Final Examination
CS170: Introduction to Computer Science

Observe the Emory College Honor Code while taking this test.

Question 1. (30 pts, 3 each) Multiple Choice

For each question, circle the best option.

1.1. Which of the following statement is true concerning a safe casting operation:

- You must tell the compiler that you agree to a loss of (some) information.
- It is performed by the Operating System.
- It is an automatic conversion.
- It may cause a program error.
- None of the above.

1.2. What mechanism is used to define a new class using an existing class as basis:

- Shadowing
- Inheritance
- Initialization
- Construct
- None of the above.

1.3. If a and b are int variables and b is not zero, which of the following expressions equals a - (a/b)*b:

- 0
- a - b
- a & b
- a % b
- None of the above.

1.4. Consider the following code fragment:

```c
int sum = 0;
int item = 0;
do
{
    item++;
    sum += item;
    if ( sum > 4 )
        break;
} while ( item < 5 );
```
What is the value of the variable sum after the loop has terminated?

- 6
- 10
- 15
- it is an infinite loop
- None of the above.

1.5. Which of the following statement is true about instance methods:

- Instance methods are defined using the keyword static.
- Instance methods are defined using the keyword void.
- Instance methods are defined without using the keyword static.
- Instance methods always have public access.
- None of the above.

1.6. Which of the following statement is true about constructor methods:

- Java always defines the default constructor in a user-defined class.
- A constructor method must declare void as its return type.
- When an object is created, Java always invokes a constructor method.
- A constructor method is always static.
- None of the above.

1.7. Suppose a class variable x (defined using the keyword static) in class myClass is shadowed by a local variable. How can you access the shadowed class variable x:

- Using: this.x
- Using: super.x
- Using: myClass.x
- Using: class.x
- None of the above.

1.8. Which of the following statements is correct?

- A class must have instance variables.
- A class must have a main method.
- A class can have multiple methods with the same name.
- The Java code of a class is stored in the heap whereas, its variable are stored in the System stack.
- A class can not have more than one constructor.
1.9. Suppose we initialize: \texttt{int [ ][ ] a = new int[3][4];}
What is the type of \texttt{a[0]}?

- \texttt{int}
- \texttt{int[ ]}
- \texttt{int[3]}
- \texttt{int[4]}
- \texttt{int[ ][ ]}

1.10. Consider the following code fragment:

```java
public static void mystery(int[ ] a, int m)
{
    int n = a.length;
    for(int i=0; i<n; i++)
    {
        int tmp = a[i];
        int j = (i+m)\%n;
        a[i] = a[j];
        a[j] = tmp;
    }
}
```

What is the value of the array \texttt{a={1,2,3,4}} after calling \texttt{mystery(a,1)}?

- \{1, 2, 3, 4\}
- \{1, 3, 4, 2\}
- \{2, 3, 4, 1\}
- \{3, 4, 2, 1\}
- \{2, 1, 4, 3\}
Question 2. (10 pts) Package Access

Question 2(a): Consider classes ClassA and Question2a below. For each commented statement in class Question2a, indicate whether it causes a compile error.

    package myPackage;

    public class ClassA
    {
        protected int a;
        int b;
        public int c;
    }

    In some other file:

    package someOtherPackage;

    public class Question2a
    {
        public static void main( String[] args )
        {
            ClassA x = new ClassA();

            x.a = 1;       // Will this statement cause an error: Y / N ?
            x.b = 1;       // Will this statement cause an error: Y / N ?
            x.c = 1;       // Will this statement cause an error: Y / N ?
        }
    }

Question 2(b): Consider class Question2b below (with the same ClassA as above). For each commented statement, indicate whether it causes a compile error.

    package myPackage;

    public class Question2b
    {
        public static void main( String[] args )
        {
            ClassA x = new ClassA();

            x.a = 1;       // Will this statement cause an error: Y / N ?
            x.b = 1;       // Will this statement cause an error: Y / N ?
            x.c = 1;       // Will this statement cause an error: Y / N ?
        }
    }
Question 3. (20 pts, 2 per blank) Fill in the Blank

Put an appropriate phrase or expression in each blank.

In order to avoid an infinite recursion, a recursive function should always include a(n) ____________.

In ____________ programming, we break a complex problem into simpler subproblems, and these subproblems should be ____________.

A class may have multiple constructors, as long as they are distinguished by their ____________.

If s is a string, a lowercase version of s is ____________.

If x and y are strings, we may test whether x should strictly precede y in sorted order, using the boolean expression ____________.

If int n is a 3-digit integer (like 123 or 876), then its middle digit is the value of the expression ____________.

If int[] a is initialized as rectangular array, then in the expression a[i][j], the maximum legal value of index i is ____________, and the maximum legal value of index j is ____________.

If we use binary search to look for 7 in the array {0, 1, 2, 3, 4, 5, 6}, we only examine these elements in the array: ____________.
Question 4. (10 pts) Inheritance

Consider these classes Person and Student:

```
public class Person {
    private String name;
    private int id;
    public Person(String name, int id) {
        this.name = name;
        this.id = id;
    }
    public String getName() {
        return name;
    }
    public int getId() {
        return id;
    }
}
```

```
public class Student extends Person {
    private double gpa;
    public Student(String name, int id, double gpa) {
        super(name, id);
        this.gpa = gpa;
    }
    public double getGPA() {
        return gpa;
    }
}
```

Consider the following program, using classes Person and Student:

```
public class Test {
    public static void main(String[] args) {
        Person a = new Person("Mark", 123 );            // Statement A
        Student b = new Student("Mary", 456, 3.4 );     // Statement B
        String name = b.getName();                     // Statement C
        Person c = b;                                  // Statement D
        Student d = a;                                 // Statement E
    }
}
```

For each commented statement in main(), state whether it causes an error (of whatever kind). If it does, explain the reason why it causes an error:

**Statement A**: Error Y / N ? If yes, reason:

**Statement B**: Error Y / N ? If yes, reason:

**Statement C**: Error Y / N ? If yes, reason:

**Statement D**: Error Y / N ? If yes, reason:

**Statement E**: Error Y / N ? If yes, reason:
Question 5. (10 pts) Writing (class Die)

Write a class Die that simulate a die with \( N \) sides ("die" is the singular form of "dice"). The sides have face values \( 1, 2, 3, ..., N \). Whenever the die is rolled, one of the \( N \) sides comes up, each with equal probability.

Complete the following class definition. Use \( \text{Math.random()} \), which returns a double precision floating point number, chosen uniformly in the interval \([0,1)\).

```java
public class Die {
    /*
     * Define any instance variables that you want here:
     */

    /*
     * Complete the constructor "Die( int nSides )"
     * nSides is the number of sides of the die
     */
    public Die( int nSides )
    {
    }

    /*
     * Complete the method "int roll( )"
     * Each time roll( ) is invoked, it returns one of the numbers 1 2 3 ... N (N = the number of sides)
     * with equal probability
     */
    public int roll( )
    {
    }
}
```
Question 6. (10 pts) Writing (recursive rangeSum)

Write a static recursive method rangeSum(a, b) that has two integer parameters a and b. If a ≤ b, it should return the sum:

\[ a + (a + 1) + (a + 2) + \cdots + b. \]

Otherwise, it should return zero. For example:

- rangeSum(4, 2) returns 0, because 4 > 2.
- rangeSum(2, 4) returns 9, because 2 + 3 + 4 = 9.

Answer (use recursion, not a loop or a clever formula):

```java
public class Question6 {

}
```
**Question 7. (10 pts) Writing (method countCommon)**

Write a static method `countCommon(int[] a, int[] b)` that takes two integer array parameters `a` and `b`, and returns the number of common elements (elements in both arrays). You may assume that there are no repeated elements in `a`, and no repeated elements in `b`. For example:

- `countCommon([1,4,3,2], [2,5,1])` returns 2, because 1 and 2 are in both arrays.
- `countCommon([2,5], [1,3,2,4])` returns 1, because only 2 is in both.
- `countCommon([2,3,1], [5,4])` returns 0, because no elements are in both.

In your solution, start with a method `isPresent(int[] a, int n)` that returns `true` if the element `n` is present in array `a`, `false` otherwise. Use this method in your `countCommon` method. Answer:

```java
public class Question7
{
    ...
}
```