THE UNIVERSITY OF AUCKLAND

First Semester, 2004
Campus: City and Tamaki

COMPUTER SCIENCE

Principles of Programming

(Time allowed: TWO HOURS)

Surname:	
Forenames:	
Student ID number:	
Login name (UPI):	

INSTRUCTIONS:

- Attempt **ALL** questions, calculators are **NOT** permitted
- There is space at the back for answers that overflow the allotted space

Examiner to complete:

Question	Mark	Question	Mark
1	(/9)	**8**	(/11)
2	(/5)	**9**	(/8)
3	(/5)	**10**	(/10)
4	(/5)	**11**	(/6)
5	(/5)	**12**	(/6)
6	(/10)	**13**	(/5)
7	(/5)	**14**	(/10)

TOTAL: (/100)

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Question 1 (9 marks)

a) What is printed by the following?

```
System.out.println(2 + 3 * 6 + "7 * 8");
```

(2 marks)

b) What is printed by the following?

```
String s = "How now brown cow?";
System.out.println(s.substring(s.lastIndexOf("ow")-1));
```

(2 marks)

c) Consider the class `FishRecord` below:

```
public class FishRecord {

     // instance variables
     private String type;
     private int amount;

     //default constructor
     public FishRecord() {
          type = "";
          amount = 0;
     }

     public FishRecord(String inputString, int inputNum) {
          type = inputString + " " + inputNum + "\n";
          amount = inputNum;
     }

     public void addRecord(String inputString, int inputNum) {
          amount += inputNum;
          type = type + inputString + " " + inputNum + ",\n";
     }

     public String toString() {
          return(type + "total: " + amount)  ;
     }

}
```

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What is the output of the application `Q1` which uses `FishRecord`?

```
public class Q1 {

     public static void main(String[] args) {

          FishRecord record1 = new FishRecord("guppy", 8);
          System.out.println(record1.toString());

          FishRecord record2 = new FishRecord();
          record2.addRecord("betta", 5);
          record2.addRecord("catfish", 10);
          System.out.println(record2.toString());

     }
}
```

(5 marks)

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Question 2 (5 marks)

Write a static method called `keepUpperCase()` which accepts a String as a parameter and returns a new String containing only the characters from the original String which were uppercase.

For example, if the following code was executed:

```
System.out.println(keepUpperCase("Hello World"));
```

The result would be:

```
HW
```

The following sections of the Java API might be useful:

java.lang
Class Character

java.lang.Object
  └ **java.lang.Character**

`public static boolean` **`isUpperCase`**`(char ch)`

Determines if the specified character is an uppercase character.

Parameters:
`ch` - the character to be tested.

Returns:
`true` if the character is uppercase; `false` otherwise.

java.lang
Class String

java.lang.Object
  └ **java.lang.String**

`public char` **`charAt`**`(int index)`

Returns the character at the specified index. An index ranges from `0` to `length() - 1`. The first character of the sequence is at index `0`, the next at index `1`, and so on, as for array indexing.

Parameters:
`index` - the index of the character.
Returns:
the character at the specified index of this string. The first character is at index `0`.

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Write your method in the space provided below:

(5 marks)

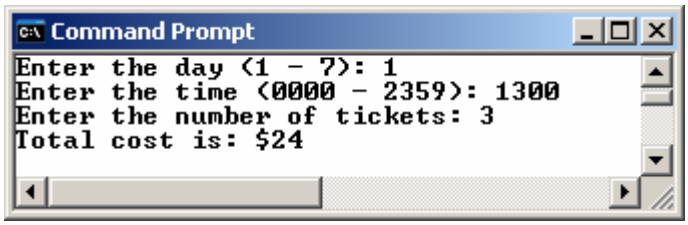
SURNAME: ..... FORENAMES: .....

Question 3 (5 marks)

Complete the application below which can be used to calculate the cost of buying movie tickets. The application asks the user to enter the day, the time, and the number of tickets. The application should then output the total cost to buy those tickets. The ticket prices are as follows:

Day	Before 5pm (1700)	5pm and later (1700+)
Mon	$8	$10
Tues	$8	$5
Wed - Fri	$8	$10
Weekend	$12	$12

To simplify the application, a number will be used to represent each day (Mon = 1, Tues = 2, etc.). The time will be entered in standard 24 hour time as a single number (0000 - 2359). You can assume that the user will only enter valid input (i.e. an integer number within the valid range). A screenshot showing the application being executed is shown below:



Complete the application below:

```
import java.io.*;

public class MovieCost {

     public static void main(String[] args) {

          final int MON=1, TUE=2, WED=3, THU=4, FRI=5;
          final int SAT=6, SUN=7;
          final int EVENING = 1700;

          int day;
          boolean before5pm;

          System.out.print("Enter the day (1 - 7): ");
          day = Integer.parseInt(readInput());

          System.out.print("Enter the time (0000 - 2359): ");
          before5pm = Integer.parseInt(readInput()) < EVENING;

          System.out.print("Enter the number of tickets: ");
          int numberOfTickets = Integer.parseInt(readInput());
```

CONTINUED

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```
          //----- ENTER YOUR CODE HERE -----
```

(5 marks)

```
          //---------------------------------
          System.out.println("Total cost is: $" + totalCost);
     }

     public static String readInput(){
          try{
               BufferedReader keyboard = new BufferedReader(
                    new InputStreamReader(
                         System.in ));
               return keyboard.readLine();
          }
          catch (IOException E){}
          return "";
     }
}
```

SURNAME: ..... FORENAMES: .....

Question 4 (5 marks)

(a) Convert the following sentence from English to Java:

if both `x` and `y` are less than `z` or either `x` or `y` are greater than `w`, then print `"a"`

(2 marks)

(b) Convert the following sentence from English to Java:

if `x` is less than `y` and `y` is not less than `z`, then print `"a"` unless `x` is equal to `z`, in which case `"b"` should be printed

(2 marks)

(c) Evaluate the following Boolean expression:

```
( 1==2 || 2==2 && 3>2 && 1>2 || 1<1)
```

(1 mark)

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Question 5 (5 marks)

What is the output produced by the following code?

```
public class Loops {
     public static void main(String[] args) {
          int size = 4;
          for (int i=0; i<=size; i++) {
               for (int j=i; j>=0; j--)
                    if (j==i || j==0 || i==size)
                         System.out.print(i);
                    else
                         System.out.print("^");
               System.out.println();
          }
     }
}
```

(5 marks)

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Question 6 (10 marks)

Complete the `Board` class below which is used to play the Connect Four game as required in Assignment 04. The `Board` class uses a single String (called `data`) to represent the positions occupied by counters in an `N*N` board used to play Connect Four.

Write a method called `setValue()` which is used to set the value at a given `(x,y)` position in the `Board` to a given character. Write a second method called `add()` which is used to add a value to a given column. The value added to the column should "fall" down to the bottom of that column (i.e. it will be placed in the lowest empty position in the given column).

```
public class Board {

     public static final char YELLOW='X';
     public static final char RED='O';
     public static final char EMPTY='.';

     private String data;     // Each position in the board is
                              // represented by a single
                              // character

     private int size;        // The height and width of the
                              // board

     public Board(int n) {
          size = n;
          data = "";
          for(int i=0; i<n; i++){
               for(int j=0;j<n;j++)
                    data+=EMPTY;
          }
     }

     public char getValue(int x, int y) {
          return data.charAt(y*size+x);
     }

     // Sets the value at a given (x,y) position on the board.
     public void setValue( int x, int y, char c ) {
```

(3 marks)

```
     }
```

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```
    // Adds the given character to the board.  The character
    // will be added to the lowest empty position in the
    // column specified
    public void add( int x, char c ) {
```

(7 marks)

```
    }
}
```

SURNAME: ..... FORENAMES: .....

Question 7 (5 marks)

The following application makes use of a `Car` class. Read the application carefully and look at the output which is produced. You must complete the `Car` class so that the code below will produce the correct results.

```
public class TestCar {

     public static void main(String[] args){

          Car c1 = new Car("Honda", "Blue", 1978);
          Car c2 = new Car("Mini", "Red", 1974);

          System.out.println(c1);

          c1.drive(2000);

          System.out.println(c1);

          c1.drive(3000);

          System.out.println(c1);

          c2.drive(5043);

          if(c1.isOlderThan(c2))
               System.out.println(c1);
          else
               System.out.println(c2);
     }
}
```

When the application above is executed, the output below is produced.

```
Blue 1978 Honda.  Has travelled: 0kms.
Blue 1978 Honda.  Has travelled: 2000kms.
Blue 1978 Honda.  Has travelled: 5000kms.
Red 1974 Mini.  Has travelled: 5043kms.
```

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Complete the `Car` class in the space provided:

```
public class Car {

}
```

(5 marks)

CONTINUED

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Question 8 (11 marks)

Consider the following `JPanel` class carefully:

```
import java.awt.*;
import javax.swing.*;
import java.awt.event.*;

public class MyJPanel extends JPanel implements
                                                ActionListener {

     private JButton b1, b2, b3;
     private int number;

     public MyJPanel() {

          setBackground(Color.white);

          number = 10;

          b1 = new JButton("One");
          b2 = new JButton("Two");
          b3 = new JButton("Three");

          b1.addActionListener(this);
          b3.addActionListener(this);

          add(b3);
          add(b2);
          add(b1);

     }

     public void actionPerformed(ActionEvent e) {

          if (e.getSource() == b3)
               number = number - 3;

          number = number - 1;

          System.out.println(number);
     }
}
```

For this question, you need to do two things:

1) draw approximately what the user interface will look like, ie. where the `JButton`s will be positioned
2) determine what the output of the program will be when the `JButton`s are pressed in a certain sequence.

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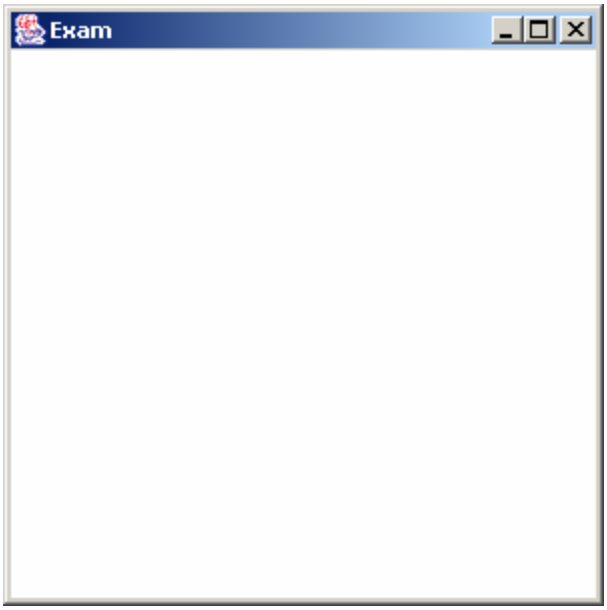
Draw the approximate positions of the three `JButton`s in the window below. All the information you need to know is given below:

- The size of the JPanel (which is the drawable area and does not include the title bar of the window or the borders of the window) is 200 pixels wide and 200 pixels high
- Each JButton will be exactly 70 pixels wide and 20 pixels high
- The smallest possible gap between the edges of any two JButtons and between the edge of a JButton and the edges of the JPanel will be 10 pixels



(5 marks)

What will be the output of the program when the `JButton`s are pressed in the following sequence:

1) the `JButton` labelled "One" is pressed,
2) then the `JButton` labelled "Two" is pressed,
3) then the `JButton` labelled "Three" is pressed,
4) then the `JButton` labelled "Three" is pressed again,
5) then the `JButton` labelled "Two" is pressed,
6) then the `JButton` labelled "One" is pressed

(6 marks)

CONTINUED

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Question 9 (8 marks)

There are four incorrect lines in the application program `Q9` below. Find and correct the lines with errors so that the program `Q9` executes and produces output as in the examples shown below – the output must be identical to that shown:

Example 1:

```
C:\> java Q9
When number1 is 1, number2 is 6.283185307179586,
and number3 is 3.141592653589793.
```

Example 2:

```
C:\> java Q9
When number1 is 6, number2 is 37.69911184307752,
and number3 is 113.09733552923255.
```

Example 3:

```
C:\> java Q9
When number1 is 9, number2 is 56.548667764616276,
and number3 is 254.46900494077323.
```

The source code for the application program `Q9` is given below. For each error, you need to clearly circle the error and provide a correction so that the program will compile and execute correctly. You do not need to write out the whole line of source code again, as long as you indicate your corrections clearly.

```
public class Q9 {

     public static main(String[] args) {

          int number1;

          int number2;

          number1 = (int) (Math.random() * 10);

          number2 = Math.PI * number1 * 2;

          System.out.println("When number1 is " + number1);

          System.out.print(", number2 is " + number2);

          System.out.println(", ");

          double number3 = Math.PI * Math.pow(number1, 2);

          System.out.println("and number3 is " + “number3” + ".");

     }
}
```

(8 marks)

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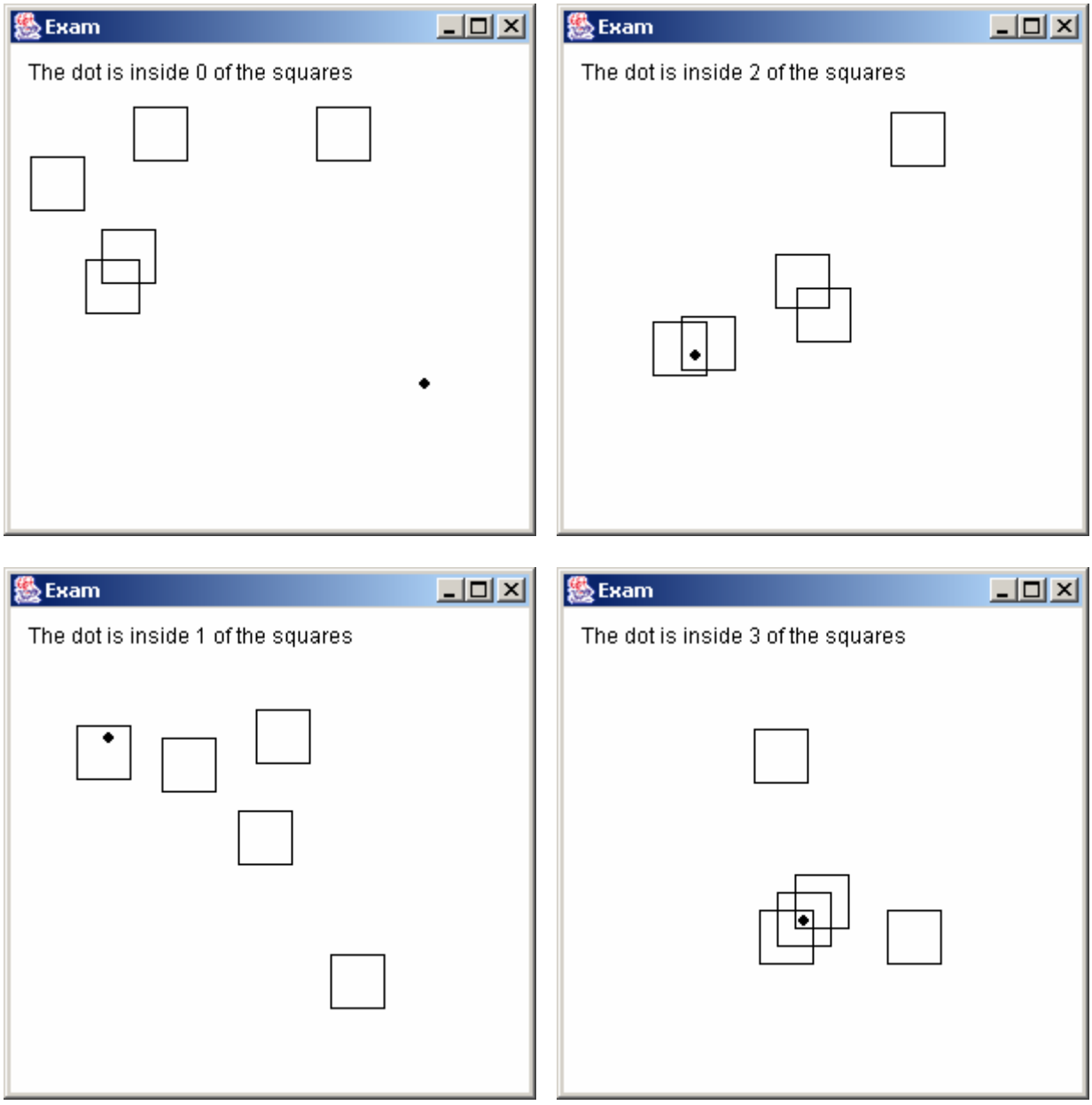
Question 10 (10 marks)

Consider the program shown in the screenshots below. Each time the program is run, a small dot is drawn at a random location on the screen. Several squares are also drawn. Finally, a String is drawn to the screen which indicates how many of the squares are positioned so that the centre of the dot is inside the square.

The screenshots below show the results of running the program four different times:



The squares which are drawn on the screen are represented by a class called `Blocks`.

The dot is represented by a class called `Location`. For this question, you need to define a method called `countInside()` in the `Location` class.

SURNAME: ..... FORENAMES: .....

The source code for the `JPanel` class is given below:

```
import java.awt.*;
import javax.swing.*;
import java.awt.event.*;

public class MyJPanel extends JPanel {

     private Location position;
     private Blocks bs;

     public MyJPanel() {

          setBackground(Color.white);

          int x = (int)(Math.random()*300);
          int y = (int)(Math.random()*300);
          position = new Location(x, y);
          bs = new Blocks(5);
     }

     public void paintComponent(Graphics g) {
          super.paintComponent(g);

          position.draw(g);
          bs.draw(g);

          int count = position.countInside(bs);
          g.drawString("The point is inside " + count + " of
                                        the rectangles", 10, 20);
     }
}
```

The source code for the `Blocks` class is given below:

```
import java.awt.*;

public class Blocks {

     private Rectangle[] rects;

     public Rectangle[] getRects() {
          return rects;
     }

     public Blocks(int howMany) {
          rects = new Rectangle[howMany];
          for (int i = 0; i < rects.length; i++) {
               int x = (int)(Math.random()*200);
               int y = (int)(Math.random()*200);
               rects[i] = new Rectangle(x, y, 30, 30);
          }
     }

     public void draw(Graphics g) {
          for (int i = 0; i < rects.length; i++)
               g.drawRect(rects[i].x, rects[i].y,
                              rects[i].width, rects[i].height);
     }
}
```

CONTINUED

SURNAME: ..... FORENAMES: .....

The (incomplete) source code for the `Location` class is given below. You need to write the code for the `countInside()` method in the blank space provided, so that the program behaves as previously described.

```
import java.awt.*;

public class Location {

     private Point pos;

     public Location(int x, int y) {
          pos = new Point(x, y);
     }

     public void draw(Graphics g) {
          g.fillOval(pos.x-3, pos.y-3, 6, 6);
     }
```

(10 marks)

```
}
```

CONTINUED

SURNAME: ..... FORENAMES: .....

Question 11 (6 marks)

What is the output of the following program:

```
public class Q11 {

    private static int[] question(int[][] vals) {

         int[] result = new int[vals[0].length];

         for (int i = 0; i < result.length; i++) {
              for (int j = 0; j < vals.length; j++)
                   result[i] += vals[j][i];
         }
         return result;
    }

    public static void main(String[] args){

         int[][] numbers = {{1,2,3}, {4,5,6}, {-2,4,1}, {0,8,5}};

         int[] answer = question(numbers);

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

(6 marks)

SURNAME: ..... FORENAMES: .....

Question 12 (6 marks)

Consider the following array of Strings, declared and initialised as below:

```
String[] words = new String[5];
words[3] = new String("word");
```

a) Write a **single** statement which uses the array `words` but would generate a `NullPointerException`. The syntax of the statement must be correct, ie. the code you write must compile.

(3 marks)

b) Write a **single** statement which uses the array `words` but would generate an `ArrayIndexOutOfBoundsException`. The syntax of the statement must be correct, ie. the code you write must compile.

(3 marks)

SURNAME: ..... FORENAMES: .....

Question 13 (5 marks)

For this question you need to write a method called `joinArrays()` which is passed two arrays of Strings as parameters and which returns a new array of Strings containing all the Strings in the first parameter array followed by all the Strings in the second parameter array.

For example, if the `joinArrays()` method is defined correctly, the following code:

```
public static void main(String[] args){

     String[] words = {"apple", "banana", "chocolate"};
     String[] moreWords = {"dog", "egg"};

     String[] result = joinArrays(words, moreWords);

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

would produce the output:

```
apple banana chocolate dog egg
```

Complete the code for the `joinArrays()` method in the space provided below:

```
public static String[] joinArrays(String[] a, String[] b) {
```

(5 marks)

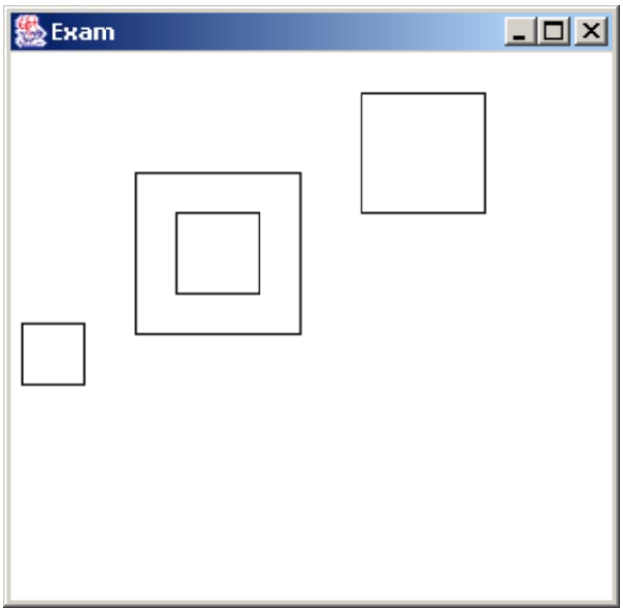
```
}
```

CONTINUED

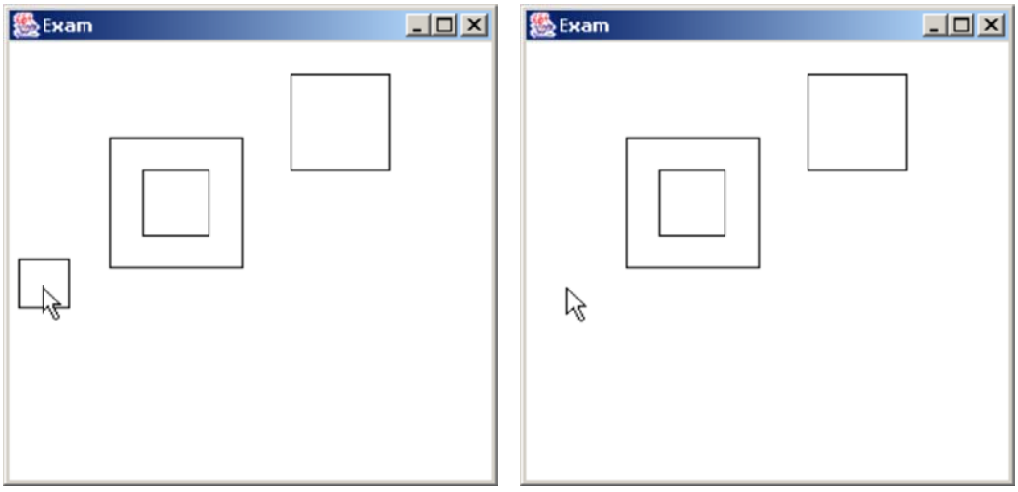
SURNAME: ..... FORENAMES: .....

Question 14 (10 marks)

Consider the program shown in the following screenshots and described below. When the program first starts, four squares are drawn in the window.



If the user presses the mouse button inside one of the squares, then the square will disappear from the screen. The screenshot on the left below shows the program just before the mouse button is pressed and the screenshot on the right below shows the program just after the mouse button is pressed. Notice that the square in which the mouse was pressed has disappeared.



Another example is shown below. This time two squares disappear as the mouse button is pressed because the position of the mouse press is located inside both of them.

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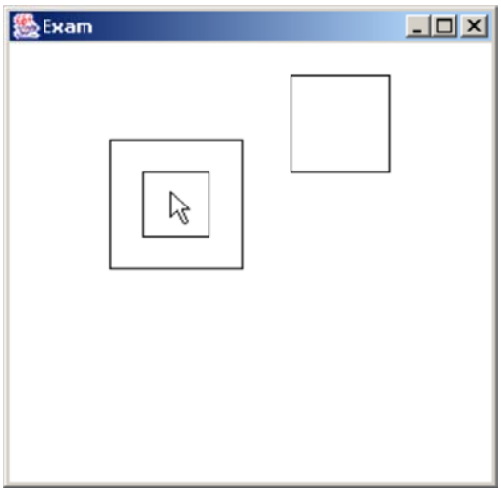

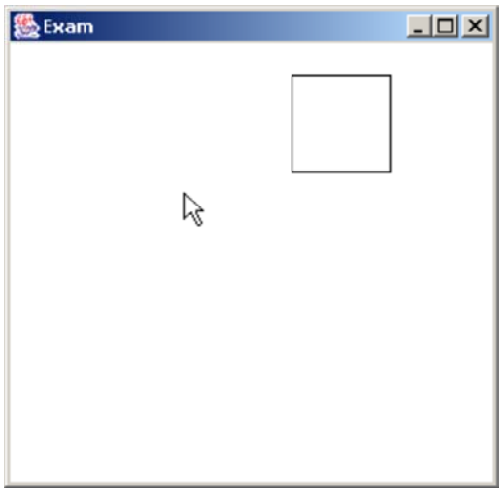

The source code for the `JPanel` class for this program is below:

```
import java.awt.*;
import javax.swing.*;
import java.awt.event.*;

public class MyJPanel extends JPanel implements MouseListener {

     private Square[] squares;

     public MyJPanel() {

          squares = new Square[4];

          // the 3 parameters passed to the constructor for the
          // Square class are the x and y positions of the centre
          // of the square, and the side length of the square
          squares[0] = new Square(100, 100, 40);
          squares[1] = new Square(100, 100, 80);
          squares[2] = new Square(200, 50, 60);
          squares[3] = new Square(20, 150, 30);

          addMouseListener(this);
     }

     public void mousePressed(MouseEvent e) {
          for (int i = 0; i < squares.length; i++)
               if (squares[i].inside(e.getPoint()))
                    squares[i].setVisible(false);
          repaint();
     }

     public void paintComponent(Graphics g) {
          super.paintComponent(g);

          for (int i = 0; i < squares.length; i++)
               squares[i].draw(g);
     }

     public void mouseReleased(MouseEvent e) {}
     public void mouseEntered(MouseEvent e) {}
     public void mouseExited(MouseEvent e) {}
     public void mouseClicked(MouseEvent e) {}
}
```

SURNAME: ..... FORENAMES: .....

Notice that this program uses the `Square` class to represent the squares that the user can remove. For this question you need to define the `Square` class in the space provided below.

```
import java.awt.*;

public class Square {









}
```

(10 marks)

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ROUGH WORKING (WILL NOT BE MARKED)

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SURNAME: ..... FORENAMES: .....

ROUGH WORKING (WILL NOT BE MARKED)

(You may detach this page from the answer booklet and use it for rough working)