**COS126 Exam 1 Mini-Test**

1. **Short Answer**

   1. Write the value of `(double) ( 22 / 7 )`.  

   2. Write this number using Java’s scientific notation, (without using `Math.pow`):  
      
      $6.022 \cdot 10^{23}$

   3. True or False. Any `for` loop can be converted into an equivalent `while` loop.

   4. True or False. Any recursive method can be re-written as a non-recursive method using loops.

   5. True or False. The following condition will compile in Java.  
      
      $(a < b < c)$

   6. You have a program called `Recipe.java` which reads from standard input and writes to standard output. You have compiled it. The command-line to run it so it reads keyboard input and writes to the terminal screen is: `java Recipe`.  
      Write the command-line to run it so it reads input redirected from a file named `cookbook.txt`.

      Write the command-line to run it so it reads input from `cookbook.txt` and writes to an output file named `meal.txt`.

      Write the command-line to run it so it reads keyboard input and pipes the output to another compiled program named `HungryThing.java`. 


2. Doubles, StdIn, Analysis of Algorithms

The following takes two command-line arguments x, y; reads from standard input a sequence of point coordinates (xi, yi), and prints what?

```java
class Mystery {
    public static void main(String[] args) {
        double x = Double.parseDouble(args[0]);
        double y = Double.parseDouble(args[1]);

        double bestx = Double.NaN;
        double besty = Double.NaN;
        double bestDist2 = Double.POSITIVE_INFINITY;

        while (!StdIn.isEmpty()) {
            double xi = StdIn.readDouble();
            double yi = StdIn.readDouble();
            double dist2 = (x - xi) * (x - xi) + (y - yi) * (y - yi);
            if (dist2 < bestDist2) {
                bestx = xi;
                besty = yi;
                bestDist2 = dist2;
            }
        }

        // output
        StdOut.printf("Closest point = (%f, %f)\n", bestx, besty);
    }
}
```

Suppose we run the Mystery program as follows:

```
% java Mystery 1.0 5.0
1.0 3.0
5.0 3.0
9.0 6.0
2.0 6.0
5.0 6.0
<Ctrl-d>
```

a) Fill in the trace table:

<table>
<thead>
<tr>
<th>x</th>
<th>y</th>
<th>bestx</th>
<th>besty</th>
<th>bestDist2</th>
<th>xi</th>
<th>yi</th>
<th>dist2</th>
</tr>
</thead>
<tbody>
<tr>
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</tbody>
</table>
2. Continued
   
   b) What does the program print?

   c) What kind of input would cause NaN, NaN to print out?

   d) In general, what does this program do?

   e) Suppose we read in N points. How many comparisons of dist2 and bestDist2 will the program make?
3. Recursion, Debugging (from Spring04, Exam 1, Question 4)
There’s a bug in the following recursive program. You need to find it and fix it.

```java
public class Series{
    public static int func(int j){
        if (j==1) return 1;
        return 2*func(j-1)+5*func(j-2);
    }

    public static void main(String[] args) {
        int N=Integer.parseInt(args[0]);
        if (N<0) {
            System.out.println(''invalid argument'');
            return;
        }
        System.out.println(func(N));
    }
}
```

a. Draw the recursion tree for `func(3)`. You only need to draw the tree up to 3 levels, which means the height of the recursion tree should be no greater than 3.

b. From the recursion tree in (a), do you see a problem with the program? Explain what is the problem.

4. Performance. The following table gives approximate running times for a program with \( N \) inputs for various values of \( N \).

<table>
<thead>
<tr>
<th>( N )</th>
<th>time</th>
</tr>
</thead>
<tbody>
<tr>
<td>1000</td>
<td>5 seconds</td>
</tr>
<tr>
<td>2000</td>
<td>20 seconds</td>
</tr>
<tr>
<td>5000</td>
<td>2 minutes</td>
</tr>
<tr>
<td>10000</td>
<td>8 minutes</td>
</tr>
</tbody>
</table>

Which of the following best describes the likely running time of this program for \( N = 100,000 \)?

V. A few minutes
W. A few hours
X. Half a day
Z. A few days