

Family Name: ..... Other Names: .....

Student ID: ..... Signature .....

# Intro to Computer Programming: Final Exam

09 January, 2017

## Instructions

- Time allowed: **2 Hours**
- Answer **all** the questions. There are 70 marks in total.
- Write your answers in the boxes in this test paper and hand in all sheets.
- If you think some question is unclear, ask for clarification.
- Brief Java documentation is provided with the test
- This test contributes 15% of your final grade  
(But your mark will be boosted up to your exam mark if that is higher.)
- You may use paper translation dictionaries, and calculators without a full set of alphabet keys.
- You may write notes and working on this paper, but make sure your answers are clear.

## Questions

## Marks

1. Understanding Java	[25]	<input type="text"/>
2. Files and Arraylists of objects	[15]	<input type="text"/>
3. Writing methods that use objects	[10]	<input type="text"/>
4. Arrays and 2D arrays	[20]	<input type="text"/>
	TOTAL:	<input type="text"/>

**SPARE PAGE FOR EXTRA ANSWERS**

Cross out rough working that you do not want marked.  
Specify the question number for work that you do want marked.

**Question 1. Understanding Java****[25 marks]**(a) **[5 marks]** Understanding parameter passing and methods calling sequence

What will be printed out if the main method of the following Thing class is called?

```
public class Thing {  
  
    public Thing() {  
        Ul.println("Initialsing.....");  
    }  
  
    public void incrementThenAdd(int x) {  
        x++;  
        Ul.println("Value = " + x);  
    }  
  
    public static void main(String[ ] args) {  
        Thing obj = new Thing();  
        int y = 10;  
        obj.incrementThenAdd(y);  
        Ul.println("Value = " + y);  
    }  
}
```

```
Initialising.....  
Value = 11  
Value = 10
```

**(Question 1 continued)**

(b) [5 marks] Understanding loops

What will be printed if the following doSomething method is called?

```
public void doSomething() {  
    for(int i = 0; i < 5; i++) {  
        for(int j = 0; j < 5-i; j++) {  
            UI.print("X");  
        }  
        UI.print("\n");  
    }  
    UI.println("done");  
}
```

XXXXX

XXXX

XXX

XX

X

done

(c) [5 marks] Understanding if statements  
What will be printed if checkThis(10) is called?

```
public void checkThis(int n) {  
    while( n >= 0)  
    {  
        if( n%2 == 0)  
        {  
            UI.println(n + " is even");  
            n--;  
        }  
        if( n%2 != 0)  
        {  
            UI.println(n + " is odd");  
            n--;  
        }  
    }  
}
```

**Hint:** be careful with the two if statements.

```
10 is even  
9 is odd  
8 is even  
7 is odd  
6 is even  
5 is odd  
4 is even  
3 is odd  
2 is even  
1 is odd  
0 is even  
-1 is odd
```

(d) [5 marks] Understanding Arrays and ArrayLists

What will be printed if the following arrayListTest method is called?

```
public void arrayListTest () {
    ArrayList <String> namesList = new ArrayList<String>();
    namesList.add("Ali");
    namesList.add("Pondy");
    namesList.add("Sharon");
    String [ ] names = new String[10];
    for (int i = 0; i < namesList.size (); i++)
    {
        names[i] = namesList.get(i);
    }
    Ul. println ("ArrayList size = "+namesList.size());
    Ul. println ("Array length = "+names.length);

    namesList.set (1, "Peter");
    if (namesList.contains ("Pondy")) {
        namesList.add(0, "Sue");
    }
    else {
        namesList.add(0, "Stu");
    }
    for (String n : namesList)
        Ul. println ("Name: " + n);
}
```

```
ArrayList size = 3
Array length = 10
Name:  Stu
Name:  Ali
Name:  Peter
Name:  Sharon
```

(e) [5 marks] Using 2D Arrays

What will be printed if the following test2D method is called?

```
public void test2D() {
    int [ ][ ] nums = new int [ ][ ]{ {12, 2, 1, 5},
                                       {31, 3, 6, 18},
                                       {14, 0, 17, 20},
                                       {4, 25, 8, 15}};

    for (int i = 0; i < nums.length; i++) {
        for (int j = 0; j < nums[i].length; j++) {
            UI. print ( nums[i][j] + ", ");
        }
        UI. println ();
    }
    UI. println ("-----");

    nums[2][nums.length-3] = 9;
    for (int k = nums[0].length-1; k >= 0; k--)
        UI. println ( nums[2][k]);
}
```

```
12, 2, 1, 5,
31, 3, 6, 18,
14, 0, 17, 20,
4, 25, 8, 15,
-----
20
17
9
14
```

**Question 2. Writing programs with objects, ArrayLists and Files** [15 marks]

Complete the loadShoppingList method below that constructs an ArrayList of Item's, checking for duplicates as it goes. It should

- Read the data for each of the Items from a file,
- Constructing each Item object,
- Check whether there is already an Item in the items ArrayList with the same ID,
- If not, it should add the Item into items.

The file contains three lines of data for each item:

1. product ID (an *integer*)
2. name (a *String* with no spaces)
3. price (a *double*)

Your code should use the constructor and methods for Item objects defined in the Item class below.

---

```

public class Item {
    private int id;
    private String name;
    private double price;

    public Item(int id, String name, double price) {
        this.id = id;
        this.name = name;
        this.price = price;
    }

    public int getID() {
        return this.id;
    }

    public String getName() {
        return this.name;
    }

    public double getPrice() {
        return this.price;
    }
}

```

---

```
public class ShoppingList {
    private ArrayList<Item> items = new ArrayList<Item>();

    public void loadShoppingList() {
        try {
            Scanner scan = new Scanner(new File(UIFileChooser.open()));
            while (scan.hasNext()){
                int id = scan.nextInt ();
                String name = scan.next();
                double price = scan.nextDouble();
                boolean found = false;
                Item item = new Item(id, name, price);
                for (Item it : this.items){
                    if (it.getID()== id){
                        found = true;
                    }
                }
                if (! found) {
                    this.items.add(item);
                }
            }

            scan.close ();
        } catch(IOException e) {UI.println ("Fail: " + e);}
    }
}
```

**Question 3. Writing methods that use objects****[10 marks]**

For this question, you must write some code for a simulation of a new electronic holiday decoration that has lots of coloured LEDs, each controlled by a little microprocessor. Each light cycles smoothly between two target colours. The speed that it cycles can be changed, and the two target colors can also be changed.

The simulation program has a

- Light class for the individual LEDs, (shown below), and
- a Decoration class for the whole decoration, containing a simulate method.

You should complete the simulate method on the facing page which should

- Create ten Light objects, spread evenly across the window (eg, from position (50,100) to position (500,100)). Each Light should have an initial speed of 1.
- Loop forever, making all the lights step through their cycles.
- Every 1000 steps, it should change the target colours of every light, and it should increase the speed by 1 (but never going over a speed of 50).

The Light class:

---

Constructor:

```
public Light(double xPos, double yPos, int speed){
    // Constructs a Light object with random target colors , and draws it on the window.
    // Parameters are :
    // the position on the window (x and y)
    // the speed the color will change (an integer between 1 and 100)
```

Methods:

```
public void step()
    // makes the light change its color one step between the two target colours .
    // the size of the step depends on the value of speed
    // a speed of 1 means a very small change;
    // a speed of 100 will jump to the target color directly
```

```
public void changeTargetColors()
    // Changes the target colors to be two new random colours.
```

```
public void setSpeed(int s )
    // Set the speed of the color change (a number from 1 to 100)
```

---

```
public void simulate(){  
  
    ArrayList<Light> lights = new ArrayList<Light>();  
    for (int i=1; i<=10; i++){  
        Light light = new Light(i*50, 100, 1);  
        lights.add(light);  
    }  
    for (int i=0; i<Integer.MAX_VALUE; i++){  
        for(Light light : lights){  
            if (i%1000 == 0){  
                light.changeTargetColors();  
                light.setSpeed(Math.min(50, i/1000));  
                //OR if (i/1000<=50) {light.setSpeed(i/1000);}  
            }  
            light.step();  
        }  
        UI.sleep(20);  
    }  
}
```

}

**Question 4. Writing programs using 1D and 2D arrays****[20 marks]**

(a) **[4 marks]** Complete the code for the dotProduct method below that computes the dot product of two vectors. The vectors may be of any size as long as they are the same size.

The dot product is the sum of the products of the corresponding elements:

$$(u_1, u_2, \dots, u_n)(v_1, v_2, \dots, v_n) = \\ u_1 \times v_1 + u_2 \times v_2 + \dots + u_n \times v_n$$

For example,

$$\begin{pmatrix} 1 \\ 2 \\ 3 \end{pmatrix} \cdot \begin{pmatrix} 6 \\ 5 \\ 4 \end{pmatrix} \Rightarrow 1 \times 6 + 2 \times 5 + 3 \times 4 = 28$$

```

public double dotProduct(double[] u, double[] v) {
    double sum = 0;
    for (int j = 0; j < vector.length; j++){
        sum = sum + matrix[i][j] * vector[j];
    }
    return sum;
}

```

(b) [8 marks] Complete the code for the `matrixTimesVector` method below that multiplies a matrix by a vector and returns a vector.

- The length of the input vector is the same as the number of **columns** in the input matrix.
- The length of the answer vector is the same as the number of **rows** in the input matrix.
- The  $i$ th element of the answer vector is the dot product of the  $i$ th row of the input matrix and the input vector.

For example,

$$\begin{pmatrix} 1 & 0 & 1 \\ 6 & 3 & -1 \end{pmatrix} \times \begin{pmatrix} 1 \\ 2 \\ 4 \end{pmatrix} \Rightarrow \begin{pmatrix} 1 \times 1 + 0 \times 2 + 1 \times 4 \\ 6 \times 1 + 3 \times 2 + -1 \times 4 \end{pmatrix} = \begin{pmatrix} 5 \\ 8 \end{pmatrix}$$

```
public double [ ] matrixTimesVector(double [ ][ ] matrix, double [ ] vector) {
    double [ ] answer = new double[matrix.length];
    for (int i = 0; i < matrix.length; i++){
        double sum = 0;
        for (int j = 0; j < vector.length; j++){
            sum = sum + matrix[i][j] * vector[j];
        }
        answer[i] = sum;
    }
    return answer;
    // OR
    double [ ] answer = new double[matrix.length];
    for (int row = 0; row < matrix.length; row++){
        answer[row] = dotProduct(matrix[row], vector);
    }
    return answer;
}
```

(c) [8 marks] Complete the code for the `matrixTranspose` method below that constructs and returns the transpose of a matrix. Transposing a matrix exchanges the rows and the columns.

For example,

$$\text{Transpose of } \begin{pmatrix} 5 & 8 & 2 \\ 6 & 10 & 11 \end{pmatrix} \Rightarrow \begin{pmatrix} 5 & 6 \\ 8 & 10 \\ 2 & 11 \end{pmatrix}$$

```
public double [ ][ ] transpose(double [ ][ ] matrix) {  
    int rows = matrix1.length;  
    int cols = matrix1[0].length;  
    double [ ][ ] answer = new double[cols][rows];  
    for (int row = 0; row < rows; row++){  
        for (int col = 0; col < cols; col++){  
            answer[col][row] = matrix[row][col];  
        }  
    }  
    return answer;  
}
```

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