Prelim 1

CS 2110, 14 March 2017, 7:30 PM

	1	**2**	**3**	**4**	**5**	**Total**
Question	Name	Short answer	OO	Recursion	Loop invariants	
Max	1	36	33	15	15	100
Score						
Grader						

The exam is closed book and closed notes. Do not begin until instructed.

You have **90 minutes**. Good luck!

Write your name and Cornell **NetID**, legibly, at the top of **every** page! There are 5 questions on 7 numbered pages, front and back. Check that you have all the pages. When you hand in your exam, make sure your pages are still stapled together. If not, please use our stapler to reattach all your pages!

We have scrap paper available. If you do a lot of crossing out and rewriting, you might want to write code on scrap paper first and then copy it to the exam so that we can make sense of what you handed in.

Write your answers in the space provided. Ambiguous answers will be considered incorrect. You should be able to fit your answers easily into the space provided.

In some places, we have abbreviated or condensed code to reduce the number of pages that must be printed for the exam. In others, code has been obfuscated to make the problem more difficult. This does not mean that it's good style.

Academic Integrity Statement: I pledge that I have neither given nor received any unauthorized aid on this exam. I will not talk about the exam with anyone in this course who has not yet taken prelim 1.

____

(signature)

1. Name (1 point)

Write your name and NetID at the top of **every** page of this exam.

2. Short Answer (36 points.)

(a) 5 points. Below are five expressions. To the right of each, write its value.

1. ’c’ == ’b’ + 1
2. ’5’ - ’0’
3. (double) (double) (int) 5.2 == 5
4. ((Double)(Object)(3.2)).equals(3.2)
5. k == 0 || 5/k != 8 [note: k is of type int]

(b) 4 points. Consider classes A and B declared to the right. Will these classes compile? If not, give as many reasons as possible for why they won’t compile.

```
public abstract class A {
    public abstract void m();
}

public class B extends A {
    public void p() {
          A b= new A();
   }
}
```

(c) 5 points. Write Java code to: Assign array element $b[h]$ to variable k, but if it throws an ArrayIndexOutOfBoundsException, store 0 in k. Do not use an if-statement, conditional expression, switch statement, or loop. Assume that all variables have already been defined.

(d) 6 points. Put a check mark before each of the following sentences that is correct and an X before each that is incorrect.

1. An abstract class cannot have a constructor because it cannot be instantiated.
2. A class can extend only one interface.
3. Methods in an interface are necessarily abstract, but you can make them public or private.
4. If a subclass implements an interface, its superclass cannot implement that interface.
5. A local variable declared with type int is automatically initialized to contain 0.
6. Every constructor must start with a call on a super-class constructor.

(e) 12 points. To the right is class CC and its subclass CB. Below is method main of class CC —it belongs in class CC.

Execute a call on method main. Write the value that is printed by each println statement to the right of that println statement.

```
public static void main(String[] p) {
   CC a= new CC();
   System.out.println(a.x);
   System.out.println(a.y);
   System.out.println(a.m(a));

    CB b= new CB();
    System.out.println(b.x);
    System.out.println(b.y);
    System.out.println(b.m(b));
}
```

```
 public class CC {
   public int x= 2;
   public int y= 10;

   public CC(int p) { x= p; }

   public CC() { this(3); }

   public int m(CC c) {
     return c instanceof CB ? 5 : 6;
   }
}

 public class CB extends CC {
   public CB() { super(4); }

   public @Override int m(CC c) {
       return y + super.m(c);
    }
 }
```

(f) 4 points. Suppose you have an abstract class *A* and its only components are public abstract methods. You would like a class *B* to extend *A*, but *B* already extends a class and it can extend only one. How can you rewrite abstract class *A* to solve this problem?

3. Object-Oriented Programming (33 points)

(a) 5 points

To the right are classes H1 and H2. Method p() is not overridden in class H2.

Modify class H2 so that a variable will contain the number of times during execution that method p() is called as a method of any object of class H2 (instead of as an object of class H1 only).

Your modifications should consist of inserting a declaration in class H2 and overriding method p.

```
public class H1 {
    public void p() { ... }
}

public class H2 extends H1 {









    ...
}
```

(b) 10 points Below are two class declarations. Complete the bodies of the constructor and function `toString` in class `Outhouse`. Be careful; pay attention to access modifiers.

```
public class Outhouse
                  extends Building {

  private int numb; // number of seats
  /** Constructor: instance at address
    *    ad with s seats */
  public Outhouse(String ad, int s) {




  }

  /** Return the building's address, a
    * space, and number of seats. */
  public String toString() {






  }
}
```

```
public class Building {
   private String address;

   /** A building at address ad. */
   public Building(String ad) {
         address= ad;
   }

  /** Return this building's address */
  public String toString() {
      return address;
  }
}
```

(c) 5 points Complete the body of method *equals*, which belongs in class `Outhouse`.:

```
/** Return true iff ob is an Outhouse and
  * ob has the same number of seats as this Outhouse. */
public @Override boolean equals(Object ob) {








}
```

(d) 5 points Write down the steps in executing a method call `m(args)` .

(e) 8 points

Consider the interface and class declarations given below. Next to each piece of Java code in the righthand column, write whether it produces no error, a run-time error, or a compile-time error. (Assume that each piece is independent of the others.)

Hint: It will help to draw objects of the classes.

```
interface J1 {}
interface J2 {}
interface J3 extends J1 {}
class D1 implements J2 {}
class D2 implements J2 {}
class D3 implements J3 {}
class D4 extends D2 implements J1 {}
```

```
(a) J2 a= new J2();

(b) J2 b= new D2();

(c) D3 c= new D4();

(d) D2 d= new D4();

(e) D4 e= new D3();

(f) D4 f= (D4)(new D2());

(g) J2 g1= new D2();
    D4 g2= new D4();
    g2= g1;

(h) J1 h1= new D4();
    J2 h2= new D2();
    h2= h1;
```

4. Recursion (15 Points)

(a) 10 points. Write the body of recursive function nf, whose specification and header appear below. Do not use loops. Use only recursion.

```
/* Return the number of times b[k] appears in a row at the beginning of b[k..]
 * Precondition: 0 <= k < b.length.
 * Examples: For b containing [2, 2, 2, 3, 2, 6],
 *           nf(b, 0) = 3  and  nf(b, 2) = 1. */
public static int nf(int[] b, int k) {













}
```

(b) 5 points. Below is function putBlank. It is complete except for the *base-case if-condition.* Circle all possible expressions from the list below that could be used for the *base-case if-condition.*

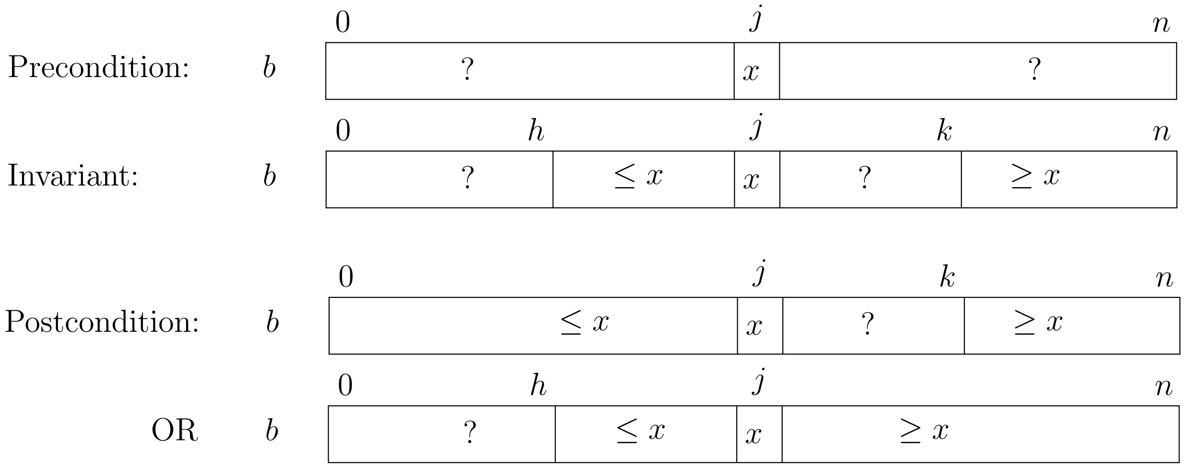
1. $s.length() < 2$
2. $s.length() \leq 2$
3. $s.length() == 2$
4. $Integer.parseInt(s) < 100$
5. $s.length() == 0$

```
/** Return s formatted by inserting a blank before every second digit.
  * E.g. ”1000” is formatted as ”10 00”, ”56” is ”56”, and ”1234567” is ”1 23 45 67”.
  * Precondition: s is a non-signed integer and the leftmost digit is not 0. **/
public String putBlank(String s) {
   if ( base-case if-condition ) return s;
   return putBlank(s.substring(0,s.length()-2)) + ’ ’ + s.substring(s.length()-2);
}
```

5. Loop Invariants (15 points)

(a) 2 points State the formula for the number of values in array segment $b[h..k-1]$.

(b) 13 points Consider the following precondition, invariant, and postcondition. The postcondition has two alternatives —either section $b[0..h]$ or section $b[j+1..k]$ is empty (the other one might be, but it is not necessary).



Write a loop with initialization that uses the invariant given above to implement the comment given below. Thus, the loop should continue as long as both ? sections are non-empty. Assume that b, j, and n are already initialized. Identifier x can't be used in the program; it just stands for the value in $b[j]$. Don't declare variables, but do assign appropriate values to h and k wherever necessary. To swap $b[i]$ and $b[j]$, just say, "Swap $b[i]$ and $b[j]$." Your grade depends only on how well you use the four loopy questions to write the code.

```
// Given the Precondition as shown above, swap values of array
// segment b[0..n] so that the Postcondition holds.
```