolean palindrome(String str){
    return palindrome(str, 0, str.length()-1);
}

public static boolean palindrome(String str, int low, int hi){
    if (low >= hi)
        return true;
    return str.charAt(low) == str.charAt(hi) && palindrome(str, low++, hi--);
}
```

1. What is the problem?
2. Modify the program to fix the problem.
3. Write a function that uses a loop instead of recursion to test if a string is a palindrome.

Question 4

The following function replicates a given array `n` (`n` > 0) times.

```
static int[] replicate(int[] a, int n)
```

For example, for `a = {1,2,3}` and `n = 2`, the returned array is `{1,2,3,1,2,3}`. Provide two implementations of the function, one iterative and the other recursive.

Question 5

Consider the following functions:

```
public static String f(String str){
    return f_aux(str, str.length());
}

static String f_aux(String str, int n){
    return (n == 0) ? "" : f_aux(str, n-1) + str.charAt(n-1);
}
```

1. Explain the behavior of the function `f`. For example, what is the return value of the function call `f("abc")`?
2. Convert the function `f_aux` to an iterative one that uses a loop.

Question 6

Consider the following program:

```
class F {
    public static void main(String[] args){
        System.out.println(f(6));
    }

    static long  f(long n){
        if (n == 0)
            return 1;
        else if (n == 1)
            return 1;
        else
            return f(n-1) + f(n-2);
    }
}
```

1. What is the output of the program?
2. Show the calls on the the run-time stack when `f(1)` is encountered for the *second* time.

Question 7 (extra 10 points)

Consider strings over the alphabet $\Sigma = \{a, b\}$, and the function `count(n)` that returns the number of strings of length `n` containing more `a`'s than `b`'s. For example, for `n = 3`, there are four such strings, namely, ["aaa", "aab", "aba", "baa"], so the count is 4. Implement the function in Java using recursion (*Assume that you are not allowed to use any formula for the count.*)