Aalborg University | BSc in Medialogy | Second Semester

Programming for Interaction

Ordinary Examination

**12 June 2017, 9.00 – 13.00**

Instructions
- You have 4 hours to complete this examination.
- Neither electronic devices nor written material are allowed in the examination room.
- This examination consists of 16 questions. Each question is worth 5 marks. You must obtain at least 40 marks to pass.
- Do not write any answers on this question paper—answers written on the question paper will be ignored by the examiner. Write all your answers on the writing paper provided.
- Do not write your answers in pencil and do not use a pen with red or green ink. Use a pen with blue or black ink.
- Hand in no more than one answer to each question.
- Do not turn over until you are told to do so by the invigilator.

Question 1

(a) Explain the meaning of the term *man-month* or *person-month*. [1 mark]

(b) If a task is estimated to require 4 person-months of effort, how long does this suggest the task would take to complete if it were carried out by a team of two people? [1 mark]

(c) How much more communication can we expect to take place between team members if the size of a team is doubled, assuming that communication between team-members is unrestricted and that approximately the same amount of communication takes place between each pair of team members? [2 marks]

(d) Why did F. P. Brooks consider the concept of a "man-month" to be "mythical"? [1 mark]

Question 2

The following UML class diagram shows the relationship between four Java classes.
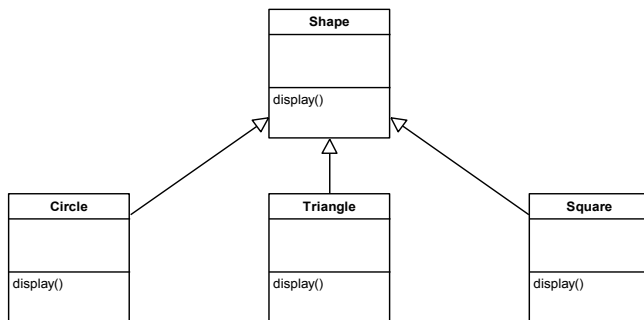
The following Java code uses the classes illustrated in the class diagram above.

```java
1  package dk.aau.imi.med4.ooadp2009.substitutability;
2
3  import java.util.ArrayList;
4
5  public class Substitutability {
6      public static void main(String[] args) {
7          //Create an ArrayList to hold Shape objects
8          ArrayList<Shape> shapeList =
9              new ArrayList<Shape>();
10         //Create a Shape object
11         Shape shape = new Shape();
12         //Create at Triangle object
13         Triangle triangle = new Triangle();
14         //Create a Circle object
15         Circle circle = new Circle();
16         //Create a Square object
17         Square square = new Square();
18         //Add all the Shape objects to shapeList
19         shapeList.add(shape);
20         shapeList.add(triangle);
21         shapeList.add(circle);
22         shapeList.add(square);
23         //Print out the objects in shapeList
24         for (Shape s : shapeList) {
25             s.display();
26         }
27     }
28 }
```

(a) Would it be possible to store a Triangle object in the circle variable declared in line 15? [1 mark]

(b) Would it be possible to store a Square object in the shape variable declared in line 11? [1 mark]

(c) Is Circle a superclass of Shape or is it a subclass of Shape? [1 mark]

(d) The diagram indicates that the Circle class definition contains a definition of a method whose signature is display(). Does the display() method in Circle *override* the display() method in Shape or does it *overload* the display() method in Shape? [1 mark]

(e) Explain why the variable s in line 24 is polymorphic. [1 mark]

Question 3

Study the following Java code and answer the questions that follow it.

```
1   public class Question3 {
2
3       static void c(int i) {
4           System.out.println(i+" is negative and "+(i%2==0?"even":"odd"));
5       }
6
7       static void d(int i) {
8           System.out.println(i+" is positive and "+(i%2==0?"even":"odd"));
9       }
10
11      public static void main(String[] args) {
12          int[] a = {-10, -5, 0, 4, 9};
13          for(int i : a)
14              if (i < 0)
15                  c(i);
16              else
17                  d(i);
18      }
19  }
```

(a) What is the output of this program? [1 mark]

(b) Why is the function d, defined in line 7-9, defined to be static? [1 mark]

(c) What is the purpose of the keyword "void" in lines 3, 7 and 11? [1 mark]

(d) What is the type of the argument of the main method? What is the purpose of this argument? [2 marks]

Question 4

Study the following UML class diagram and answer the questions that follow it.

(a) State whether the association shown in the diagram is an aggregation or a composition. [1 mark]

(b) How many Course type objects are associated with each Degree programme? [1 mark]

(c) How many Degree programme objects are associated with each Course object? [1 mark]

(d) Which of the two classes is the "container" object? If an instance of this container object is destroyed, are all the objects that it contains also destroyed? [2 marks]

Question 5

Write down the output of the following Java program. [5 marks]

```java
public class Question5 {

    static class Point {
        int x, y;
        public String toString() { return "("+x+","+y+")";}
    }

    public static void main(String[] args) {
        Point p = new Point();
        p.x = 1;
        p.y = 2;
        Point q = p;
        p.x += 2;
        p.y -= 3;
        p = new Point();
        Point r = p;
        p = null;
        System.out.println(p);
        System.out.println(q);
        System.out.println(r);
    }
}
```

Question 6

Study the following Java code and answer the question that follows it.

```java
public class Question6 {

    static interface A {
        int a(int i); // returns i * i
    }

    static interface B {
        int b(int i); // returns i * i * i
    }

    static abstract class C implements A {
        public int c(int i) { return i * i * i * i; }
    }

    static class D extends C {
        public int a(int i) { return i * i; }
    }

    static class E extends D implements B {
        public int b(int i) { return i * i * i; }
    }

    static class F implements B {
        public int b(int i) { return i * i * i; }
    }

    static class G implements A, B {
        public int a(int i) { return i * i; }
        public int b(int i) { return i * i * i; }
    }

    public static void main(String[] args) {
        D objD = new D();
        E objE = new E();
        F objF = new F();
        G objG = new G();
        A[] aList = { objD, objE, objF, objG };
        B[] bList = { objD, objE, objF, objG };
        C[] cList = { objD, objE, objF, objG };
        D[] dList = { objD, objE, objF, objG };
        E[] eList = { objD, objE, objF, objG };
        F[] fList = { objD, objE, objF, objG };
        G[] gList = { objD, objE, objF, objG };
    }
}
```

In lines 37 to 43, seven arrays are declared and each is initialized to contain the four objects constructed in lines 33 to 36. However, this program will not compile because each of these seven arrays is defined to contain one or more objects that it cannot contain due to a type mismatch. For example, the array, aList, in line 37 cannot contain the object objF. objF would therefore need to be removed from the definition of aList in order to correct this error.

For each of the arrays in lines 38-43, write down the objects that need to be removed from the array in order to correct the error(s) in that line of the code.

Question 7

Study the following code and answer the question that follows it.

```
1   public class Question7 {
2
3       int u = 5;
4       private int v = 6;
5       static final int x = 2;
6       static int y = 3;
7       final int z = 4;
8
9       public static void main(String[] args) {
10          Question7 q = new Question7();
11          u *= u;
12          v *= v;
13          x *= x;
14          y *= y;
15          z *= z;
16          q.u *= q.u;
17          q.v *= q.v;
18          q.x *= q.x;
19          q.y *= q.y;
20          q.z *= q.z;
21      }
22  }
```

This program will not compile because of multiple errors in lines 11-20.

For each of the lines 11-20, describe the error or errors that occur in that line (or state that there are no errors in that line if that is the case).

Question 8

Study the following UML class diagram and answer the questions that follow it.
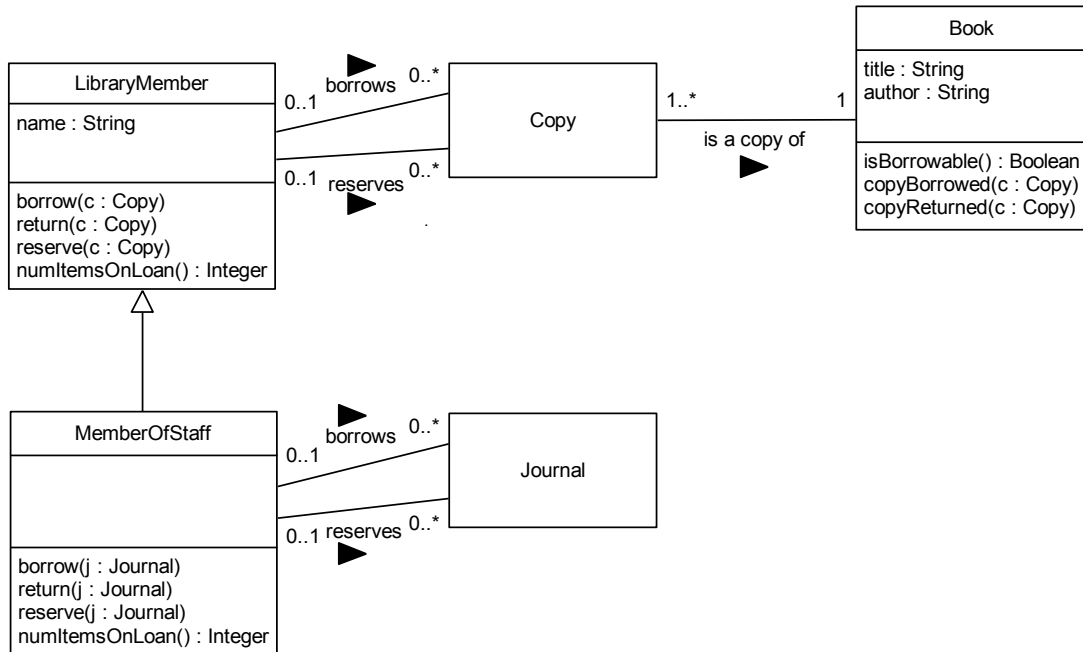
(a) What is the maximum number of LibraryMember objects that can be associated with a single Copy object? [1 mark]

(b) Each of the methods defined in MemberOfStaff either overloads or overrides a method in LibraryMember. For each of these methods, state whether it overloads or overrides a method in LibraryMember. [2 marks]

(c) How many Copy objects can a MemberOfStaff object borrow? [1 mark]

(d) Can a LibraryMember object reserve a Journal object? Explain your answer. [1 mark]

Question 9

Write down the output of the following program.

```java
public class NewQuestion9 {

    static void print(String s) {
        System.out.print(s);
    }

    public static void main(String[] args) {
        for(int i = 0; i < 5; i++)
            switch (i) {
            case 0: print("0");
            case 1: print("1");
            case 2: print("2");
            case 3: print("3");
            case 4: print("4");
            default:
            }
    }
}
```

Question 10

Write down the output of the following program.

```java
public class NewQuestion10 {
    public static void main(String[] args) {
        System.out.println(3/2 + 3 + "a");
        System.out.println(1.0/2*3);
        int i = 1, j = 2, k = 3;
        double x = 1.0, y = 2.0, z = 3.0;
        System.out.println((k%j)*(x/y));
        System.out.println("i"+i+i);
        System.out.println(x+x+"x");
    }
}
```

Question 11

Write down the output of the following program.

```java
public class NewQuestion12 {

    static class FlipException extends Exception {
        private static final long serialVersionUID = 1L;
        public FlipException( ) { super(); }
        public FlipException(String s) { super(s); }
    }

    static void flip(int i) throws FlipException {
        if (i > 3)
            throw new FlipException("i too high");
        else if (i < 2)
            throw new FlipException("i too low");
        System.out.println("i just right");
    }

    public static void main(String[] args) {
        for(int i = 0; i < 5; i++) {
            try {
                flip(i);
            } catch (FlipException e) {
                System.out.println(e.getMessage());
            }
        }
    }
}
```

Question 12

Study the following code and answer the questions that follow it.

```java
public class Question9 {

    public static void print(int i) {
        System.out.print(Thread.currentThread().getName() + ":" + i + " ");
    }

    public static void main(String[] args) {
        Thread thread1 = new Thread(new Runnable() {
            public void run() {
                try {
                    for(int i = 0; ; i++) {
                        Thread.sleep(100);
                        Question9.print(i);
                    }
                } catch (InterruptedException e) {
                    return;
                }
            }
        }, "A");
        Thread thread2 = new Thread(new Runnable() {
            public void run() {
                try {
                    for(int i = -1; ; i--) {
                        Thread.sleep(100);
                        Question9.print(i);
                    }
                } catch (InterruptedException e) {
                    return;
                }
            }
        }, "B");
        thread1.start();
        thread2.start();
        try {
            Thread.sleep(500);
        } catch (InterruptedException e) {
            e.printStackTrace();
        }
        thread1.interrupt();
        thread2.interrupt();
    }

}
```

(a) Which of the following five strings is a possible output from this program?
(At least one of the strings is a possible output.) [2 ½ marks]

    a.   A:0 B:-1 A:1 B:-2 A:2 B:-3 A:3 B:-4

    b.   B:-1 A:0 B:-2 A:1 B:-3 A:2 B:-4 A:3

    c.   B:-1 A:0 B:-2 A:1 A:2 B:-4 A:3 B:-3

    d.   B:-1 A:0 A:1 B:-2 A:2 B:-3 A:3 B:-4

    e.   A:0 B:-1 A:2 B:-2 A:1 B:-3 A:3 B:-4

(b) What is the purpose of line 35? [1 mark]

(c) In which three lines can an InterruptedException object be thrown?
(1 ½ marks)

Question 13

Study the two Java class definitions below and answer the questions that follow.

```java
public class Question10Server {
    public static void main(String[] args) {
        try {
            ServerSocket serverSocket = new ServerSocket(50000);
            Socket clientSocket = serverSocket.accept();
            PrintWriter out = new PrintWriter(clientSocket.getOutputStream(), true);
            BufferedReader in = new BufferedReader(new InputStreamReader(clientSocket.getInputStream()));
            for(;;) {
                int input = Integer.parseInt(in.readLine());
                out.println(input * input);
                if (input==0)
                    break;
            }
            in.close();
            out.close();
            clientSocket.close();
            serverSocket.close();
        } catch (IOException e) {
            e.printStackTrace();
        }
    }
}
```

```java
public class Question10Client {
    static PrintWriter out;
    static BufferedReader in;
    static void getAnswer(int i) {
        try {
            out.println(i);
            System.out.println(in.readLine());
            Thread.sleep(1000);
        } catch (IOException e) {
            e.printStackTrace();
        } catch (InterruptedException e) {
            e.printStackTrace();
        }
    }

    public static void main(String[] args) {
        try {
            Socket socket = new Socket("localhost", 50000);
            out = new PrintWriter(socket.getOutputStream(),true);
            in = new BufferedReader(new InputStreamReader(socket.getInputStream()));
            getAnswer(2); getAnswer(3); getAnswer(4); getAnswer(0);
            in.close();
            out.close();
            socket.close();
        } catch (UnknownHostException e) {
            e.printStackTrace();
        } catch (IOException e) {
            e.printStackTrace();
        }
    }
}
```

Assume that the Question10Server program is started and then the Question10Client program is started on the same machine.

(a) What is written to the console window by the Question10Client program? [1 mark]

(b) What is written to the console window by the Question10Server program? [1 mark]

(c) What is the purpose of the InputStreamReader, constructed in line 20 of Question10Client? [1 mark]

(d) What is the purpose of the "50000" provided as the second argument to the Socket constructor in line 18 of Question10Client? [1 mark]

(e) Describe what the accept() method does in line 5 of Question10Server. [1 mark]

Question 14

Study the following code and answer the questions that follow it.

```
1    public class Question11 extends JFrame implements ActionListener {
2        private static final long serialVersionUID = 1L;
3        private JButton button = new JButton("Click me!");
4        public void actionPerformed(ActionEvent e) { button.setText("You clicked me!"); }
5        public Question11() {
6            setTitle("Question11");
7            getContentPane().add(button);
8            button.addActionListener(this);
9            pack();
10           setVisible(true);
11       }
12       public static void main(String[] args) {
13           SwingUtilities.invokeLater(new Runnable() {
14               public void run() { new Question11(); }
15           });
16       }
17   }
```

(a) Draw a sketch of the GUI that appears when this program is run. [1 mark]

(b) Which callback method is called in response to the event emitted when the button is clicked and what does this method do? [1 mark]

(c) Which object serves as an ActionListener? [1 mark]

(d) Explain what the invokeLater method does in line 13. [1 mark]

(e) Describe what happens when line 7 is executed. [1 mark]

Question 15

Which of the following statements are true? (At least one of the statements is true.)

(a) An Android app starts a component in another app by sending an intent *directly* to that other app.

(b) An explicit intent is a request for any component that can carry out a specified action; whereas an implicit intent is a request for a component of a specified class.

(c) Each Android application is made up of four different types of component: activities, services, content providers and broadcast receivers.

(d) Each Android process runs in its own virtual machine.

(e) Each component in an Android app has a corresponding element within the <application> element in the Android Manifest XML file (AndroidManifest.xml).

(f) In contrast with a Java or C program which has a "main()" method, Android apps do not have any single point of entry.

(g) The Android OS is a multi-user system based on Microsoft Windows.

(h) The onActivityResult method runs automatically when an intent is returned in response to a call to the startActivityForResult method.

(i) The process for an app only starts when the app is launched from the launcher.

(j) Whenever you define a new Android resource (e.g., a layout or a widget), you have to manually assign it a static final int id which is stored in a file called R.java.

[1/2 mark for each correct answer]

Question 16

Suppose we have an Android app containing the following MainActivity.java file:

```java
public class MainActivity extends Activity {

    @Override
    protected void onCreate(Bundle savedInstanceState) {
        super.onCreate(savedInstanceState);
        setContentView(R.layout.activity_main);
    }

    public void buttonPressed(View view) {
        Button button = (Button)view;
        button.setText("Button pressed");
    }

    public void buttonClicked(View view) {
        Toast.makeText(getApplicationContext(),"You clicked the button!",Toast.LENGTH_LONG).show();
    }

}
```

Suppose that the app has a file called activity_main.xml with the following content:

```xml
<?xml version="1.0" encoding="utf-8"?>
<android.support.design.widget.CoordinatorLayout
    xmlns:android="http://schemas.android.com/apk/res/android"
    xmlns:app="http://schemas.android.com/apk/res-auto"
    xmlns:tools="http://schemas.android.com/tools"
    android:layout_width="match_parent"
    android:layout_height="match_parent"
    tools:context="com.example.dave.exam01.MainActivity">
    <android.support.constraint.ConstraintLayout
        android:layout_width="match_parent"
        android:layout_height="match_parent">
        <TextView
            android:layout_width="wrap_content"
            android:layout_height="wrap_content"
            android:text="Hello World!"
            app:layout_constraintBottom_toBottomOf="parent"
            app:layout_constraintLeft_toLeftOf="parent"
            app:layout_constraintRight_toRightOf="parent"
            app:layout_constraintTop_toTopOf="parent"
            tools:layout_constraintTop_creator="1"
            tools:layout_constraintRight_creator="1"
            tools:layout_constraintBottom_creator="1"
            tools:layout_constraintLeft_creator="1"
            android:id="@+id/textView" />
        <Button
            android:id="@+id/button"
            android:layout_width="wrap_content"
            android:layout_height="wrap_content"
            android:text="Button"
            tools:layout_constraintTop_creator="1"
            tools:layout_constraintRight_creator="1"
            app:layout_constraintRight_toRightOf="parent"
            android:layout_marginTop="33dp"
            app:layout_constraintTop_toBottomOf="@+id/textView"
            tools:layout_constraintLeft_creator="1"
            app:layout_constraintLeft_toLeftOf="parent"
            android:onClick="buttonPressed"/>
    </android.support.constraint.ConstraintLayout>
</android.support.design.widget.CoordinatorLayout>
```

(a) Sketch what the app looks like on the screen when it runs. [1 mark]

(b) What happens when the button is clicked? [1 mark]

(c) In which line in the MainActivity.java file is the layout of this activity inflated? [1 mark]

(d) Explain what is being done in line 10 of MainActivity.java and why this is necessary. [1 mark]

(e) Explain the purpose and effect of line 26 in activity_main.xml. [1 mark]