UNIVERSITY OF LONDON 291 0211 ZB

EXTERNAL PROGRAMME

B. Sc. Examination 2008

COMPUTING AND INFORMATION SYSTEMS

2910211 Computer Programming Paradigms [Eastern]

Duration: 3 hours

Date and time: Thursday 8 May 2008 : 10.00 – 1.00 pm

There are TEN questions on this paper. Answer SIX questions.
Full marks will be awarded for complete answers to SIX questions.
You must answer THREE questions from section A and THREE questions from section B. You must answer at least ONE question on Prolog in Section B.
There are 150 marks on this paper.

A hand held calculator may be used when answering questions on this paper but it must not be pre-programmed or able to display graphics, text or algebraic equations. The make and type of machine must be stated clearly on the front cover of the answer book.

THIS EXAMINATION PAPER MUST NOT BE REMOVED FROM THE EXAMINATION ROOM

Section A

Question 1

(a) Write a void method `showMe` that takes a non-negative integer `n` as the argument and displays three times `n` ($3 \times$ `n`) of the symbol "#"s on the screen. [5]

(b) With the aid of the statements below as an example, explain briefly what is meant by *actual parameter*. [5]

```
private int methodOne(int x, int y) {
  return x+y;
}

...

System.out.println(methodOne(2,3));
```

(c) Write a for statement that is equivalent to the following while statement, where max is 100. [5]

```
i=0;
while (i<max){
  System.out.println(i);
  i=i+1;
}
```

(d) Define a class that includes three standard methods for a one dimensional array of integers: *get*, *put*, *display* to retrieve the content of each cell, to store a value into a cell and to display the contents of the whole array. Assume that each record contains only a decimal number and there are at most two hundred of them. [10]

Question 2

(a) Write a boolean type method `positive` which takes an array of integers as an argument and determine if all the integers in the array are non-negative (return true; otherwise return false). [5]

(b) Consider the Java program below. Write what will be displayed on the screen after the execution of the main class C. [5]

```
class A {
  void brown() {
    System.out.println("Brown");
  }
}

class B extends A {
  void brown() {
  System.out.print("Green + ");
  super.brown();
  }
}

class C {
  public static void main (String [] args) {
    A a = new A ();
    B b = new B ();
    a.brown();
    b.brown();
  }
}
```

(c) Using the classes given in (b) as an example, explain briefly the meaning of the terms *subclass, superclass,* and *overrides.* [5]

(d) Explain what an event is in Java. Provide an example of an event. [5]

(e) Write a method that takes a given Greenwich hour as the input and returns two integers as the New York time (-5) and the Sydney time (+10). [5]

Question 3

(a) Convert the application below into an applet. Describe briefly, step by step, how you would embed the applet in a simple web page. [5]

```
import javax.swing.*;

class text1 {
  public static void main(String [] xxx) {
    JTextArea myText = new JTextArea(10,20);
    myText.append("This is a test message !\n\n");
    JOptionPane.showMessageDialog(null,myText);
    System.exit(0);
  }
}
```

(b) Define a class `TreeNode` for reference-based implementation of binary trees. Each treeNode should contain *three* data fields, namely `leftChild`, `treeItem` (Object type) and `rightChild`, and the necessary operations for initialising and accessing a tree node. [10]

(Hint: Use constructors and define `getXXX` and `setXXX` for accesses.)

(c) Explain what it means if the heading of a method contains the word public. Further, indicate what it means if a method heading does not contain either the word public or the word private. [5]

(d) An error occurs when the following Java code is complied. State what the error is and the cuase of the error. [5]

```
class testSignature {
   public int method(int x, double y) {
      // method 1
   }

   public static method(int a, double b) {
      // method 2
   }

   public static void main(String[] args) {

   }
}
```

Question 4

(a) Write a method `triangle` that takes the number of lines as an input and displays a triangle of numbers. An example of a triangle of 5 lines is given below: [10]

```
        1
      2 2
    3 3 3
  4 4 4 4
5 5 5 5 5
```

(b) Two important techniques in Java programming are *abstraction* and *inheritance*. Explain briefly how these techniques can be used in programming. [5]

(c) Refer to the simple Java program below. Identify a *package, modifier, identifier, class, method, formal parameter, actual parameter* and an *array* in the program. [5]

```
import java.io.*;

public class SimpleProgram {
  public static void main (String [] args) {
    System.out.println("A simple Java Program");
  }
}
```

(d) There is a non-syntax compile error in the Java class below. Explain what the error is and correct the erroneous statement. [5]

```
class methodTest5 {

   int sum(int a, int b) {
      return a+b;
   }

   public static void main(String[] argus) {
      System.out.println("sum(2,3)=" + sum(2,3));
   }
}
```

Question 5

(a) Write a method, `isMultiple`, that takes two `long` values, n and m, and returns true if and only if n is a multiple of m, that is, $n = m \times k$ for some integer k. [5]

(b) Explain the concept of *exception* in Java using the case in question (a) as an example. [5]

(c) Explain the concept of *constructor* in Java. Identify the constructors in the class `Circle` below. Explain how each "`this`" statement works, and demonstrate with an example how each constructor might be called. [10]

```
class Circle {
  double r; // the circle radius
  Circle(){ this(0); }
  Circle(double r){ this.r=r; }
}
```

(d) Write Java instance methods to perform each of the following tasks: [5]

(i) Print out a given string `s`, where `s` is a parameter.

(ii) Inspect the value of an integer parameter `n` and return the boolean value `true` if `n` equals 1, and `false` otherwise.

Section B

Question 6

a) "At its simplest level, an SML program consists of an *expression*. In turn, these expressions consist of *operations*(or operators), *operands*, and *punctuation marks*."
Define each of the terms in italics in this quoted statement and give an example of each.

[8]

b) Amongst others, SML has the following primitive types of values: *integer*, *boolean* and *characters*. Explain the meaning of each term in italics and give an example as well as a use of each.

[6]

c) Give a step by step evaluation of:
If 1 < 3 then if 1+1=2 then 9*2 else 2+3 else 2-3;

[4]

d) What is an *exception* in SML? Using a function of two real parameters that divides the first by the second as an example, show how exceptions are raised and handled in SML.

[7]

Question 7

a) Distinguish between the SML data types ***Lists***, ***Records*** and ***Tuples*** giving an example and typical use of each.

[5]

b) Write SML expressions to extract:
i) The element in position 3 in a list, so that c is extracted from [a, b, c, ...]
ii) The second element from a tuple so that 'second' is extracted from ("first", "second", ...)

[4]

c) Explain the mechanisms allowing us to obtain parts from an SML record.

[4]

d) Using the example of a simple telephone directory, describe the mechanism SML provides for user defined data types.

[5]

e) Using your definitions from d) above outline algorithms for adding, removing and looking up items in such a directory.

[7]

Question 8

Using a procedural language of your choice, SML (as an example of a functional language) and Prolog (as an example of a logic programming language) compare and contrast these three programming styles in terms of:

a) How parameters are passed

b) The scope of variables

c) How user defined datatypes are represented

In each case a), b) and c) illustrate your answers with examples.

[25]

Question 9

Prolog

a) Describe the use of the *cut* in Prolog, giving a suitable example to illustrate your answer.

[2]

b) Consider the following Prolog rules:

```
member(X, [X|T]).
member(X, [_|T]) :- member(X, T).
```

i) Give a step by step trace of member(1, [1,2]).

ii) Give a step by step trace of member(2, [1, 2, 3]).

[5]

c) Given the predicate member in a) above:

i) What output would the code above for member give to the query member(X, [1,2,3])?

ii) What would be the response if a sequence of semicolons ';' each followed by return were typed in response to the result of i) above? Give reasons for your answers. [4]

d) Explain the difference, if any, that would be made to your answer in c) above had a cut been included before the end of the second line of member (so that the line read: member(X, [_|T]) :- member(X, T),!). Explain your reasoning.

[6]

e) Explain the use of assert and retract(and their other forms) in Prolog giving examples to illustrate your explanation. [8]

Question 10

a) Explain the meaning and use of the reserved word *is* in Prolog. [2]

b) List the operators that are used to compare numbers in Prolog. [3]

c) Write a Prolog predicate *choose(L, N, E)* which results in *E* being the element of list *L* in position N, so that choose([5, 1, 2, 3, 4, 5, 7], 4, X) results in X=3.

[4]

d) Write a Prolog predicate from_to(L, N, M, R) which given list L and two integers N and M results in R being the list from its Nth to its Mth elements. So for example from_to([a,b,c,d,e,f,g,h,i], 3, 6, L). results in L=[c,d,e,f]. For each clause in your answer give a few lines of text explaining how it works.

[16]

END OF EXAMINATION