UNIVERSITY OF LONDON

GOLDSMITHS COLLEGE

Department of Computing

B. Sc. Examination 2014

IS51021B
Problem Solving for Computer Science

Duration: 2 hours 15 minutes

Date and time:

There are five questions in this paper. You should answer no more than THREE questions. Full marks will be awarded for complete answers to a total of THREE questions. Each question carries 25 marks. The marks for each part of a question are indicated at the end of the part in [.] _brackets._

There are 75 marks available on this paper.

**THIS PAPER MUST NOT BE REMOVED
FROM THE EXAMINATION ROOM**

Question 1

(a) Consider the following method:

```
 String replace(int n)
{
          if (n==0) return "o";
          if (n==1) return "X";
          return "-";
}
```

   i. What is the value of `replace(0)`?
  ii. What is the value of `replace(1)`?
 iii. What is the value of `replace(3)`?
  iv. What is wrong with the following expression: `replace("1")`?

[9]

(b) What is the output of the following program?:

```java
public class oxo3
{
    private int M;
    private  int [][] board;

    String replace(int n)
    {
            if (n==0) return "O";
            if (n==1) return "X";
            return "-";
    }

    void  grid()
    {
     for (int i=0;i<M;i++)
     {
       for (int j=0;j<M;j++) System.out.print(replace(board[i][j]));
       System.out.println();
      }
     }

     public oxo3(int k)
     {
      M=k;
      board = new int[M][M];
      for (int i=0;i<M;i++)
        for (int j=0;j<M;j++)board[i][j]=2;
      }

     public static void main(String[] args)
     {
      new oxo3(5).grid();
      }
}
```

[8]

(c) Write a method whose heading is `boolean allTheSame (string [] a)` which returns true if all the elements of array a are the same and equal to the string "x", and false otherwise. [8]

Question 2

(a) i. What is `"hello".length()`?

    ii. What is `"hello".charAt(1)`?

    iii. What is `"hello".charAt(1)+'z'`?

    iv. What is `"hello".substring(1,5)`?

                        [9]

(b) Consider the following method:

```
static String compare(String sofar, String orig, char g)
{
    String result="";
    for (int i=0;i<orig.length();i++)
    if (orig.charAt(i)==g) result=result+g;
    else result=result+sofar.charAt(i);
    return result;
}
```

  i. What is the output of `compare("******","cactus",'c')`?

  ii. What is the output of `compare("******","cactus",'d')`?

                        [8]

(c) Write a method whose heading is `static boolean isEqual(String s1,String s2)`
    Which returns true if `s1` and `s2` are equal and false otherwise. You are not allowed
    to use any String methods apart from charAt() and length().   [8]

Question 3

(a) Consider the following class:

```java
import java.util.*;
public class sets
{

    public static HashSet union (HashSet x, HashSet y)
    {
      HashSet t = new HashSet(x);
      t.addAll(y);
      return t;
    }

    public static HashSet intersection (HashSet x, HashSet y)
    {
      HashSet t = new HashSet(x);
      t.retainAll(y);
      return t;
    }

    public static HashSet minus (HashSet x, HashSet y)
    {
      HashSet t = new HashSet();
      for (Object o:x)
      if (!y.contains(o)) t.add(o);
      return t;
    }
}
```

What is the output of the following:

```java
HashSet k= new Hashset();
HashSet m= new Hashset();
k.add(1);
k.add(2);
m.aadd(2);
m.add(3);

System.out.println(union(k,m));
System.out.println(intersection(k,m));
System.out.println(minus(k,m));
```

[9]

(b) The symmetric difference of sets A and B are all the elements of A which are not in B together with all the elements of B which are not in A. Define this in Java using the methods above. [8]

(c) What is the difference between a list and a set? Write a method which takes a list and returns the set of all its elements. [8]

Question 4

(a) i. Explain when you would use lists to store data instead of an an array.

    ii. The following code has a bug in it. Explain what causes this error and what kind of java exception will be thrown?

```
int[][] arr = new int[40][3];
   for (int i = 0; i <= arr.length; i++)
   {
     for (int j = 0; j < arr[i].length; j++)
     {
       arr[j][i] = i*j;
     }
   }
```

                                                                              [9]

(b) Below is an incomplete method for checking whether array a contains the integer x.

```
boolean find (int [] a, int x)
{
    int i=0;
    boolean found=false;
    while (...)
    {
       found = x==a[i];
       i++;
    }
    return found;
}
```

    i. Replace the ... with a correct boolean expression which enables the method to perform this check correctly.

    ii. If the array had 1000 elements what is the maximum number of comparisons it would take to find x in a.

                                                                              [8]

(c) Assume the array a is sorted, how can we improve the efficiency of the above so it only requires about 10 comparisons to find x in a. Write a method for doing this.   [8]

Question 5

(a) What is the output of the following Java program?:

```
HashMap <String, Integer> m = new HashMap <String, Integer>();
m.put("apple",1);
m.put("orange",1);
m.put("apple",2);
System.out.println(m.keySet());
System.out.println(m.get("apple"));
m.put("dog",3);
for (String s:m.keySet()) System.out.println(m.get(s));
```

[9]

(b) Consider the following program fragment:

```
Scanner in = new Scanner(new File("words"));
Map <String,Integer> map = new TreeMap <String,Integer>(  );
while (in.hasNext())
{
    String word=in.next();
    if (!map.containsKey(word)) map.put(word, 1);
    else map.put(word, map.get(word) + 1);
}
System.out.println(map);
```

If the file `words` contains:

```
ape
dog
ape
cat
orange
```

What will the output be? [8]

(c) Write a method which takes a Set of Strings and returns a map which maps each character to the set of Strings starting with that character. [8]