CS 307 – Midterm 1 – Fall 2002

Your Name_______________________________

Last 4 digits of SSN / Student ID _____________

Section Leaders Name _______________________

Instructions:
1. There are 4 questions on this test.
2. You will have 3 hours to complete the test.
3. You may not use a calculator.
4. When code is required, write Java code.
5. Please make your answers legible.
6. The style guide is not in effect, except as noted.
7. Unless noted on the question, you may not use any of the classes or methods from the Java standard library. You may use native arrays

1. (2 points each, 30 points total) Java Mechanics. For all parts, what is the output of the code fragment? Write your answer on the line provided. Consider each piece of code in isolation. If the code would cause an error, answer "syntax error" or "runtime error" depending on what type of error it would be.

A.

```java
int xa = 12;
int ya = 5;

double aa = xa / ya + 1.5;

System.out.println( aa );
```

_________________________________________

B.

```java
int xb = 37;
int yb = 5;

int zb = xb % yb + xb / yb;

System.out.println( zb );
```

_________________________________________
For parts C – J consider the following class:

```java
public class Ellipse {
    private int iMyX;
    private int iMyY;

    private int iMyXDistance;
    private int iMyYDistance;

    public Ellipse(int x, int y, int xDistance, int yDistance) {
        iMyX = x;
        iMyY = y;
        iMyXDistance = xDistance;
        iMyYDistance = yDistance;
    }

    public void setX(int x) {
        iMyX = x;
    }

    public void setY(int y) {
        iMyY = y;
    }

    public int getX() {
        return iMyX;
    }

    public int getY() {
        return iMyY;
    }

    public String toString() {
        return iMyX + " " + iMyY + " " + iMyXDistance + " " +
               iMyYDistance;
    }
}
```
C.

```java
public class EllipseUser {
    public void tree(Ellipse e1, Ellipse e2) {
        int tempX = e1.getX();
        int tempY = e1.getY();
        e1.setX( e2.getX() );
        e1.setY( e2.getY() );
        e2.setX( tempX );
        e2.setY( tempY );
    }

    public void cardinal() {
        Ellipse ep1 = new Ellipse(2, 4, 6, 8);
        Ellipse ep2 = new Ellipse(5, 10, 15, 20);
        ep1.setX(12);
        tree(ep1, ep2);
        System.out.println( ep1.toString() );
        System.out.println( ep2.toString() );
    }
}

What is the output when method cardinal in class EllipseUser is called?
```

D.

```java
public class EllipseUser2 {
    public void wave(Ellipse e1) {
        e1.setY( 50 );
        e1 = new Ellipse(100, 200, 250, 250);
        e1.setX( 12 );
    }

    public void pack() {
        Ellipse ep1 = new Ellipse(10, 20, 30, 35);
        ep1.setY(40);
        System.out.println( ep1.toString() );
    }
}

What is the output when method pack in class EllipseUser2 is called?
```
E.  
public class EllipseUser3  
{
    public void crimson( Ellipse e1 )
    {
        e1.setX( e1.getY() );
        e1.setY( e1.getX() );
    }

    public void volunteers()
    {
        Ellipse ep1 = new Ellipse(3, 6, 9, 12);
        crimson( ep1 );
        ep1.iMyXDistance = 50;
        System.out.println( ep1.toString() );
    }
}

What is the output when method volunteers in class EllipseUser3 is called?

F.  
public class EllipseUser4  
{
    private Ellipse myEllipse;
    private static final int SCALE_FACTOR = 5;

    public EllipseUser4(int x, int y)
    {
        myEllipse = new Ellipse(x, y, y * 2, x * 2); 
    }

    public void scale()
    {
        myEllipse.setX( myEllipse.getX() * SCALE_FACTOR );
        myEllipse.setY( myEllipse.getY() * SCALE_FACTOR );
    }

    public String toString()
    {
        return myEllipse.toString() + " Scale Factor" + SCALE_FACTOR; }
}

public class SuperUser
{
    public void compute()
    {
        EllipseUser4 eu1 = new EllipseUser4(2, 3);
        eu1.scale();
        eu1.scale();
        System.out.println( eu1.toString() );
    }
}

What is the output when method compute in class SuperUser is called?
G.

```java
Ellipse e1 = new Ellipse(10, 10, 20, 30);
Ellipse e2 = new Ellipse(5, 10, 20, 30);
e2.setX(10);
System.out.println( e1 == e2 );
```

What is the output of the above code?

H.

```java
Ellipse e1 = new Ellipse(5, 20, 30, 50);
Ellipse e2 = new Ellipse(12, 8, 30, 50);
e1.setX( e2.getX() );
e2.setY(112);
e1.setY(110);
System.out.println( e1.getX() == e2.getX() );
```

What is the output of the above code?

I.

```java
public class EllipseUser5
{
    public int bananaSlugs(int x, int y)
    {
        int temp = x;
        x = x * 2;
        y = temp + 2;
        return x + y;
    }

    public void bruins()
    {
        Ellipse ep1 = new Ellipse(1, 2, 3, 4);
        Ellipse ep2 = new Ellipse(2, 1, 5, 6);
        int result = bananaSlugs(ep1.getY(), ep2.getY());
        System.out.println( ep1.getY() + " " + ep2.getY() + " " + " " + result);
    }
}
```

What is the output when method bruins in class EllipseUser5 is called?
J.

```java
int x = 3;
int y = x + 2;
Ellipse[] eList = new Ellipse[y];
System.out.println( eList[3].getY() );
```

What is the output of the above code?

---

K.

```java
int limit = 3 * 5;
int[] intList = new int[limit];

for(int i = 0; i < limit; i++)
    intList[i] = i - 2;

limit += 2;

for(int i = 0; i < limit; i++)
    System.out.print( intList[i] + " " );
```

What is the output of the above code?

---

L.

```java
int[] intList2 = new int[5];
for(int i = 1; i <= intList2.length; i++)
    intList2[ intList2.length - i ] = i * i;

for(int i = 0; i < intList2.length; i++)
    System.out.print( intList2[i] + " " );
```

What is the output of the above code?
M.

```java
int size = 10;
int[][] mat = new int[size][size / 2];
System.out.println(mat[7].length);
```

What is the output of the above code?

N.

```java
// pre: list != null
public void wolfpack(int[] list)
{
    int times = 0;
    for(int i = 0; i < list.length; i++)
        for(int j = 0; j < list.length; j++)
            for(int k = 0; k < list.length; k++)
                times++;
    System.out.println(times);
}
```

What is the output of the above code when method `wolfpack` is called, assuming the precondition is met? (formula required)

O.

```java
public void yellowJackets(int x)
{
    int temp;
    for(int i = 0; i < x; i++)
        temp += i + 2;
    System.out.println(temp);
}
```

What is the output of the above code assuming method `yellowJackets` is called with an argument of 5? `yellowJackets(5);`
2. Arrays: (25 points) Compression of data is done to save space and minimize transmission time. One simple method of compression is known as run length encoding. In this form of compression, instead of representing every bit of data, the number of repeated bits of the current data are sent. In this example you will be encoding a black and white bitmap with 1 representing black and 0 representing white. Here is an example of raw data:

```
0000000001111100000000000000100000000000000100000000000001000000000000001
```

Employing run length encoding would yield the following encoded data. The first num in the pair is the data and the second is the number of times this data occurs in this run.

```
(0, 10), (1, 5), (0, 12), (1, 1), (0, 14), (1, 1), (0, 14), (1, 1), (0, 14),
```

In this question you will write a method that accepts an array of booleans and produces a run length encoded version of the data.

You may use the following class for this question:

```java
public class EncodeData {
    // value = true if this encodes a 1,
    // value = false if this encodes a 0
    // num = number of 1s or 0s in this run
    public EncodeData(boolean value, byte num)
}
```

recall that the byte data type represents signed integer values between –128 and 127. When coding your solution only use the values between 1 and 127. If you get a run of greater than 127 trues or falses you will have to break them up into multiple EncodeData objects.

Complete the following method on the next page. You may write your code assuming the precondition is met.

```java
/* pre: data != null, an element equal to true represents a 1 and an element equal to false represents a 0.

   post: return an array of EncodeData objects. There are to be no null objects in the array. It encodes the data using run length encoding as described above.

   */
public EncodeData[] compress(boolean[] data)
```
/* pre: data != null, an element equal to true represents a 1 and an element equal to false represents a 0. 

post: return an array of EncodeData objects. There are to be no null objects in the array. It encodes the data using run length encoding as described above. */

public EncodeData[] compress(boolean[] data) 
{
3. 2D Arrays (25 points) This question also involves run length encoding. In this question you will take an array of EncodeData objects and create a 2D array representing the data. The size of the desired matrix will be specified and the encoded data will be converted to a matrix of type byte. There is no guarantee that the size of the matrix is equal to the amount of data encoded. There may be left over data or extra space in the resulting matrix. For example given an encoded set of data:

\[(false, 6), (true, 1), (false, 1), (true, 1), (false, 8), (true, 1), (false, 8), (true, 3)\]

and rows specified to equal 7 and columns specified to equal 5 the following is the result:

```
0 0 0 0 0
0 1 0 1 0
0 0 0 0 0
0 0 1 0 0
0 0 0 0 0
0 1 1 1 0
0 0 0 0 0
```

Note, extra spaces are filled in with 0s.

You will may use the following methods from the EncodeData class:

```java
public class EncodeData
{
    // if encoded data is a 1, returns true
    // if encoded data is a 0, returns false
    public boolean getValue()
    {
        // return number of 1s or 0s in this run
        public byte getNum()
    }
}
```

Complete the following method:

```java
/* pre: code != null, numRows > 0, numCols > 0
post: return a 2D matrix of bytes with rows = numRows and numCols columns per row. Use the first numRows * numCols bits represented by code. All elements of result are 1 or 0.
     if numRows * numCols > the number of bits represented in code the extra spots in result = 0 */
public byte[][] decompress(EncodeData[] code, int numRows, int numCols)
```
/* pre: code != null, numRows > 0, numCols > 0
   post: return a 2D matrix of bytes with rows = numRows and numCols
   columns per row. Use the first numRows * numCols bits represented
   by code. All elements of result are 1 or 0.

   if numRows * numCols > (the number of bits represented in code) the
   extra spots in result = 0
*/
public byte[][] decompress(EncodeData[] code, int numRows,
   int numCols)
{

4. Classes and Objects(20 points) Write a class to represent a packet of information that is sent across networks. Packets have the following characteristics. (Simplified for this question.)

1. The IP address of the sender
2. the IP address of the destination.
   IP addresses are 12 digits numbers so use a long or String to represent them.
3. A packet ID number from 0 to 2,000,000,000.
4. And finally the data itself. This is an array of bytes and in this question every packet has a fixed length of 1000 bytes. If there is not enough data to fill the 1000 bytes then it is padded with a series of alternating bytes equal to –1 and 0.

Write a class to represent a network packet. Each packet object should be able to store the data listed above. Provide the following functionality for your class.

1. Create a constructor with parameters for the IP addresses of the sender and receiver, the packet ID, and an array of type byte. You choose the data types for the IP addresses and packet ID. The data will be in an array of bytes, byte[], whose length will be <= 1000. All elements of this array contain valid data. (No padding.)
2. Write an accessor for the IPAddress of the receiver.
3. Write an accessor that allows a class user to specify an element in the data array and returns that element.
4. Override the equals method from the Object class. Two packets are equal if the IP addresses of the receiver and sender match and the packet IDs match.
5. Have the class implement the Comparable interface and override the compareTo method. Packets are ordered based on their packet ID.

You do not have to follow the naming conventions in the class coding standards, but other elements of style will be considered on this question.