Two Hours

UNIVERSITY OF MANCHESTER
SCHOOL OF COMPUTER SCIENCE

M.Sc. in Informatics

High Level Programming

Thursday 22\textsuperscript{nd} January 2009

Time: 09:45 – 11:45

Answer **ALL** Questions in **Sections A and B** and **one question** from **Section C**

Electronic calculators may be used, provided that they cannot store text
SECTION A

Answer ALL questions in this section

A1. What is Java bytecode? Where does bytecode come from? (1 mark)

A2. What are the eight Java primitive types? (1 mark)

A3. Explain the difference between an object and a class. (1 mark)

A4. Explain the difference between the = symbol in Java and mathematics. (1 mark)

A5. If a and b refer to different objects of class BankAccount containing methods void deposit(double amount) and double getBalance(), consider the following instructions:

\[ a.\text{deposit}(b.\text{getBalance}()); \]
\[ b.\text{deposit}(a.\text{getBalance}()); \]

Are the balances of a and b now identical? Explain. (1 mark)

A6. What is the difference between a while statement and an if statement. (1 mark)

A7. What is wrong with the following loop?

```java
double[] data = new double[10];
for (int i = 1; i <= 10; i++)
    data[i] = 2 * i;
```

Explain two ways of fixing the errors. (1 mark)

A8. Consider the following problem description:

"Employees receive their biweekly pay cheques. They are paid their hourly rates for each hour worked; however, if they worked more than 40 hours per week, they are paid overtime at 200% of the regular wage."

What classes should you use to implement it? Explain. (1 mark)

A9. How do you discover syntax errors in a program? How do you discover logic errors in a program? (1 mark)

A10. What do the following statements print?

a) System.out.println("2 + 3");

b) System.out.println(2 + "3"); (1 mark)
SECTION B

Answer ALL questions in this section

B1. Write a class ChristmasTree whose toString method produces a string depicting a Christmas tree like this:

```
  /
 / \
/   \
------
 "  "
 "  
 "  
```

(Hint: remember to use escape sequences.) (6 marks)

B2. The following class BankAccount is incomplete; some methods are not implemented. Complete the class by implementing four methods: getAccountNumber, deposit, withdraw, and getBalance based on the specification described in comments.

```java
public class BankAccount {
    private int accountNumber;
    private double balance;

    /**
     * Constructs a bank account with a zero balance
     * @param anAccountNumber the account number for this account
     */
    public BankAccount(int anAccountNumber) {
        accountNumber = anAccountNumber;
        balance = 0;
    }

    /**
     * Constructs a bank account with a given balance
     * @param anAccountNumber the account number for this account
     * @param initialBalance the initial balance
     */
    public BankAccount(int anAccountNumber, double initialBalance) {
        accountNumber = anAccountNumber;
        balance = initialBalance;
    }

    /**
     * Gets the account number of this bank account.
     * @return the account number
     */
    public int getAccountNumber() {
        fill in your code
    }
}
```
/**
 * Deposits money into the bank account.
 * @param amount the amount to deposit
 */
public void deposit(double amount)
{
    fill in your code
}

/**
 * Withdraws money from the bank account.
 * @param amount the amount to withdraw
 */
public void withdraw(double amount)
{
    fill in your code
}

/**
 * Gets the current balance of the bank account.
 * @return the current balance
 */
public double getBalance()
{
    fill in your code
}

(4 marks)

B3. A line in the two-dimensional plane can be specified in various ways:

- by giving a point \((x,y)\) and a slope \(m\)
- by giving two points \((x_1,y_1)\) and \((x_2,y_2)\)
- as an equation in slope-intercept form \(y = mx + b\)
- as an equation \(x = a\) if the line is vertical

Implement a class `Line` with four constructors, corresponding to the four cases above. (Hint: Three variables, `slope`, `intercept`, and `isVertical`, should be used to describe the properties of a line in this class.) (6 marks)
B4. What is the output from the following program? List all printed results in order.

class errHandling {
    public static void main(String args[]) {
        int numer[] = { 4, 8, 64, 128 };  
        int denom[] = { 2, 0, 0, 32 };  

        for(int i=0; i<numer.length; i++) {
            try {
                System.out.println(numer[i] + " / " + 
                    denom[i] + " is " + 
                    numer[i]/denom[i]);
            }
            catch (ArithmeticException exc) {
                // catch the exception
                System.out.println("Can't divide by Zero!");
            }
        }
    }
}
SECTION C

Answer ONE question in this section

C1. a) Given three Java methods

    static void inputGuest();
    static void saveRegister();
    static void restoreRegister();

and a method

    static char getCommand()

for prompting the user to type a character followed by RETURN and reading and returning the next character that is typed, write a Java method static void performProcessRepeatedly() which will behave as follows:

It will repeatedly read a character and
if the character is ‘i’ it will execute inputGuest()
if the character is ‘s’ it will execute saveRegister()
if the character is ‘r’ it will execute restoreRegister()
if the character is ‘e’ then the process will immediately terminate. (10 marks)

b) Answer the following questions about the method you have written in part (a)

i) How user friendly is your method when a character other than one of the four valid commands is typed? What could you do (or what have you already done) to give a helpful response in such cases? (2 marks)

ii) How would you alter your software to allow other commands (invoking other functions) and to treat uppercase characters as alternatives for lowercase commands, e.g. ‘I’ instead of ‘i’? (2 marks)

iii) What feature of Java allows us to write robust software that will not crash when incorrect input is provided? Illustrate your answer by showing how the function getCommand() might be designed. (4 marks)

iv) performProcessRepeatedly() is an example for repeatedly selecting and performing one of several optional tasks on the basis of choices made by the user, which can be viewed as a design pattern. How often do you expect such a pattern to be used in computer programs for real applications? Justify your answer. (2 marks)
C2.  

a) Explain the concept of a 1-dimensional array in Java and illustrate how such arrays are declared and how their elements are accessed. 

In Java, arrays are examples of objects and are referenced via addresses. Explain why this causes difficulty both with assignment and comparison for equality. 

What is the difference between the size (or length) of an array and the number of items which it is used to store. How can the size of an array be calculated? 

b) Given the following declarations

```java
final static int terminator = 999;
final static int MaxSize = 100;
static int[] Seq = new Seq[MaxSize];
static int n = 0;
```

and a method, which does not raise any exceptions,

```java
static int GetInt()
```

which skips input that cannot be parsed as an integer and returns the value of the next valid integer typed by the user. Write a segment of Java code to read a sequence of integers different from and terminated by terminator, and to store them in Seq[0], Seq[1], ..., Seq[n-1] respectively. The value of n, which is the number of items in the sequence, is to be calculated as part of the process of reading the sequence. Assume that the user will not type more than MaxSize integers. 

How would your Java code react to an attempt to enter more than MaxSize integers? 

How could you alter your code to avoid such reaction? What do you regard as the best way to warn the user that too much data is being entered? Justify your choice.