There are 20 multiple choice questions. Each one is worth 2 points. There are 4 programming questions worth a total of 60 points.

Answer the multiple choice questions on the bubble sheet given and the programming questions on the exam booklet.

Fill in the Instructor, Course, Signature, Test, and Date blanks. For "Instructor" put your Recitation Instructor’s last name. For "Course" put CS 180. For "Test" put Exam 1.

Fill in the bubbles that correspond to your name, section and Student ID in the bubble sheet. For your section number, use 0830, 0930, 1030, 1130, ... – based on the start time of your Friday recitation. Consult the following list:

08:30 recitation in LWSN B134: Elizabeth Blythe
09:30 recitation in LILY G401: Matt Carlson
10:30 recitation in LILY G424: Matt Carlson
10:30 recitation in CIVL 1266: Alvin Law
11:30 recitation in REC 122: Alvin Law
12:30 recitation in LILY G424: Isuru Ranaweera
01:30 recitation in REC 308: Nick Sumner
02:30 recitation in LWSN B134: Nick Sumner
03:30 recitation in REC 226: Isuru Ranaweera

For your student ID, use the 10 digit ID number on your student ID card. DO NOT USE YOUR SOCIAL SECURITY NUMBER!

Exams without names will be graded as zero. Only the answers on the bubble sheet will be counted. The questions will be discarded.

Recitation Start Time ________________________________

Recitation TA’s Name ________________________________

Student Last Name ________________________________

Student First Name ________________________________
Part I. Multiple Choice Questions (2 points each):

1. Which of the following represents the life-cycle of software development?
   (a) Analysis -> Design -> Coding -> Testing -> Operation and Maintenance
   (b) Design -> Analysis -> Coding -> Testing -> Operation and Maintenance
   (c) Design -> Analysis -> Coding -> Testing
   (d) Analysis -> Design -> Coding -> Operation and Maintenance

2. Defining a class so that the implementation of the data and methods of the class are not known to the programmers who use the class is called:
   (a) Data Binding
   (b) Polymorphism
   (c) Encapsulation
   (d) Inheritance

3. Which of the following is an incorrect identifier?
   (a) 3theValue
   (b) THE_IDENTIFIER
   (c) a_b_
   (d) neolithic123FOUR

4. In the following block of code, what is the value of theVar?
   ```
   int theVar =  // 2
   /* /* 4 + 5 */
   6 * 3
   // - 2
   ;
   ```
   (a) 18
   (b) 9
   (c) -2
   (d) 2

5. Which of the following is the proper order of promotion?
   (a) short -> byte -> long -> int -> float -> double
   (b) short -> byte -> int -> long -> float -> double
   (c) short -> byte -> int -> float -> double -> long
   (d) byte -> short -> int -> long -> float -> double
6. In the following block of code, what is the value of thePhrase?

```java
String S1 = "anabolic regzrding vaccination";
String S2 = "itate";
String S3 = "grad";
String thePhrase = S1.substring(S1.indexOf("r"), S1.indexOf("z")) +
                    S3.substring(1) + S2;
```

(a) "egraditate"
(b) "regraditate"
(c) "regzgraditate"
(d) None of these

7. Which of the following is an illegal assignment expression?

(a) float x = 3.5;
(b) int x = 3;
(c) double x = 4.66f;
(d) long x = (int)4;

8. What is the resulting value of the following Java expression?

```java
double x = (4.0f + (3.0)/(int)1.5) * (3/(int)4.0);
```

(a) 4.125
(b) 3.5
(c) 0.0
(d) 4.5

9. Given the following class and usage thereof, which of the labeled lines are incorrect?

```java
public class Exam1
{
    private final int aQuandry;
    public Exam1(int quandry)
    {
        I: aQuandry = quandry;
    }
}

// ... In some other class, in some method:

II: Exam1 exam = new Exam1();
III: exam.aQuandry = 42;
IV: Exam1 = new Exam1(99);
```

(a) I, II
(b) III, IV
(c) II, III, IV
(d) II, III
10. What is printed by the code below?

```java
public class Test {
    private static final int value = 5;
    public static void main( String[] args ) {
        int total, value = 4;
        total = value + value;
        total = total + someMethod( total );
        System.out.println( total );
    }
    public static int someMethod( int val ) {
        return value;
    }
}
```

(a) 13
(b) None of these
(c) 16
(d) 15

11. A mutator method is a method that:

(a) prints to the screen the value of a data member
(b) reads and returns the value of a data member
(c) changes the value of a data member
(d) constructs a class
12. What is the output of the following program?

```java
public class Query
{
    private static String someString = "hello";
    private String name;
    public Query( String newName )
    {
        name = newName;
    }
    public static void main( String[] args )
    {
        Query query = new Query( "Gordon" );
        changeString( someString );
        changeName( query );
        System.out.println( someString + query.name );
    }
    public static void changeString( String str )
    {
        str = "Howdy";
    }
    public static void changeName( Query q )
    {
        q.name = "Lightfoot";
    }
}
```
(a) HowdyLightfoot
(b) helloLightfoot
(c) HowdyGordon
(d) helloGordon

13. Which of the following boolean expressions is always true?

(a) 10 <= x && !( x >= 10 )
(b) y == x + y && x == x + y
(c) 10 <= x || !( x >= 10 )
(d) y == x + y || x == x + y
14. What is displayed by the following?

```java
public class Quest {
    public Quest() {
    }
    public void display(String goal, String days, int adj) {
        System.out.println( "I am on a " + adj + " quest for the " + goal + " in " + days + " days." );
    }
    public static void main(String[] args) {
        String adj = "perilous", goal = "sticky wicket";
        int days = 3;
        Quest q = new Quest();
        q.display(adj, goal, days);
    }
}
```

(a) I am on a sticky wicket quest for the perilous in 3 days.
(b) I am on a perilous quest for the sticky wicket in 3 days.
(c) I am on a 3 quest for the perilous in sticky wicket days.
(d) I am on a perilous quest for the 3 in sticky wicket days.

15. Assuming: a = -1, b = -2, c = -4, d = 2, e = -1. What is the output of the following code fragment?

```java
if (a < 0)
    if (b < 0)
        if (c < 0)
            if (!(d < 0 && e < 0))
                System.out.println( "One" );
            else
                System.out.println( "Two" );
        if (a == e)
            System.out.println( "Three" );
        else
            System.out.println( "Four" );
```

(a) Two
    Three
(b) Two
    Four
(c) One
    Four
(d) One
    Three
16. Which of the following if statements is equivalent to this switch statement?

```java
switch( grade ) {
    case 5:
    case 4:
        a = 1;
        b = 2;
        break;
    case 3:
        a = 5;
        break;
    default:
        a = 2;
        break;
}

(a) if (grade == 4 || grade == 5 ) {
    a = 1;
    b = 2;
} else if (grade == 3) {
    a = 5;
} else {
    a = 2;
}

(b) if( grade == 4 ) {
    a = 1;
    b = 2;
} else if( grade == 3 ) {
    a = 5;
} else {
    a = 2;
}

(c) if (grade == 4 && grade == 5) {
    a = 1;
    b = 2;
} else if (grade == 3) {
    a = 5;
} else {
    a = 2;
}

(d) if( grade != 5 ) {
    if( grade == 4 ) {
        a = 1;
        b = 2;
    } else if( grade == 3 ) {
        a = 5;
    } else {
        a = 2;
    }
}
```
17. Given the following StudentID class:

```java
class StudentID {
    private String id;
    public StudentID( String newid ) {
        id = newid;
    }
    public String getID() { return id; }
    public boolean equals( StudentID otherid ) {
        return id.equals( otherid.getID() );
    }
}
```

What is the output of the following code:

```java
StudentID s1 = new StudentID( "8675309" );
StudentID s2 = new StudentID( "8675309" );

boolean result1 = s1 == s2;
boolean result2 = s1.equals( s2 );

System.out.println( result1 );
System.out.println( result2 );
```

(a) true
    true
(b) false
    true
(c) true
    false
(d) false
    false

18. Which two of the following statements are true about constructors:

I. A constructor has no return type and is therefore a void method.
II. A constructor has the same name as the class.
III. A class can have more than one constructor.
IV. Constructors are called like any other method.

(a) III and IV
(b) I and II
(c) II and III
(d) I and IV
19. The basic idea of __________ is that it allows the same program instruction to mean different things in different contexts.

(a) object oriented programming  
(b) polymorphism  
(c) encapsulation  
(d) inheritance

20. Complete the following Java statement to allow the instance of the Scanner class to read keyboard input.

```java
Scanner keyboard = new Scanner(__________); 
```

(a) System.out  
(b) System.in  
(c) System.keyboard  
(d) System.input

The version of your test is A. Please FILL IN CIRCLE (A) for the TEST FORM field on the BUBBLE SHEET directly under the DATE field and turn in your exam booklet and answer sheet to the stack labeled (A) in the front of the classroom. Thank you.
Part II. Programming Questions (60 points total):

1. (15 pts) Create a class called Kitten that has three fields: String name, Person owner, and int age.
   Create a constructor for Kitten that takes a String name and a Person owner for the Kitten and uses them for initialization. Have the age for a Kitten start at 0;
   Implement accessor and mutator methods for both name and owner. Make the mutator for name such that whenever a name is applied to a Kitten, the actual name of the Kitten is "<Given Name> the Feline". (e.g. given "Bob", the Kitten’s name becomes "Bob the Feline")
   Implement only an accessor for age. Implement a method called haveBirthday that does not return anything and simply increases a Kitten’s age by one.
   Finally, write a method called toString that returns a string of the form: "<Kitten name> is <age> and belongs to <Owner name>" e.g. "Bob the Feline is 87 and belongs to Gregor Samsa"
   The definition for Person is found below.

   public class Person
   {
      private final String name;
      public Person( String newName )
      {
         name = newName;
      }
      public String getName()
      {
         return name;
      }
   }
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2. (15 pts) Implement a Bicycle class which has the following three methods:

public void increaseSpeed();
public void decreaseSpeed();
public boolean isMoving();

Within the Bicycle class, you must keep track of the Bicycle’s state: moving or not moving. You must also keep track of the Bicycle’s current speed. Whenever the Bicycle has a positive current speed, the state should be moving. Whenever the Bicycle has a current speed of 0 the state must be not moving. You must use a boolean variable to maintain the Bicycle’s state. The methods increaseSpeed() and decreaseSpeed() always increment and decrement [respectively] the current speed by 1. If increaseSpeed() is called on a Bicycle which is not currently moving, the Bicycle should be set to moving, and the current speed should be increased by 1. If decreaseSpeed() is called on a Bicycle which is moving, the current speed should be decremented by one. If the current speed is ever decreased to 0, the Bicycle’s state should change from moving to not moving.

The method isMoving() should return the status of the Bicycle.

Your Bicycle class should also provide two constructors. One constructor takes no arguments and the other takes an integer representing the initial speed of the Bicycle. The default constructor should create a Bicycle which is not currently moving and has a current speed of 0. The second constructor should set the current speed to the passed initial speed ONLY if the speed is positive. It should also set the Bicycle’s state to moving. If the initial speed given is negative or 0, the current speed should be set to 0 and the Bicycle’s state should be not moving.
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3. (15 pts) Part I: In mathematics, a polynomial equation of the second degree is commonly known as a quadratic equation. This equation can be generalized to the following:

\[ ax^2 + bx + c = 0 \]

We also know that there is a very simple formula to solve this equation. Recall this formula as the following:

\[
x_1 = \frac{-b + \sqrt{b^2 - 4ac}}{2a} \quad \quad x_2 = \frac{-b - \sqrt{b^2 - 4ac}}{2a}
\]

Write a method, `solveQuadratic`, which takes in a, b, and c and solves the appropriate quadratic equation. Your method should return a Pair object, as defined by the class below. This object simply holds two doubles, in this case, the two doubles are the solutions to the quadratic. If the quadratic equation has no real roots (i.e., the discriminant under the square root is negative), then return a Pair object where both numbers are Double.NaN (standing for Not a Number).

```java
public class Pair {
    private double x1, x2;

    public Pair() {
        x1 = Double.NaN;
        x2 = Double.NaN;
    }

    public Pair(double newX1, double newX2) {
        x1 = newX1;
        x2 = newX2;
    }

    public void setPair(double newX1, double newX2) {
        x1 = newX1;
        x2 = newX2;
    }

    public double getX() { return x1; }
    public double getY() { return x2; }
}
```
public Pair solveQuadratic(double a, double b, double c) {
    // write your code here
(15 pts) Part II: A less known equation is a unique quartic equation called the biquadratic equation. This is a fourth order equation of the form:

\[ ax^4 + bx^2 + c = 0 \]

To solve a biquadratic equation, we can observe that this type of equation can be made to the form of a quadratic by substituting \( z = x^2 \). This results in the following equation:

\[ az^2 + bz + c = 0 \]

Using the quadratic equation, we can get a pair of solutions \((z1, z2)\). To get the four solutions to the biquadratic equation, substitute back in for \( x \):

\[ x1 = \sqrt{z1} \quad x2 = -\sqrt{z1} \quad x3 = \sqrt{z2} \quad x4 = -\sqrt{z2} \]

Using the quadratic equation solver from PART I (you may assume it is written correctly if you are unsure of your solution), write a biquadratic equation solver method, solveBiquadratic. Your method should call the solveQuadratic method to solve the quadratic equation defined by the above substitution and return a Quad object, which simply holds four doubles. If a particular solution to the quadratic equation is not real (that is, the Pair object returned from solveQuadratic contains a Double.NaN value), then its associated pair of biquadratic solutions is also not real and should be set to Double.NaN as well.

```java
public class Quad
{
    private double x1, x2, x3, x4;

    public Quad()
    {
        x1 = Double.NaN;
        x2 = Double.NaN;
        x3 = Double.NaN;
        x4 = Double.NaN;
    }

    public Quad(double newX1, double newX2, double newX3, double newX4)
    {
        x1 = newX1;
        x2 = newX2;
        x3 = newX3;
        x4 = newX4;
    }

    public void setQuad(double newX1, double newX2, double newX3, double newX4)
    {
        x1 = newX1;
        x2 = newX2;
        x3 = newX3;
        x4 = newX4;
    }

    public double getX1() { return x1; }
    public double getX2() { return x2; }
    public double getX3() { return x3; }
    public double getX4() { return x4; }
}
```
public Quad solveBiquadratic(double a, double b, double c) {
    // write your code here