RECURSIVE TRACING:

NICOLE DELOS REYES

I.

1. Given the method defined below what does the following print:
`mystery(4,3)`?

```java
public static int mystery(int n, int a){
    if (n == 1)
        return a;

    return a * mystery(n-1,a);
}
```

81 = 3 × mystery (3,3)
$\downarrow$
27 = 3×mystery (2,3)
$\downarrow$
9 = 3 × mystery (1,3)
$\downarrow$
3

Alternative way:
mystery (4,3) = 3 × mystery (3,3)
= 3 × 3 × mystery (2,3)
= 3 × 3 × 3 × mystery (1,3)
= 3 × 3 × 3 × 1
= 81

2. What happens when we call `bunnyEars(5)`?

```java
public static int bunnyEars(int bunnies){
    if (bunnies == 0)
        return 0;
    else if (bunnies == 1)
        return 2;
    else
        return 2 + bunnyEars(bunnies - 1);
}
```

Alternative way:
bunnyEars (5)
= 2 + bE(4)
= 2 + 2 + bE(3)
= 2 + 2 + 2+bE (2)
= 2 + 2 + 2 + 2+bE (1)
= 2 + 2 + 2 + 2 +2
= 10

bunny Ears (5) = 10
$\llcorner\rightarrow$ 2 + bunny Ears (4) = 10
$\llcorner\rightarrow$ 2 + bunny Ears (3) = 8
$\llcorner\rightarrow$ 2 + bunny Ears (2) = 6
$\llcorner\rightarrow$ 2 + bunny Ears (1) = 4
$\llcorner\rightarrow$ 2

3. Given the method defined below what does the following print:
`mystery(1234)`?

```java
public static void mystery (int x) {
    System.out.print(x % 10);

    if ((x / 10) != 0) {
        mystery(x / 10);
    }
    System.out.print(x % 10);
}
```

completes the rest
of each method
after (x/10) != 0

Console: " 4 3 2 1 1 2 3 4"

mystery (1234) = "4"
$\llcorner\rightarrow$ mystery (123) = "3"
$\llcorner\rightarrow$ mystery (12) = "2"
$\llcorner\rightarrow$ mystery (1) = "1"

4. Given the method defined below what does the following return:
`mystery("xyzxyxy")`? length = 7

```java
public static int mystery(String str)
{
    if (str.length() == 1)
        return 0;
    else
    {
        if (str.substring(0,1).equals("y"))
            return 1 +  mystery(str.substring(1));
        else
            return mystery(str.substring(1));
    }
}
```

mystery ("xyzxyxy") = 2
$\llcorner\rightarrow$ mystery ("yzxyxy") = 2
$\llcorner\rightarrow$ 1 + mystery ("zxyxy") = 2
$\llcorner\rightarrow$ mystery ("xyxy") = 1
$\llcorner\rightarrow$ mystery ("yxy") = 1
$\llcorner\rightarrow$ 1+ mystery ("xy") = 1
$\llcorner\rightarrow$ mystery ("y") = 0

5. Given the method defined below what does the following return: a) starString(4)? b) starString(5)?

```java
public String starString(int n)
{
    if (n == 0) {
        return "*";
    } else {
        return starString(n - 1) + starString(n - 1);
    }
}
```

MS. ZIE'S WAY

a) starString(5) = "* *"×32

↓

starString(4) + starString(4) → "**" ×32

↓

starString(3) + starString(3) → "**"×16

↓

starString(2) + starString(2) → "**××××××"

↓

starString(1) + starString(1) → "****"

↓

starString(0) + starString(0) → "**"

b) starString(5) = "**"×64

↳ starString(4) + starString(4) = "* *"×32

↳ starString(3) + starString(3) = "**"×8

↳ starString(2) + starString(2) = "******"

↳ starString(1) + starString(1) = "****"

↳ starString(0) + starString(0) = "**"

↳ "*"

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6. Given the method defined below what does the following return multiplyEvens(3)?

```java
public static int multiplyEvens(int n)
{
    if (n == 1) {
        return 2;
    } else {
        return 2 * n * multiplyEvens(n - 1);
    }
}
```

multiplyEvens(3) = 48

↳ 2 × 3 × multiplyEvens(2) = 24

↳ 2 × 2 × multiplyEvens(1) = 8

↳ 2

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7. Given the following method declaration, what value is returned as the result of the call product(5)?

```java
public static int product(int n)
{
    if (n <= 1)
        return 1;
    else
        return n * product(n - 2);
}
```

product(5) = 15

↳ 5 × product(3) = 15

↳ 3 × product(1) = 3

↳ 1

---

8. Given the following method declaration, what value is returned as the result of the call f(5)?

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

f(5) = 5

↳ f(4) + f(3) = 3+2 = 5

↳ f(3) + f(2) = 2+1 = 3

↳ f(2) + f(1) = 1+1 = 2

↳ f(1) + f(0) = 1

↳ 1   ↳ 0

★ DOUBLE CHECK!!!

9. Given the following method declaration, this method will return true if and only if:

```java
public static boolean check(String s)
{
    return s.length() >= 2 &&
        (s.charAt(0) == s.charAt(1)
||check(s.substring(1)));
}
```

A. The string s contains two or more of the same characters.
B. The string s starts with two or more of the same characters.
C. The string s contains two or more of the same character that are next to each other.
D. The string s ends with two or more of the same characters

10. Given the following method declaration, what will `redo(82, 3)` return?

```
public static int redo(int i, int j)
{
    if (i==0)
        return 0;
    else
        return redo(i/j, j)+1;
}
```

redo (82, 3) = 5
 └ redo (27,3) +1 = 5
  └ redo (9,3) +1 = 4
   └ redo (3,3) +1 = 3.
    └ redo (1,3)+1= 2
     └ redo (0,3) +1 = 1
      └ 0.

11. Given the following method declaration, what will `mystery ("Hello", 3)` return?

```
public static String mystery(String s, int n)
    {
            if (n == 0) {
                return "";
            } else {
                return s+ " " + mystery(s, n - 1);
            }
    }
```

← empty

mystery ("Hello",3) ='Hello"+ " " + "Hello" + " " + "Hello" + " " + " "
 └ "Hello" + " " + mystery ("Hello", 2) = "Hello"+ " " + "Hello" + " " + "Hello" + " " + " "
  └ "Hello"+ " " + mystery ("Hello", 1) = "Hello" + " " + "Hello" + " " + " "
   └ "Hello"+ " " + mystery ("Hello, 0) = "Hello" + " " + " "
    └ " "

12. Given the following method declaration, what will `mystery(6)` return?

```
public static String mystery( int n)
    {
            if (n == 0) {
                return "0...";
            } else {
                return mystery(n - 1)+n+"...";
            }
    }
```

mystery (6) =" 0...1...2...3...4...5...6..."
 └ mystery (5) + 6+"..." =" 0...1...2...3...4...5...6..."
  └ mystery (4) + 5 + "..." = "0...1...2...3...4...5.."
   └ mystery (3) + 4 +"..'' = "0...1...2...3...4..."
    └ mystery (2) +3 + "..." ="0...1...2...3..."
     └ mystery(1) +2 +"..."="0...1...2..."
      └ mystery (0) +1+"..." = "0...1.."
       └ "0..."

13. Consider the following recursive function.

```
public static int mystery(int a, int b) {
    if (b == 0)      return 0;
    if (b % 2 == 0) return mystery(a+a, b/2);
    return mystery(a+a, b/2) + a;
}
```

What are the values of `mystery(2, 25)` and `mystery(3, 11)`? Given positive integers a and b, describe what value `mystery(a, b)` computes. Answer the same question, but replace + with * and replace `return 0` with `return 1`.

```
public static int mystery(int a, int b) {
    if (b == 0)      return 1;
    if (b % 2 == 0) return mystery(a*a, b/2);
    return mystery(a*a, b/2) * a;
}
```

PART B:

PART 1)

mystery (2, 25) = 50
 └ mystery (4, 12) + 2 = 50
  └ mystery (8, 6) = 48
   └ mystery (16, 3) = 48
    └ mystery (32, 1)+16 = 48
     └ mystery (64, 0) + 32 = 32
      └ 0

mystery (3, 11) = 33
 └ mystery (6, 5) +3 = 33
  └ mystery (12, 2) + 6 = 30
   └ mystery (24, 1) = 24
    └ mystery (48, 0) + 24 = 24
     └ 0

mystery (2, 25) = 33554432
 └ mystery (4, 12) × 2 = 33554432
  └ mystery (16, 6) = 16777216
   └ mystery (256, 3) = 16777216
    └ mystery (65536, 1) × 256 = 16777216
     └ mystery (4294967296, 0) × 65536 = 65536
      └ 1

mystery (3, 11) = 177147
 └ mystery (9, 5) × 3 = 177147
  └ mystery (81, 2) × 9 = 59049
   └ mystery (656, 1) = 6561
    └ mystery (43046721, 0) × 656) = 6561
     └ 1