Cardiff University

School of Computer Science and Informatics

CMT219

Algorithms, Data Structures And Programming

2021-2022

Class Test

CARDIFF UNIVERSITY
EXAMINATION PAPER

Academic Year:	2012/2013
Examination Period:	Spring
Examination Paper Number:	CMT205
Examination Paper Title:	Object Oriented Development with Java
Duration:	2 hours

Q1.

(a). What are the values of the variables result1, result2, result3 result4, result5 after the following Java statements have been executed?

```
int inum = 11;
double dnum = 3.7;
double result1, result2;
result1 = (double) intm / 4 + dnum;
decresult2 = (double) ((1/3) * inum + (1/2) * dnum);
int result3;
result3 = (inum / 2) << 2;
String result4 = dnum + " " + inum;
StringBuffer buffer = new StringBuffer(result4);
buffer.replace(2, 5, "***");
String result5 = buffer.toString();
```

(b). Complete the following code to check if the command line contains exactly three arguments, wit each being a string representing a properly formatted 32-bit integer. Output "Pass" if the command line arguments are correct and "Fail" otherwise.

```
public class InputTest{
  public static void main (String[] args){
    // TODO: Complete the code here
  }
}
```

(c). Draw a circle in red with centre at (120,150) and a radius of 50, given a Graphics object g.

(d). Suppose that you are writing a class **`Consoleoutput`** that keeps track of information printed in the console window. There is only one console window available and only one instance of the class should be created.What design pattern will be useful in this scenario? Briefly give one approach to implement this design pattern (up to three sentences).

(e). Assume that you have a class `TestThread` that has the following code structure:

```
public class TestThread extends Thread {
  public void run() {
    // code omitted for simplicity
  }
}
```

i. Rewrite the class `TestThread` such that `TestThread` still contains the code that runs in a separate thread but also needs to be inherited from another class `GeneralTest`.

ii. Write the Java statements to create an instance of the thread for the rewritten class, and start running it.

Q2.

(a). What is the Model-View-Controller (MVC)paradigm and why is it important to Graphical User Interface (GUD)Design?Briefly describe the function of each of the MVC units.

(b). How do the MVC Architectures in Classic GUI Design and Java Swing differ? What is the reason for the difference?

(c). What are the main features of Java Swing Components?What is meant by the term lightweight components in relation to Swing?

(d). For most applications the default Look-and-Feel libraries provided by Swing are adequate. However, there may be some occasions when a customised Look-and-Feel is more appropriate.
How is customised rendering of the look and feel of Swing Components facilitated by the MVC architecture?
Give two such situations with reasons why a customised Look-and-Feel should be adopted. Describe how you would achieve this with fragments of JAVA Swing code.

(e). What are actions in relation to Java Swing Components?Give an example application where actions might typically be used.

Q3.

(a). Suppose we wish to store employee records in a structured binary random access file such that a record can be updated (or added/deleted):

i. Suggest an advantage of using a random access file for this purpose. Whatare the disadvantages of using this type of file?

ii. Assume a record includes the following fields (name and type)

employeeID: int (the ID of the employee)

name: String (the full name, with up to 50 characters)

salary: double (the salary)

What is the space (number of bytes) each field takes on the disk?

(b). Given a text file 'document.txt', complete the following Java method to count how many times each character of interest appears in the text file. The method takes one argument of type String which contains characters of interest (in the order as they appear in the String). If there are *n* characters of interest, the output to the console should involve *n* lines, with each line of the form

`<character>: <count>`
where `<character>` and `<count>` are replaced with the actual character/number. Your code should only read the text file once and the text file/user input may contain general Unicode characters. You need to handle exceptions properly.
The following skeleton code is provided and only the code to complete the program needs to be provided.

```
import java.io.*;
public class CharCount {
  public static void CountPrint(String charList) {
    // TODO: Complete the code
  }
}
```

Q4.

Write a Java program TotalServer which listens to incoming connections at the port 12345. For simplicity only one connection needs to be dealt with at a time.Every time a new connection is made, the running total is set to 0.
While the connection keeps alive, the client sends a line at a time, containing one or more integers (separated by blank space(s)). The server's job is to calculate two numbers: the first is the sum of all the numbers in the current line, and the second is the sum of all the numbers since connected.The server sends back aline containing these two numbers separated by a blank space every time a line is received from the client.
You may assume that the content received from the client is always in the correct format but communication exceptions need to be handled properly.

Example:

Received:

2 5

6 -3 2

Send Back:

7 7

5 12

The following skeleton program is provided and only the code to complete the program needs to be provided.

```
import java.net.*;
import java.io.*;
import java.util.*;
public class TotalServer {
  public static void main() {
    // Create a Server Socket object
    ServerSocket sSock = null;
    try {
      sSocket = new ServerSocket(12345)
    } cache (IOExpection e){
      System.err.println(e);
      System.exit(1);
    }
    // TODO: Complete the program
  }
}
```

CARDIFF UNIVERSITY
EXAMINATION PAPER

Academic Year:	2013/2014
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Examination Paper Title:	Object Oriented Development with Java
Duration:	2 hours

Q1.

(a). What are the values of the variables res1, res2, res3, res4 and res5 after the following Java statements have been executed?

```
int inum = 23;
double dnum = 5.4;
double res1 = (double) inum / 5 + inum / 4;
double res2 = (double) (inum / 3 + dnum * (1/3));
int res3 = (int)dnum << 2;
String res4 = inum + "+" + dnum;
StringBuffer buffer = new StringBuffer(res4);
buffer.insert(1, "-");
String res5 = buffer.toString();
```

(b). Write Java statements for the following tasks:

i. Fill a square of size 10 x 10 pixels in blue with the top left corner at coordinates (100,120), given a Graphics object *g*.

ii. Define and initialise an array *num* with 100 random double numbers between 0.0 (inclusive) and 1.0 (exclusive).

iii. Given a class named *TaskThread* which implements the *Runnable* interface and *two* instances of this class *t1* and t2, create and start *two* threads each running one of these instances simultaneously, and wait until both threads finish.

(c). Write Java statements to get an integer from keyboard input and store the result in an *int* variable *ival*. If the user input is not an integer, allow the user to try until a proper integer is entered.You **do not need** to print prompt messages. You may assume that *IOException* will be handled elsewhere.

(d). To allow some arbitrary operation to be applied to all the elements in a collection, what design pattern would be suitable?Briefly explain the basic idea of how to implement this design pattern in Java (no more than three sentences).

Q2.

(a). Describe how you may create a Combo box that gives a selection of countries. E.g Wales,Scotland,England,Ireland,France and Germany.How may you add and delete countries from this list?

(b). An application is required to filter out all references to web sites that end with the extension *inappropriate.com*. Having detected a suitably inappropriate web site it should inform the user with a suitable prompt.
Show, with the aid of suitable diagrams and code fragments only, how you would achieve this with the appropriate Java Swing Components.Your solution should only focus on the mechanisms that achieve the filtering and informing operations
--- You **do not need** to develop a complete GUI.

Q3.

(a). Suppose we wish to store student records in a structured binary file.Each record contains the following fields (field name and type):

Number: int **(the student number, starting from 1)**
Name: String **(the full name, with up to 30 characters)**
Marks: double **(the student marks)**

Assume that the student number is more or less allocated sequentially.There are100 students currently enrolled and the maximum student number is 120. The student name on average takes 15 bytes when represented in UTF-8 (including the bytes corresponding to the string length).

i. How many bytes will be needed to store all the records using a sequential access file and a random access file, respectively?

ii. If records need to be updated frequently, which one will be more suitable: a sequential access file or a random access file? Why?

(b). Complete the following Java program *Count* that reads in a text file and count show many alphabetic letters and words appear in the text file. For simplicity, a word is defined as a maximum consecutive sequence of alphabetic letters (separated by any non-alphabetic characters). For example, *That's good*. is considered to have three words (*That*, *s* and *good*). The program takes a single command line argument that specifies the filename of the text file to be processed. You should handle exceptions properly. You can assume that relevant Java standard library classes have already been imported.

The following code is provided and only the missing code needs to be completed:

```
import java.io.*;
public class Count {
  public static void main(String[] args) {
    int countLetters = 0;
    int countWords = 0;
    // check if one command line argument is provided
    if (args.length != 1) {
      System.out.println("One command line argument needed!");
      System.exit(-1);
    }
    // TODO: complete the code here
    // ...

    // Print the numbers of letters and words in the text file
    System.out.println("Total letters  = " + countLetters);
      System.out.println("Total words  = " + countWords);
  }
}
```

Q4.

Complete the following Java program Encserver that implements a UDP server which accepts UDP packets at port 6000. Each packet received is a string containing a text message to be encrypted. For each received packet, the server sends back a packet containing a string corresponding to the encrypted message using the following rule: **replace each lower case letter with the next letter cyclically**, i.e. 'a' becomes 'b', 'b' becomes 'c', ... and 'z' becomes 'a'. Punctuation, any unexpected uppercase letters, and any other non-alphabetic characters should be left unchanged. You can assume that the incoming packets are in the right format but exceptions need to be handled properly. You can assume that relevant Java standard library classes have already been imported.

The following code is provided and only the missing code needs to be completed:

```
import java.io.*;
import java.net.*;
public class EncServer {
  public static void main(String[] args) {
    // TODO: complete the code here
  }
}
```

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EXAMINATION PAPER

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Q1.

(a). What are the values of the variables result1, result2, result 3, result4 and result 5 after the following Java statements have been executed?

```
int inum = 19;
double dnum = 2.6;
double result1 = (double)inum /5 dnum;
double result2 = (double) (inum % 3 (1/2)*dnum);
String result3 = inum + "+" + dnum;
StringBuffer buffer = new StringBuffer(result3)
buffer.insert(2, “abc");
String result4 = buffer.toString();
buffer.replace(1, 4, "to");
String result5 = buffer.toString();
```

Write Java code fragments for the following tasks:

i. Draw a filled disc in **blue** with centre at (60,80) and a radius of 40, given a Graphics object g.

ii. Define a hash map *StuMarks* that maps student names to their marks, assuming each student name is represented as a *String* and each mark as an *int*. Add an entry to the map to indicate Bill has got 60 marks.

iii. Given a *double* array *num*, print the minimum number in the array.

(c). Assuming a remote server implements the following interface

```
import java.rmi.*;
public interface DosyCalc extends Remote {
  public double CityDist(String city1, String city2) throws
RemoteException;
}
```

which calculates the distance in miles between two cities (with city1 and city2 being the name of two cities). The RMI service is registered with a URL of rmi://rmi.cs.cf.ac.uk/dist Complete the following code to print the distance between Cardiff and London using RMI.

```
import java.rmi.*;
public class DistClient {
  // main method
  public static void main(String[] args){
    // TODO: complete your code here
  }
}
```

(d). Assume you are developing a Java program for a water supply company. The program involves a class named Account that represents a generic user account, a class named FlatRateAccount that represents a user paying a flat rate (independent of their usage) and a class named MeteredAccount that represents a user whose charge is based on the amount of water they use.

i. When you define these classes, what are the relationships between them(if any)?

ii. Define a method *CalcBill* to work out the bill for each user, for all the user accounts.Briefly explain how you defined this method and how you would implement it in these classes.

Q2.

(a). Describe, using suitable fragments of Java code, how you would create a JTable with the following elements:

First Name | Last Name | Student Number | Year of Study | Date of Birth

Clearly state which are the data types of each element.
Illustrate how you populate the table by adding two rows to your table.

(b). For the table given above, show (with suitable fragments of Java code)how you implement a method to sort a selected column of the table.You should be able to order the data numerically or lexically according to the data type.
Your solution should only detail how you control a *JTable* to get user selection and display of data once sorted. You may assume that a data sorting method exists for any data type in your JTable's columns: You do not need to create a sorting algorithm.

Q3.

(a). Suppose we wish to store book records for a library in a structured binary file. A record includes the following fields(name and type):

bookID: int (the ID of the book)

title: String (the title of the book, up to 60 characters)

publisher: String (the publisher of the book, up to 30 characters)

price: double (the price of the book)

We further assume that bookID is allocated sequentially, starting from 1. However some books may later be withdrawn from the library. At the moment, there are 2000 books in the library and the maximum bookID is 3000. The fields title and publisher when represented in UTF-8 take on average 30 and 10bytes respectively.

i. If a sequential access file is used, work out the space (number of bytes) each record takes on average, and the total number of bytes needed.

ii. If a random access file is used, work out the space (number of bytes) each record takes, and the total number of bytes needed.

iii. Assuming we now need to backup all the book records to some cloud storage(for later recovery if needed), which type is more suitable, sequential or random access file? Justify your answer.

(b). Write a Java program that takes a text file as input and produces a new text file containing the content from the input text file but with characters in each line in a reversed order.For example, if the input text file contains

abc 123

The output ext file should contain

cba 312

Your program takes two command line arguments, giving the input and output filenames respectively.The text file may contain general Unicode characters. You can assume all the necessary classes from the Java standard library are imported.
The following skeleton code is provided and only the code to complete the pro-gram needs to be provided.

```
import java.io.*
public class TextReverse {
  public static void main(String[] args) {
    if (args.length != 2){
      System.err.println ("Two arguments expected.");
      System.exit (-1);
    }
    // TODO: Complete the code
  }
}
```

Q4.

(a). Write a Java program TransServer that receives information of transactions, each containing the unit price and the number of units purchased, and sends back the running total (the total amount based on the transactions received).Your pro-gram should listen to incoming TCP connections at the port 8000.For simplicity only one connection needs to be dealt with at a time.Every time a new connection is made, the running total is set to 0.While the connection keeps alive, the client sends a line at a time, containing two double numbers, separated by blank space(s).The first number gives the unit price and the second number gives the number of units purchased.The server should send back a line containing a single number, corresponding to the running total based on the transactions received so far.
You may assume that the content received from the client is always in the correct format but communication exceptions need to be handled properly.You can assume all the necessary classes from the Java standard library are imported.

Example:

Received:

3.0 2 5.2 1.5

Send Back:

6.0 13.8

Here, 6.0 = 3.0×2, and 13.8 = 3.0×2+5.2×1.5.
The following skeleton program is provided and only the code to complete the program needs to be provided.

```
import java.net.*;
import java.io.*;
import java.util.*;
public class TransServer {
  public static void main() {
    // Create a Server Socket object
    ServerSocket sSock = null;
    try {
      sSock = new ServerSocket(8000);
    } catch(IOException e) {
      System.err.orintln(e);
      System.exit(1);
    }
    // TODO: Complete the program
  }
}
```

(b). What changes will be needed so that the server can handle multiple connections at the same time?Briefly describe your approach.You don't need to write the Java program but you need to cover all the major implementation ideas.

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EXAMINATION PAPER

Academic Year:	2015/2016
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Duration:	2 hours

Q1.

(a). What are the values of the variables res1, res2, res3 and res4 after the following Java statements have been executed?

```
int i = 23;
double d = 3.2;
double res1 = Math.round((double)i / 5) + d;
double res2 = (double) (d * (1/3) + i);
StringBuffer buffer = new StringBuffer("Hello" + i);
String res3 = buffer.toString();
buffer.append("#");
buffer.reverse();
String res4 = buffer.toString();
```

(b). Write Java code fragments for the following tasks:

i. Given a String str, create a new String with variable name num only that keeps all the digits ('0','1',...'9')only and in the order they appear in str.

ii. Create an integer array nums that contains 10 random numbers in the range of 1000 to 9999 (both inclusive).

(c). Assume you are developing a Java program that manages electronic records for book borrowing from the University library.The program involves a class named User that represents a generic user account, a class named Student that represents a student user, and a class named Staff that represents a member of staff user.

i. When you define these classes, what are the relationships between them?

ii. Define a method getEntitlement to provide a consistent way of finding out the borrowing entitlement for an individual user, assuming the entitlement for Student users are 12 and Staff users are 20.Thus for a general User no well defined answer can be given.Briefly explain how you would define this method and how you would implement it in these classes.
You should follow object-oriented development principles and justify your choices.

(d). Assume you are developing a Java program that manages bank accounts for users.It involves a class BankAccount which currently involves methods setName to set the account name, setDoB to set the date of birth of the user, and deposit and withdraw methods to deposit to and withdraw from the account.

i. To help monitor account activities, before executing any method of the BankAccount class starting with set (such as setName)as well as the deposit and withdraw methods, the monitoring code should be executed.To provide such monitoring code in a centralised place, what technique is useful?Briefly explain major benefits of this technique.

ii. Write simple code snippets to demonstrate how the technique can be used to allow the monitoring code in the centralised place to be run as desired. You don't need to provide the actual implementation for the monitoring code.

Q2.

(a). JavaFX 不考

Q3.

(a). Suppose we wish to store student records in a structured binary file.A record includes the following fields (name and type):

studentID: int (the ID of the student)
name: String (the name of the student, up to 30 characters)
address: String (the address of the student, up to 100 characters)
avgMark: double (the average mark for the student in the current academic year)

We further assume that student ID is allocated sequentially when they first enrolled, starting from 10,000, and the maximum student ID currently allocated is 12,000.

i. Assuming we need to dynamically update some student records with the remaining records unchanged, which type is more suitable, sequential or random access file? Justify your answer.

ii. Work out the space(number of bytes)each record takes for a random access file.

iii. To a void wasting space unnecessarily, how do you decide where to store each record?Write the line of code that is responsible for locating where to read/write a record with a given student ID, assuming file is the datafile object.

(b). Write a Java program Line counter that finds all the text files in the current directory (referred to as“.”,not including any subdirectories))with“.txt”extension. For each file found, print the filename, followed by the number of lines in the text file. For example, assuming the current directory contains abc.txt with 20 lines of text, and def.txt with 50 lines of text, the program should print:

abc.txt 20 def.txt 50
You can assume all the necessary classes from the Java standard library are imported. The following skeleton code is provided and only the code to complete the program needs to be provided.

```
import java.io.*;
public class LineCounter {
  public static void main(String[] args){
    //  TODO: Complete the code
  }
}
```

Q4.

(a). Write a Java program **AddServer** which implements a TCP server that sends a question of adding two random single digit numbers to the client, waits to receive a line from the client containing the number, and the server then sends back a message indicating if the answer is correct.Your program should listen to incoming TCP connections at the port 6000.For simplicity only one connection needs to be dealt with at a time.Every time a new connection is made, the program sends a line to the client in the format of a+b where a and b are single digit numbers (0,1,2,...9).The server then waits for the client to send back aline containing a single integer number.If this number gives the correct answer for a+b, the server sends back“Correct'”,otherwise it sends back“Incorrect'”,

Once this is completed, the server will close the TCP connection.

You may assume that the content received from the client is always in the cor-rect format but communication exceptions need to be handled properly.You can assume all the necessary classes from the Java standard library are imported.

Example:

Send | Receive | SendBack

3+8 | 11 | Correct

The following skeleton program is provided and only the code to complete theprogram needs to be provided.

```
import java.net.*;
import java.io.*;
import java.util.*;
public class AddServer {
  public static void main() {
    // Create a Server Socket Object
    ServerSocket sSocket = null;
    try {
      sSocket = new ServerSocket(6000);
    }catch (IOExpection e){
      System.err.println(e);
      System.exit(1);
    }
    // TODO: Complete the program
  }
}
```

(b). Using code snippets if necessary, describe all the changes to the code above to use multi-threading so that the server can handle multiple connections at the same time. You can refer to the code you have given in the previous answer and don’t need to repeat it.

CARDIFF UNIVERSITY
EXAMINATION PAPER

Academic Year:	2016/2017
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Duration:	2 hours

Q1.

(a). What are the values of the variables res1, res2, res3 and res4 after the following sequence of Java statements has been executed?

```
int inum = -4;
double dnum = 9.75;
double res1 = (int)dnum / inum;
double res2 = inum > 0 ? dnum :-dnum;
String res3 = inum + dnum + "abc";
StringBuffer buffer = new StringBuffer(res3);
buffer.replace(1, 4, "=");
String res4 = buffer.toString();
```

(b). Write Java statements for the following tasks:

i. Given a String str, create a new String with variable name letterOnly that keeps all the letters only and in the order they appear in str.
ii. Generate a double array numbers and initialise it with 100 random float-ing point numbers in the range of 5 to 10.
iii. Assuming MyTask is a class that implements the Runnable interface(but not a subclass of Thread),create an instance of this class using the default constructor and start running the code in a separate thread with the highest priority.

(c). Assume you are developing a Java server program and you are writing a class NetworkMonitor that monitors all the network communication in your application. As only one instance of the class NetworkMonitor should be created, what design pattern will be useful in this scenario?Briefly give one approach to implement this design pattern (no more than three sentences).

(d). Assume that a remote server implements the following interface

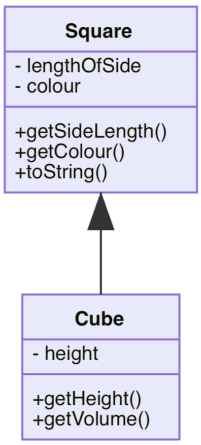
```
import java.rmi.*;
public interface CurrencyEx extends Remote {
  public double exchangeRate(String from, String to) throws RemoteException;
}
```

which returns the real-time exchange rate for the amount of the to currency equivalent to 1 unit of the from currency, where from and to are the currency code (USD for US dollars and GBP for British pounds).The RMI service is registered with a URL of rmi://rmi.cs.cf.ac.uk/curreny.
Complete the following code to print the amount of US dollars equivalent to 100British pounds using RMI.

```
import java.rmi.*
public class CurrencyClient{
  // main method
  public static void main(String[args ){
    // TODO: Complete your code here
   }
}
```

Q2.

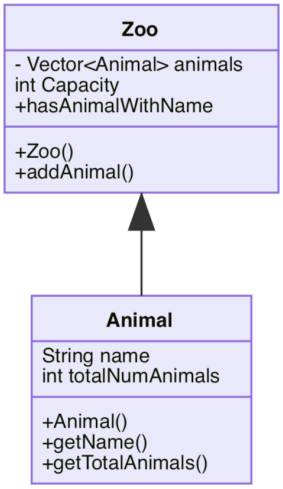
(a). Consider the following class diagram:



For each of the following concepts, explain how they work and using the classes Cube and Square(as defined in the class diagram above), provide a specific code example to demonstrate them:

- Substitutability
- Upcasting
- Downcasting

(b). The following class diagram represents the relationship between two classes: Zoo and Animal, through composition (i.e.the Zoo class is composed of the class Animal):



Given that composition exhibits a”has-a"relationship, we can say:

- A zoo is composed of one to many animals;
- OR,a zoo has one to many animals.

Detail how the Zoo and Animal classes could be redesigned to take advantage of object oriented features in Java, such as inheritance and polymorphism. The focus of your design should be to promote code reuse and to separate the interface/implementation to allow programmers that use your classes, to program at the implementation level.

NOTE: You are NOT required to provide an implementation, only a design. This can be in any form you deem appropriate (such as using a UML class diagram ora written commentary).

Q3.

Write a Java program Sum that reads a general text file containing integer numbers along with other general characters (e.g.letters).The user should provide only one command line argument, which specifies the text file name.Your program should find all the integer numbers in the text file, print these numbers (one number per line)and finally print the sum of all these numbers.An integer number is defined as a consecutive sequence of digits, separated by any non-digit character.You can assume that all the integer numbers in the text file and their sum can be represented using32-bit integers. Your program should include appropriate error handling.You can assume all the necessary classes from the Java standard library are imported.
The following skeleton program is provided and only the code to complete the program needs to be provided.

```
import java.io.*;
public class Sum {
  public static void main(String[] args) {
    if (args.length != 1){
      System.err.println("One argument expected!");
      System.exit(1);
    }
    // TODO: Complete the program
  }
}
```

Q4.

Complete the following Java program **LoginServer** which listens to incoming UDP packets at port 7000.Each packet contains a string containing a user name and a password, separated by whitespace.Every time a packet is received, the server pro-gram LoginServer sends back a packet containing a String containing either 'Successful' or 'Unsuccessful' depending on whether the username/password pair received matches one of the existing records.You can assume that the user account records are preloaded (code omitted for simplicity)into two String arrays (of the same length)users and pwds for usernames and passwords respectively.You should implement your server as efficiently as possible.
You may assume that the content received from the client is always in the correct format but communication exceptions need to be handled properly.
You can assume that relevant Java standard library classes have already been imported.
The following code is provided and only the missing code needs to be completed:

```
import java.io.*;
import java.net.*;
import java.util.*;
public class LoginServer {
  public static void main(String[] args) {
    // Code for loading users and pwds are omitted here.

    // TODO: Complete your code here
  }
}
```

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EXAMINATION PAPER

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Duration:	2 hours

Q1.

(a). What are the values of the variables res1, res2, res3 and res4 after the following sequence of Java statements has been executed?

```
int i = 31;
double d = 2.7;
double res1 = d * (5/2) + 1;
double res2 = i%2 == 0 ? d : -d;
StringBuffer buffer = new StringBuffer("Test123");
buffer.replace(3, 5, "#");
String res3 = buffer.toString();
buffer.reverse();
buffer.insert(4, "+");
String res4 = buffer.toString();
```

(b). Write Java statements for the following tasks:

i.Given a double array nums, print the largest number and the position of this number in the array.The position starts from 0 and when multiple entries in the array have the largest number, the position of the first entry should be printed.

ii.Given a class named MyTask that is a subclass of Thread and has a constructor that takes an integer (task ID)as input,Start 10 threads with the highest priority each running an instance of MyTask with task ID consecutively assigned from I to 10.Wait until all tasks complete.

(c). Assume that you are writing a class EventLogger which records events in your program in a single log file.What design pattern will be useful in this scenario? Briefly describe one approach to implement this design pattern (up to three sentences).

(d). Assume that a remote server implements the following interface

```
import java.rmi.*;
public interface CityMap extends Remote {
  public double getDist(String city1,String city2) throws RemoteException;
}
```

which retrieves the travel distance from one city to another specified by the parameters city1 and city2 respectively.The RMI service is registered with aURL of rmi://rmi.cs.cf.ac.uk/citymap
Complete the following code to print the total travel distance from Cardiff to London with a stopover at Newport using RMI.

```
import java.rmi.*;
public class TravelDistClient {
  // main method
  public static void main(String[] args){
    // TODO: Complete your code here
  }
}
```

Q2.

i.Briefly describe the Java Collections Framework and name TWO interfaces that are provided through this Framework.

ii.Describe the classes that Java provides to allow primitive types to be stored in collections.Include a code example to show how a float primitive type can be stored in an ArrayList.

iii.Code that uses generics has many benefits over non-generic code. Outline the concept of generics in Java and provide TWO advantages they offer.

(b). The following code defines an interface in Java called Pet:

```
interface Pet {
  public String eat();
  public String talk();
  public String toString();
}
```

Provide the code for a class called Dog that implements the interface Pet. Show how your class Dog could be re-designed to allow the creation of sub-classes to represent specific dog types (e.g.Boxer,Poodle).The main aim of your design should be to reduce code duplication across the sub-classes.

Q3.

Write a Java program Find that reads a text file, containing a list of different actors names (one on each line)and prints out all lines in that file, each on a separate line, that match a particular keyword provided by the user.Matching should be case insensitive. The user should provide TWO command line arguments, the FIRST, which specifies the text file name containing the list of actors names and the SECOND, which specifies the keyword to be searched. Finally, the number of lines that match the keyword should be printed, or if no matches exist, an appropriate message is printed.
Your program should include appropriate error handling.You can assume all the necessary classes from the Java standard library are imported.The following skeleton program is provided

```
import java.io.*;
public class Find {
  public static void main(String[] args) {
    if (args.length != 2) {
      System.err.println("One argument expected!");
      System.exit(1);
    }

    // TODO: Complete the program
  }
}
```

Q4.

Complete the following Java program CalcServer which implements a TCP server listening to incoming connections at the port 6000. For simplicity only one connection needs to be dealt with at a time.Every time a new connection is made, the current value is set to 0.0 (a double number).While the connection keeps alive, the client sends a line at a time, containing a calculation operation in the following format:

operator operand

The operation (and associated operand)is then applied to the current value and the current value is set to the new result.The operator can be one of the following:+ (addition),-(subtraction),*(multiplication)and /(division).The operand is a double number. For instance, if the current value is 3.0, and the received line is
*2.3
this means 3.0 x 2.3 (where 3.0 is the current value)is to be calculated and the current value is updated to the result (6.9 in this case).The server sends back a line containing the updated current value every time a line is received from the client.When division by zero is attempted, instead of sending back the updated current value, the message "Error" should be returned for this and all subsequent calculation operations.
You may assume that the content received from the client is always in the correct format but communication exceptions need to be handled properly.
You can assume that relevant Java standard library classes have already been imported.
The following code is provided and only the missing code needs to be completed:

```
import java.io.*;
import java.net.*;
import java.util.*;
public class CalcServer {
  public static void main(String[] args){
    // TODO: Complete the code here
  }
}
```

CARDIFF UNIVERSITY
EXAMINATION PAPER

Academic Year:	2018/2019
Examination Period:	Spring
Examination Paper Number:	CM2307
Examination Paper Title:	Object Orientation, Algorithms and Data Structures
Duration:	2 hours

Do not turn this page over until instructed to do so by the Senior Invigilator.

Structure of Examination Paper:

There are 5 pages.
This examination paper is divided into 2 sections.
There are 4 questions in total.
There are no appendices.
The maximum mark for the exam paper is 60, and the mark obtainable for a question or part of a question is shown in brackets alongside the question.

Students to be provided with:

The following items of stationery are to be provided:
TWO answer books.

Instructions to Students:

Answer 3 questions.
Answer at least 1 question from Section A and at least 1 question from Section B.
Questions from each Section should be answered in a different answer book.

The use of calculators is permitted in this examination. Please note that calculators that have been pre-programmed and calculators with an alphabetic keyboard are NOT allowed in any examination.

Important note: if you answer more than the number of questions instructed, then answers will be marked in the order they appear only until the above instruction is met. Extra answers will be ignored. Clearly cancel any answers not intended for marking. Write clearly on the front of the answer book the question number of the answers to be marked.

The use of translation dictionaries between English or Welsh and a foreign language bearing an appropriate school stamp is permitted in this examination.

SECTION A

Q1. (a) Suppose we have an array of integers where each integer occupies 2 bytes in memory. If the memory address of the 11th element is 0220, what is the memory address of the 15th element? Briefly explain your reasoning. [2]

(b) Suppose we apply the following operations to a **double-ended queue**:

addFirst(10)
addLast(12)
addFirst(8)
addLast(5)
removeFirst()
removeLast()

Afterwards, it contains the following elements (from front to back):

10, 12, 8, 5, 10, 12.

What are the elements inside the double-ended queue before the above sequence of operations? [2]

(c) (i) Given the following (unordered) values: 17, 8, 6, 10, 15, 20, show **two** possible **binary search trees** that can be constructed to contain all the values. [4]

(ii) Construct from the same values **two** possible **binary trees** that are **not** valid binary search trees. [4]

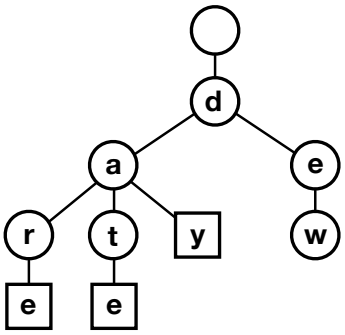
(iii) For a binary search tree with n nodes, what is the worst-case time complexity of searching for an item? Briefly explain your reasoning. [2]

(d) Given an initially empty AVL tree, we insert the following nodes sequentially:

3, 7, 4, 2, 8, 11.

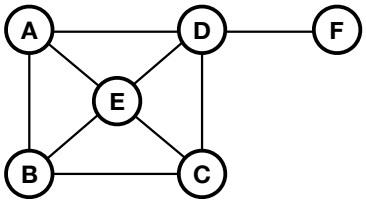
Draw the AVL tree after the insertion of **each** element. [6]

Q2. (a) The following **standard trie** is constructed from a set of strings:



Assuming that no string in the set is a prefix of another string, what are the strings in the set? [4]

(b) Suppose we traverse the following **undirected** graph **starting from vertex A**.

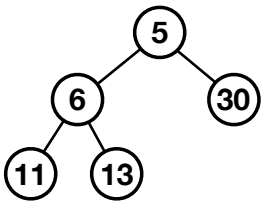


Is each of the following statements true of false? Briefly explain your reasoning:

(i) Depth-first search (DFS) **must** visit vertex D before vertex F. [3]

(ii) Breadth-first search (BFS) **may** visit vertex C before vertex D. [3]

(c) Suppose we are given the following **heap**:



We apply the following operations sequentially to the heap:
insert(20)
insert(12)
remove(5)
Draw the heap after **each** operation. [6]

(d) Suppose we are given the following Java code to compute a function F for a **positive** integer n:

```
int F (int n) {
   if (n==1) { return 1; }
   else { return 2 * F(n/2); }
}
```

What is the maximum depth of call stack during the call of function `F(n)`? Give your answer using big-O notation in terms of n, and briefly explain your reasoning. [4]

SECTION B

Q3. (a) Explain the meaning of the following two terms, in the context of software design:

(i) Cohesion [2]

(ii) Coupling [2]

Why is it generally desirable to maximise cohesion and minimise coupling? [2]

(b) List and explain **five** methods of Swing Worker in Threads. [5]

(c) Which of the following are **not** shared between threads executing in the context of a multithreaded Java code: file handles, stack, heap, program counter, local variables? [3]

(d) Give **three** reasons why **modelling** is an important aspect of software construction [6]

Q4. (a) Explain what is meant by an **atomic operation** in multi-threaded programming. [5]

(b) A method of a Java class contains a block of code that must be executed atomically. Explain, using appropriate pseudocode, how you would ensure that this block of code is executed atomically. [5]

(c) Consider the following code:

```
public class MemVisTest extends Thread {
   int answer = 0;

   public static void main(String[] args)
                        throws InterruptedException {
      MemVisTest t = new MemVisTest();
      t.start();
      Thread.sleep(1000);
      t.answer = 42;
      System.out.println("Answer is now 42");
   }


   public void run() {
      while (answer == 0)
      {}
      System.out.println("End of program reached");
   }
}
```

(i) Based on your understanding of Threads, how and why might this code fail? [5]

(ii) Explain what is meant by a **volatile** variable in Java, and why declaring `answer` as volatile would solve the problem identified in part (c)(i) of this question. [5]