**CSCI 136 Written Exam #1** **Name: _____**
**Fundamentals of Computer Science II**
**Spring 2012**

This exam consists of 5 problems on the following 8 pages.

You may use your double-sided hand-written 8 ½ x 11 note sheet during the exam. No computers, mobile devices, cell phones, or other communication devices of any kind are permitted.

If you have a question, raise your hand and I will stop by. Since partial credit is possible, **please write legibly and show your work**.

| Problem | Points | Score |
|---|---|---|
| 1 | 8 | |
| 2 | 12 | |
| 3 | 16 | |
| 4 | 12 | |
| 5 | 14 | |
| Total | 62 | |

1. **Loops, Conditionals, I/O** (8 points). Consider the following program:

```
public class Prob1
{
   public static void main(String [] args)
   {
      double d = Double.parseDouble(args[0]);
      int a = 0;
      for (int i = 1; i < args.length; i++)
      {
         if (Double.parseDouble(args[i]) > d)
            a++;
      }
      System.out.printf("%d out of %d\n", a, args.length - 1);
   }
}
```

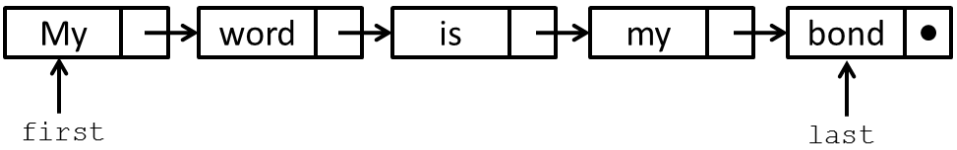
Below are four example executions of the program. Give the output produced by the program. If the given input would cause a runtime error, write "runtime error". If the given input would cause a stack overflow error, write "stack overflow".

| Command line | Output |
|---|---|
| `% java Prob1 0.5 2.3 0.3 0.6` | |
| `% java Prob1 0.5` | |
| `% java Prob1` | |
| `% java Prob1 0.5 0 -1 2.0 3` | |

2. **Linked Structures** (12 points). Assume you have a linked list that holds Strings. It uses the following inner class `Node`:

```
private class Node
{
   String item;
   Node next;
   Node(String s, Node n) { item = s; next = n; }
};
```

Currently the linked list has the following data and structure:




Draw the linked list resulting from running each of the following code segments. Be sure to ***show where the `first` and `last`*** variables are pointing. ***Each part is independent*** of the other parts (assume each part starts with the linked list shown in the above diagram).

```
last.next = new Node("!", null);
last = last.next;
```

```
first = new Node("Sorry but", first);
```

```
for (Node c = first; c != null; c = c.next)
{
   if (c.item.equals("my"))
      c.item = "your";
}
```

```
for (Node c = first; c != null; c = c.next)
{
   if (c.item.equals("my"))
      c.next = new Node("super", c.next);
}
```

3. **Multiple choice** (2 points each). For each question, circle the ***ONE*** correct answer.

a) All of the following lines of code result in the variable `i` being increased by one on the line following the given line ***EXCEPT***:

```
 I.  i++;
II.  ++i;
III. foo(i + 1);
 IV. i += 1;
 V.  i = i + 1;
VI.  foo(i++);
```

`foo` is a method with the signature `void foo(int val)`

b) Assume `vals` is a single dimension array that has been declared and instantiated to contain one or more elements of type `double`. Which of the following lines has the ***potential*** to generate an `ArrayIndexOutOfBounds` runtime exception?

```
 I.  vals[(int) Math.random() * vals.length] = 0.0;
II.  vals[vals.length - 1] = vals[0];
III. vals[(int) (Math.random() * (vals.length - 1))] = 0.0;
IV.  vals[vals.length - 1] = vals[vals.length - 2];
```

c) You are benchmarking an algorithm that takes an input of size N. For an input of size N=50,000, the algorithm took 4.1 hours. For an input of size N=100,000 it took 16.2 hours. Which of the following best describes the order of growth of the algorithm:

I. O(1)
II. O(N)
III. $O(N^2)$
IV. $O(N^3)$
V. $O(2^N)$

d) In Java socket programming, which of the following lines causes a ***server*** program to block (i.e. suspend its execution) until a client requests a new connection:

```
 I.  Socket sock = new Socket("localhost", 5000);
II.  Socket sock2 = sock.accept();
III. InputStreamReader stream = new InputStreamReader(sock.getInputStream());
IV.  BufferedReader reader = new BufferedReader(stream);
 V.  PrintWriter writer = new PrintWriter(sock.getOutputStream());
```

e) You have a single instance of a Java class `Foo` that has three methods `m1`, `m2` and `m3`. Methods `m1` and `m2` are marked as `synchronized` while method `m3` is not. The program has several active threads. If method `m1` is currently being executed by one thread, which of the following is true:

I. No other thread can be inside method `m1`, but one could be inside method `m2` or `m3`.
II. No other thread can be inside method `m1` or `m2`, but one could be inside method `m3`.
III. No other thread can be inside any method in class `Foo`.
IV. A thread's `run()` method can call `join()` to wait for all other threads to exit `m1` and `m2`.

f) All the following are ***reliable*** conditions testing if the `String` variable `password` is "secret" ***EXCEPT***:

```
 I. (password.equals("secret"))
II. (password.compareTo("secret") == 0)
III. (password.matches("secret"))
IV. (password == "secret")
 V. (new String("secret").equals(password))
```

g) Which of the following is ***true*** about threading in Java:

I. When a thread calls `Thread.sleep(1000)`, it will enter the running state and start executing on the CPU in exactly one second.
II. You must have a multi-core CPU to run a multi-threaded Java program.
III. The `Runnable` interface requires you implement a single method, namely `void run()`.
IV. Catching an `InterruptedException` is optional when calling `join()` or `sleep()`.
V. The `join()` method is used to copy output data from a worker thread.

h) You have a large array of N integers. You want to know if a given value is in that array. Which of the following is **true** about using a recursive binary search algorithm to look for the value:

I. $\log_2(N)$ worker threads are required to perform the search in O(log N) time.
II. The array must not have any repeated values.
III. The array must be sorted.
IV. In the worst case, binary search may need to make $N^2$ passes over the array elements.
V. All the array values must be nonnegative.

4. **Recursion** (12 points). Consider the following recursive method:

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

What value is returned for the call `mystery(7, 3)`?

What function does `mystery()` compute for positive `n` and `m`?

5. **Threads** (14 points). Consider the following multi-threaded program:

```
public class Nums
{
   public static void main(String [] args)
   {
      int N = Integer.parseInt(args[0]);
      int M = Integer.parseInt(args[1]);

      double [] a = new double[N];
      for (int i = 0; i < N; i++)
         a[i] = StdIn.readDouble();

      Thread [] threads = new Thread[M];
      for (int i = 0; i < M; i++)
      {
         Worker w = new Worker(a, i, M);
         threads[i] = new Thread(w);
         threads[i].start();
      }

      try
      {
         for (Thread t : threads)
            t.join();
      }
      catch (InterruptedException e)
      {
         e.printStackTrace();
      }

      for (double d: a)
         System.out.printf("%.2f ", d);
      }
}
```

```
public class Worker implements Runnable
{
   private double [] d;
   private int start;
   private int stride;

   public Worker(double [] d, int s, int t)
   {
      this.d      = d;
      this.start  = s;
      this.stride = t;
   }

   public void run()
   {
      for (int i = start;
           i < d.length;
           i = i + stride)
      {
          d[i] = Math.sqrt(d[i]);
      }
   }
}
```

a) What does `N` control in the `Nums` program?

b) What does `M` control in the `Nums` program?

c) What is the goal of the program?

**(continued on next page)**

5. **Threads** (continued)

d) What is a possible advantage of using M > 1 in this program?

e) Assume a user executes "`java Nums 5 2`" and then enters the numbers 1, 4, 9, 16, and 100. What is the console output of the program?

f) Assume you removed the for-loop containing the `t.join()` line from `Nums`. What problem might this cause?