Two hours

UNIVERSITY OF MANCHESTER
SCHOOL OF COMPUTER SCIENCE

Software Engineering 3

Date: Wednesday 20th January 2010
Time: 14.00 – 16.00

Please answer any THREE Questions from the FIVE questions provided

The use of electronic calculators is NOT permitted
1. a) Describe, briefly, two advantages and two disadvantages of PRINCE2 as a project management methodology. (8 Marks)

b) RUP (the Rapid Unified Process) is said to be *Use-Case driven*. In the example Use-Cases below, a *Borrower* in a typical Library system is depicted. Complete the diagrams with appropriate use of <<includes>> relationship(s) and <<extends>> relationship(s) between the unconnected “Check for Reservation” and “Refuse Loan” Use-Cases, and explain briefly why the relationship chosen is appropriate.

![Diagram](image)

(c) What kinds of project are the project management organisations referred to as “Chief Programmer Team” and “Business Team” best suited to and why? (4 Marks)
2. a) Consider the declarations of the Java classes `Root`, `Derived`, `Derived2`, `Separate` and `InterType` below:-

```java
public class Root {
    public String m1() {
        return "Root.m1()";
    }
    public String m2(String s) {
        return "Root.m2(" + s + ")";
    }
}

public class Derived extends Root implements InterType {
    public String m1() {
        return "Derived.m1()";
    }
    public String m2(String s) {
        return "Derived.m2(" + s + ")";
    }
    public String m3() {
        return "Derived.m3()";
    }
}

public class Derived2 extends Derived {
    public String m2(String s) {
        return "Derived2.m2(" + s + ")";
    }
    public String m4() {
        return "Derived2.m4()";
    }
}

public class Separate implements Intertype {
    public String m1() {
        return "Separate.m1()";
    }
    public String m2(String s) {
        return "Separate.m2(" + s + ")";
    }
    public String m3() {
        return "Separate.m3()";
    }
}

interface InterType {
    String m2(String s);
    String m3();
}
```

(Question 2 continues on the following page)
Given the statements below:-

```java
Derived2 derived2 = new Derived2();
Root root = derived2;
String s;
```

Add comments to the statements below indicating what string value is assigned to the variable “s”, or, in the case of an error, the nature of the error that occurs.

```java
s = derived2.m1();
s = derived2.m2("Hello");
s = root.m1();
s = root.m2("Hello");
s = derived2.m3();
s = derived2.m4();
s = root.m3();
s = root.m4();
```

(8 Marks)

b) Construct an XML grammar suitable for representing a collection of cooking recipes given the following definitions:-

- Recipes consist of ingredients, steps for preparation, possibly some comments, and a specification of its nutritional value in calories, fat, carbohydrate and protein
- An ingredient can be simple or composite
- A simple ingredient has a name, an amount (possibly unspecified) and an metric unit (unless amount is dimensionless)
- A composite ingredient is recursively a recipe with ingredients and preparation

(8 Marks)

c) What are two advantages of using the MVC (Model, View, Controller) “design pattern”?

(4 Marks)
3. a) Given the conventional record type `person` below, and variables `manager` & `employee` of that type, construct an “equivalent” Java definition with two objects of type `person` suitably initialised.

```
TYPE person = RECORD
    surname : string;
    forename: string;
    age     : integer
END;

VAR manager, employee: person;  
```

b) The “-3G” mobile enables calls to be made if it is currently in an “active” state, i.e. it has been switched “On” (and, of course, has battery power and can detect a network transmitter). In its “active” state it can be turned off, i.e. go into a “passive” state by pressing the “Off” button. Also, in its “active” state a call can be made by entering digits via the keypad and then pressing the “Select” button to place a call. In addition, in its “active” state a call can be made by pressing the “Memory” button and scrolling through the stored telephone numbers using the arrow buttons until the desired number is shown in the display, and then pressing the “Select” button to place the call.

Write an EBNF grammar for the sequences of keystrokes made by users of the “-3G” mobile.

```
Write an EBNF grammar for the sequences of keystrokes made by users of the “-3G” mobile.  
```

(8 Marks)

c) What two advantages does the use of a parameterised type such as `LinkedList<String>` (instead of `LinkedList`) have?  

[PTO]
4. a) Given the definition of the variant type `four_types` below, explain briefly with simple examples, four ways in which the type can be “mimicked” with increasing levels of sophistication in a conventional (class-based) object-oriented programming language.

```plaintext
TYPE four_types;
    VARIANT T_is_bigger_than_U;
    VARIANT T_is_smaller_than_U;
    VARIANT T_is_equal_to_U;
    VARIANT T_is_unrelated_to_U;
END;
```

(8 Marks)

b) Given the definition of the abstract data type `triple` in the equational specification below:-

```plaintext
ADT-MODULE triple_definition;

INTERFACE

    TYPE triple;
    USES integer, Boolean;

    FUNCTION empty: triple;
    FUNCTION is_empty(t: triple): Boolean;
    FUNCTION insert(i, j, k: integer; t: triple): triple;
    FUNCTION remove(t: triple): triple;
    FUNCTION first_of(t: triple): integer;
    FUNCTION second_of(t: triple): integer;
    FUNCTION third_of(t: triple): integer;

SPECIFICATION

    VAR i, j, k: integer;
    t: triple;

    EQUATIONS

        is_empty(empty) = true;               //axiom 1
        is_empty(insert(i, j, k, t)) = false; //axiom 2
        remove(empty) = error                 //axiom 3
        remove(insert(i, j, k, t)) = empty;   //axiom 4
        first_of(empty) = error;              //axiom 5
        second_of(empty) = error;             //axiom 6
        third_of(empty) = error;              //axiom 7
        first_of(insert(i, j, k, t)) = i;     //axiom 8
        second_of(insert(i, j, k, t)) = j;    //axiom 9
        third_of(insert(i, j, k, t)) = k;     //axiom 10

END.
```

(Question 4 continues on the following page)
(Question 4 continues from the previous page)

Convert the following triple expression to reduced form:

```
insert(1,
    first_of(insert(4, 5, 6, remove(insert(7, 8, 9, empty) )
    )
    ),
    third_of(insert(6, 5, 4, remove(insert(9, 8, 7, empty) )
    )
    ),
    empty
)
```

(8 Marks)

c) In an operational context, where does the “power” of inheritance come from?

(4 Marks)
5. a) Explain, briefly, the following terms in the context of (class-based object-oriented) design patterns.

<table>
<thead>
<tr>
<th>Term</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Problem</td>
<td>1 Mark</td>
</tr>
<tr>
<td>Context</td>
<td>1 Mark</td>
</tr>
<tr>
<td>Forces</td>
<td>2 Marks</td>
</tr>
<tr>
<td>Solution</td>
<td>4 Marks</td>
</tr>
</tbody>
</table>

(8 Marks in total)

b) Draw a syntax diagram to define the structure of a Gas Bill which comprises a header, a body, and a balance, where the body comprises zero or more lines of payments made.

Convert the syntax diagram into an equivalent finite state transition diagram and reduce the resulting automaton to a minimised form without lambda transitions.

What would be the equivalent EBNF production rule for the resulting minimised, lambda free diagram, and hence also the equivalent regular expression?

Convert the regular expression to an equivalent Jackson Diagram. (8 Marks)

c) Consider the following statement:-

“The key principle of object-oriented design is that each program object should correspond to an object in the real world, that is to say, a program is a metaphor for the world.”

Do the original “Design Patterns” (of Gamma et. al.) adhere to this principle? Briefly justify your answer. (4 Marks)