



EXAMINATIONS — 2005

MID-YEAR

COMP 102
INTRODUCTION TO
COMPUTER PROGRAM DESIGN

Time Allowed: 3 Hours

Instructions: Attempt ALL Questions.

Answer in the appropriate boxes if possible — if you write your answer elsewhere, make it clear where your answer can be found.

The exam will be marked out of 180 marks.

Non-programmable calculators without a full alphabetic key pad are permitted.

Non-electronic foreign language dictionaries are permitted.

There are spare pages for your working and your answers in this exam.

Questions

	Marks
1. Understanding Java programs	[45]
2. Writing simple Java Programs	[30]
3. Classes and objects	[15]
4. Files	[15]
5. Composition	[20]
5. Inheritance	[20]
6. GUI	[15]
7. Recursion	[20]

Question 1. Understanding Java programs

[45 marks]

In parts (a) to (g), you should assume each method is declared in a suitable class and called on an object of this class. The name and other details of this class are unimportant as the methods do not refer to fields or other methods of the class.

(a) [3 marks] What will be printed when the following method Q1a is called?

```
public void Q1a() {
    int x = 5;
    int y = 4;
    int z = x*y;
    y = z-y;
    System.out.println(x);
    System.out.println(y);
    System.out.println(z);
}
```

(b) [5 marks] What will be printed when the following method Q1b is called?

```
public void Q1b() {
    String s = "Wellington";
    System.out.println( s.length() );
    System.out.println( s.charAt(1) );
    int a = s.indexOf('i');
    System.out.println( a );
    System.out.println( s.substring(0, a) );
    System.out.println( s.substring(a+1));
}
```

(c) [6 marks] Consider the following method definition:

```
public void Q1c(int a, int b) {  
    int c = 0;  
    int d;  
    if ( a < b) {  
        c = a+b;  
    }  
    d = 2*b;  
    if ( a > c )  
        c = a;  
    else  
        d = b;  
    System.out.println(c + " " + d);  
}
```

(i) [2 marks] What will be printed when method Q1c is called with **3** and **0** as its arguments?

(ii) [2 marks] What will be printed when method Q1c is called with **2** and **2** as its arguments?

(iii) [2 marks] What will be printed when method Q1c is called with **5** and **1** as its arguments?

(d) [5 marks] What will be printed when the following method Q1d is called?

```
public void Q1d() {  
    int s = 25;  
    int k = 1;  
    while ( s > 0 ) {  
        System.out.println( k + " " + s);  
        s = s - 2*k + 1;  
        k = k + 1;  
    }  
}
```

(e) [4 marks] What will be printed when the following method Q1e is called?

```
public void Q1e() {  
    int[] a = {2, 0, -1, 4};  
    int s = 0;  
    for (int i = 0; i < a.length; i++) {  
        System.out.println(a[i] + " " + s);  
        s = s + a[i];  
    }  
}
```

(f) [6 marks] What will be printed when the following method Q1f is called?

```
public void Q1f() {
    int m = 3;
    int[] a = new int[2*m];
    for (int k = 0; k < a.length; k++) {
        a[k] = 3*k;
        System.out.print(a[k] + " ");
    }
    System.out.println();
    for (int k = 0; k < m; k++) {
        System.out.println(a[2*k] + a[a.length-k-1]);
    }
}
```

(g) [9 marks] What will be printed when the following method Q1g is called?

```
public void Q1g() {
    int m = 3;
    int k = 1;
    int[][] a = new int[m][m];
    for (int i = 0; i < m; i++) {
        for (int j = 0; j < m; j++) {
            a[i][j] = k;
            k = k+1;
            System.out.print(a[i][j] + " ");
        }
        System.out.println();
    }
    for (int i = 0; i < m; i++) {
        System.out.print(a[i][m-i-1] + " ");
    }
    System.out.println();
}
```

(h) [7 marks] What will the following program print out?

```
public class Q1h {
    public static void main(String[] args) {
        int[] points1 = {5, 8, 10};
        int[] points2 = {9, 8, 7};
        Contestant a = new Contestant("Chris");
        Contestant b = new Contestant("Susan");
        for (int k = 0; k < points1.length; k++) {
            a.addScore(points1[k]);
            b.addScore(points2[k]);
            System.out.println(
                a.getName() + " has " + a.getScore() + " " +
                b.getName() + " has " + b.getScore());
        }
        String result = "Results is a tie";
        if ( a.getScore() > b.getScore() )
            result = a.getName() + " wins";
        else if ( a.getScore() < b.getScore() )
            result = b.getName() + " wins";
        System.out.println(result);
    }
}

class Contestant {
    private String name;
    private int score = 0;
    public Contestant(String n) {
        name = n;
    }
    public void addScore(int x) {
        score = score + x;
    }
    public int getScore() {
        return score;
    }
    public String getName() {
        return name;
    }
}
```



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 2. Writing simple Java programs

[30 marks]

(a) [15 marks] Strings and conditionals

You are to write a program that reads a string and analyses it. If the string contains exactly one space, the program should print the string with the space replaced by a colon (:). If the string contains no space or more than one space, the program should print `Invalid input`.

For example, the following table shows the output that should be produced for three possible inputs:

Input	Output
123 abcd	123:abcd
a+b-c+d*e	Invalid input
f(a, bb, ccc)	Invalid input

Complete the following program so that it behaves as described above. You may print output using either `System.out` or `JOptionPane` methods.

```
import javax.swing.*;
public class StringAnalyser {
    public static void main(String[] args) {
        // Read and analyse a string
        String s = JOptionPane.showInputDialog("Enter string");

    }
}
```

(b) [15 marks] Loops and arrays

You are to write a method that takes as arguments two arrays of integers and prints a table with three columns, as follows. The first column should show the values in the first array; the second column should show the values of the second array; and the third column should show the difference between the two values on that row. The difference should be displayed with a leading plus sign (+) if the number in the first column is bigger and a minus sign (-) if the number in the second column is bigger. An equals sign (=) should be printed in place of the difference if the two values are equal.

You may assume that the two arrays have the same size, and you do not need to make the columns line up. You may print output using either `System.out` or `JOptionPane` methods.

For example, if the method was called as follows:

```
int[] avals = {17, -5, 18, 15, 12};
int[] bvals = {11, 12, 27, 15, -9};
printTable(avals, bvals);
```

the output would be:

```
17 11 +6
-5 12 -17
18 27 -9
15 15 =
12 -9 +21
```

Complete the following method so that it behaves as described above.

```
public void printTable(int[] a, int[] b) {

}
}
```

Question 3. Classes and Objects

[15 marks]

The following is an outline of a class for printing text arranged in groups of lines, such as verses of a poem or song. The method `printLine` is used to print a line, and `newGroup` is used to start a new group of lines, printing a blank line to separate the new group from the previous group.

```
public class LinePrinter {
    public LinePrinter() {
    }
    public void printLine(String s) {
        System.out.println(s);
    }
    public void newGroup() {
        System.out.println();
    }
}
```

You are to modify this class so that lines are numbered within each group. Also, the `LinePrinter` should take an argument giving the maximum number of lines in each group, and a new group should be started if more than that number of lines are printed since the current group was started.

For example, once you have completed this modification, executing the program shown below on the left should produce the output shown below on the right.

<pre>public class Printer { public static void main(String[] args) { LinePrinter p = new LinePrinter(3); p.printLine("One"); p.printLine("Two"); p.printLine("Three"); p.printLine("Four"); p.printLine("Five"); p.newGroup(); p.printLine("Six"); p.printLine("Seven"); p.printLine("Eight"); p.printLine("Nine"); p.printLine("Ten"); } }</pre>	<pre>1 One 2 Two 3 Three 1 Four 2 Five 1 Six 2 Seven 3 Eight 1 Nine 2 Ten</pre>
---	--

Show the modifications necessary on the following copy of `LinePrinter`:

```
public class LinePrinter {  
  
    public LinePrinter(  
        ) {  
  
    }  
    public void printLine(String s) {  
  
        System.out.println(s);  
  
    }  
    public void newGroup() {  
  
        System.out.println();  
  
    }  
}
```

Question 4. Files

[15 marks]

The following file data.txt is used in both parts of this question.

```
Group1
1.00
3.00
4.00
7.00
Group2
25.00
20.00
5.00
Group3
2.00
1.00
```

Consider the following program:

```
import java.io.*;

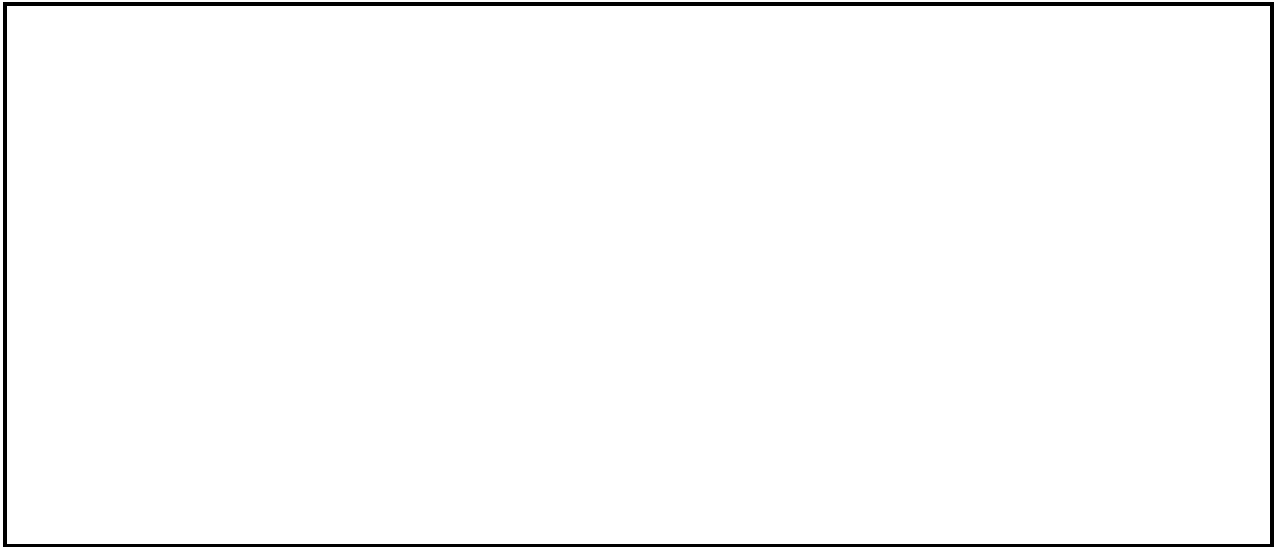
public class FilesProgram {
    public static void main(String[] args) {

        try {
            FileReader inStream = new FileReader("data.txt");
            BufferedReader inFile = new BufferedReader(inStream);

            double sum = 0.0;
            String dataLine = inFile.readLine();
            System.out.println(dataLine);
            System.out.println(inFile.readLine() + inFile.readLine());

            dataLine = inFile.readLine();
            while(dataLine != null) {
                System.out.println(dataLine);
                sum = sum + Double.parseDouble(dataLine);
                dataLine = inFile.readLine();
            }
            System.out.println(sum);
            inFile.close();
        }
        catch(NumberFormatException ex) {
            System.out.println("wrong number format");
        }
        catch(IOException ex) {
            System.out.println("File I/O error");
        }
    }
}
```

(a) [7 marks] What will the program `FilesProgram` print out to the screen?



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

(b) [8 marks] Complete the following program `SumGroups.java` so that given a file containing named groups of numbers as in `data.txt`, it prints the group name and the sum of all numbers for each group. For `data.txt`, it should print out:

```
Group1
15.00
Group2
50.00
Group3
3.00
```

```
import java.io.*;

public class SumGroups {
    public static void main(String[] args) {

        try {
            FileReader inStream = new FileReader("data.txt");
            BufferedReader inFile = new BufferedReader(inStream);

            inFile.close();
        }
        catch(NumberFormatException ex) {
            System.out.println("wrong number format");
        }
        catch(IOException ex) {
            System.out.println("File I/O error");
        }
    }
}
```

Question 5. Composition

[20 marks]

This question concerns a program for storing and printing out information about cars, including information about the colour, the engine and the wheels. Two classes are given below:

```
class Engine {
    private String code;

    public Engine() {
        code = JOptionPane.showInputDialog("Enter the engine code: ");
    }
    public void print() {
        System.out.println("Engine Code: " + code);
    }
}
```

```
class Wheel {
    private String position;
    private String tyreChangeYear;

    public Wheel() {
        position = JOptionPane.showInputDialog("Which wheel? ");
        tyreChangeYear = JOptionPane.showInputDialog("When was this tyre changed?" );
    }
    public void print() {
        System.out.println("The wheel at: " + position);
        System.out.println("The tyre was changed in " + tyreChangeYear);
    }
}
```

You are required to complete the Car class on the facing page using the two classes given above. You are given code which reads and prints the colour. Your task is:

- Add data fields to store the engine and the wheels. A car has an engine and 4 wheels.
- Complete the constructor so that it asks the user for details for the engine and for each wheel.
- Complete the `print()` method so that it prints the details of the engine and the four wheels.

```
class Car {
    private String colour;

    public Car() {
        colour = JOptionPane.showInputDialog("what is the colour of the car ");
    }

    public void print() {
        System.out.println("colour:" + colour);
    }
}
```

Question 6. Inheritance

[20 marks]

In Lab assignment 8, you worked on the `BankProgram1.java` program. In this question, you are to add one more type of account: `ClassicSavingsAccount`. This type of account is similar to the `SavingsAccount` except that:

- The `withdraw` method is different: the first five withdrawals from a `ClassicSavingsAccount` are free; any withdrawal after the fifth time is charged the same as withdrawal from a `SavingsAccount`.
- The value returned by the `toString` method should start with “Classic Savings”, followed by ID, balance, and how many times the customer has withdrawn money from this account.

You are required to use **Inheritance** to design this class. The `SavingsAccount` class is given below.

```
class SavingsAccount implements Account {
    private String id;
    private double balance;

    public void enter() {
        id = JOptionPane.showInputDialog("Enter ID: ");
        balance = Double.parseDouble(JOptionPane.showInputDialog("Enter Balance: "));
    }
    public void deposit(double money) {
        balance = balance + money;
    }
    public void withdraw(double money) {
        balance = balance - money - 5;
    }
    public String getID() {
        return id;
    }
    public double getBalance() {
        return balance;
    }
    public void setBalance(double b) {
        balance = b;
    }
    public String toString() {
        return "SavingAccount " + id + " " + balance;
    }
    public boolean equals(Object a) {
        Account aa = (Account) a;
        return this.id.equals(aa.getID());
    }
}
```

(a) [15 marks] Write your `ClassicSavingsAccount` class here.

```
class ClassicSavingsAccount
```

(b) [5 marks] In order to add the `ClassicSavingsAccount` class to the program and make the whole program work properly with this new type of account, what classes and methods need to be modified? You do not need to code/implement the changes, you only need to write down the class names and the method names. The outline of `BankProgram1.java` showing all the class names and method names is on the facing page.

```

public class BankProgram1 {
    public static void main (String[] args)
    }
class Bank {
    private Set accounts = new Set();
    public void newAccount()
        //Ask the user the type of account, create an account and add it to the collection.
    public void deposit()
        //Ask the user to select an account and give an amount, deduct the amount
    public void withdraw() //Similar to deposit
    public void showAccount() //Print the details of all accounts in the collection
}
class Set {
    private Object elements[];
    private int MAX = 500;
    private int pos;

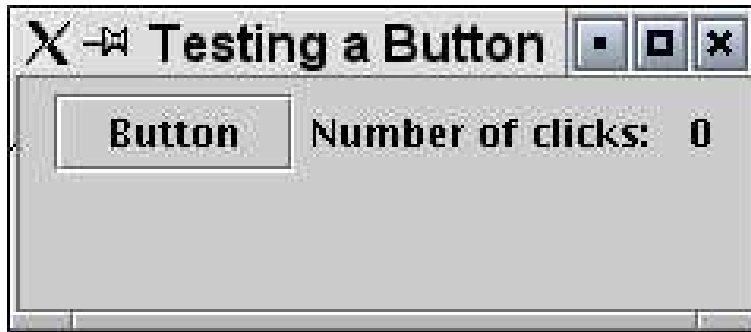
    public Set()
    public void reset()
    public boolean addElement(Object x)
    public boolean containsElement(Object x)
    public Object findElement(Object x)
    public void getElementInit()
    public Object getElement()
    public Object getElement(int n)
}
interface Account {
    public void enter();
    public void deposit(double money);
    public void withdraw(double money);
    public String getID();
    public double getBalance();
    public boolean equals(Object a);
    public String toString();
}
class SavingsAccount implements Account {
    public void enter();
    public void deposit(double money);
    public void withdraw(double money);
    public String getID();
    public double getBalance();
    public boolean equals(Object a);
    public String toString();
}
class ChequeAccount implements Account {
    public void enter();
    public void deposit(double money);
    public void withdraw(double money);
    public String getID();
    public double getBalance();
    public boolean equals(Object a);
    public String toString();
}
class GoalSavingAccount extends SavingsAccount {
    public void enter();
    public void deposit(double money);
    public void withdraw(double money);
    public String getID();
    public double getBalance();
    public boolean equals(Object a);
    public String toString();
}
}

```

Question 7. GUI

[15 marks]

Someone has written a program that is supposed to create a simple GUI with one button and one label as shown in the figure below.



The program is intended to allow the user to click on the button and then show the number of clicks in the label. However, this program has several problems and your task is to fix them. To fix each problem, you will need to modify/add several lines. Write your answers (cross out the mistakes and write your code) on the program given on the facing page.

```

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

public class ButtonClick {
    public static void main(String args[]) {
        new TestButton();
    }
}

class TestButton {
    private JFrame frame;
    private JPanel panel;
    private JButton button;
    private JLabel label;
    private int clicks = 0;

    public TestButton() {

        frame = new JFrame("Testing a Button");

        panel = new JPanel();

        button = new JButton("Button");

        label = new JLabel("Number of clicks: " + clicks);

        frame.getContentPane().add(button);

        frame.getContentPane().add(label);

        button.ButtonClicked();

        frame.setSize(240,100);

        frame.setVisible(true);
    }

    public void ButtonClicked() {
        clicks++;

        label.setText("Number of clicks: " + clicks);
    }
}

```

Question 8. Recursion

[20 marks]

Consider the following program:

```
public class RecursionProgram {  
  
    public static void main (String[] args) {  
        Calculator p = new Calculator();  
        int result = p.myMethod(3,4);  
        System.out.println("result: " + result);  
    }  
}  
  
class Calculator {  
    public int myMethod(int x, int n) {  
        System.out.println("n: " + n);  
        int ans;  
        if (n == 0)  
            ans = 1;  
        else {  
            int f = myMethod(x, n-1);  
            ans = x * f;  
        }  
        System.out.println("ans: " + ans);  
        return ans;  
    }  
}
```

(a) [12 marks] What will the program print out?

Note: Each time the recursive method is called, one of the arguments and the returned value are printed. The program also prints the final result.

(b) [8 marks] Rewrite the `MyMethod` method using a `for` (or `while`) loop that returns the same result but does not print anything out.

SPARE PAGE FOR EXTRA ANSWERS

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