NATIONAL UNIVERSITY OF SINGAPORE

SCHOOL OF COMPUTING
SEMESTER I (2016-2017)

MIDTERM TEST FOR
CS1020: DATA STRUCTURES AND ALGORITHMS I

11.00am, Oct 1, 2016
Time Allowed: 1.5 Hour

MATRICULATION NUMBER:____

INSTRUCTIONS TO CANDIDATES

1. Write your matriculation number in the space provided above.
2. This examination paper consists of **11 MCQ questions and 2 short questions** and comprises **TWELVE (12)** printed pages including this front page.
3. Answer all questions. Use the provided OCR form for MCQ questions (Q1 to Q11). Write your answer for the short questions (Q12 and Q13) directly in the space given after each question.
4. Use 2B or darker pencil to shade the OCR form. You are allowed to use PENCIL to write your answers.
5. You must submit both the OCR form and this paper. It is your responsibility to ensure that you have submitted both to the invigilator at the end of the test.
6. Marks allocated to each question are indicated. Total marks for the paper is 100.

EXAMINER'S USE ONLY			
Section	**Possible**	**Marks**	**Check**
1	40		
2	30		
3	30		
Total	100		

Section 1. MCQ questions (4 marks each)

1. Which of the following statements about Abstract Class and Interface is/are TRUE?
    i) Both can be used as data type to declare variables
    ii) We can create object from an abstract but not an interface.
    iii) A sub-class can extend many abstract classes as long as all the abstract methods are implemented in the sub-class.
    iv) A class can implement many interfaces as long as all the methods in the interfaces are implemented.

a) (i) only　　b) (i) and (iv)　　c) (i), (ii) and (iv)
d) (ii) and (iii)　　e) (ii) and (iv)

2. Given the following segment of codes

```
Scanner myScan = new Scanner(“555 haha lol\n”);
int  num;
String str;
```

which of the following is/are TRUE:

```
i)   num = myScan.nextInt();
     str = myScan.nextLine();
     will put “haha lol” into str
ii)  num = myScan.nextInt();
     System.out.print(myScan.nextLine().charAt(0));
     will print a space
iii) num = myScan.next();
     str = myScan.nextLine();
     str.size() is 9
```

a) (i) only　　b) (i) and (ii)　　c) (ii) and (iii)
d) all are true　　e) none of (a), (b), (c), (d) is true

3. In order to achieve polymorphism, which of the following must be true?

    i) There must be overriding methods in the sub-classes.
    ii) There must be overloading methods in the sub-classes.
    iii) A sub-class reference must point to a super-class object.
    iv) A super-class reference must point to a sub-class object.

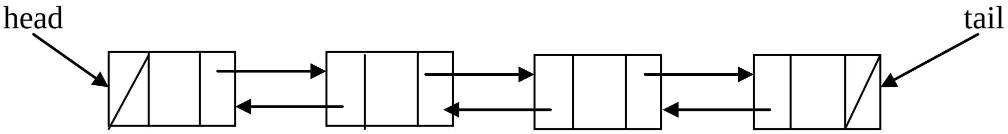
a) (i) only　　b) (i) and (iii)　　c) (ii) and (iv)
d) (i) and (iv)　　e) (i), (ii) and (iv)

4. What is the output of this program fragment? **Read it carefully!**

```
String greet = "Hi";
String name = "Smedley";
String nickName = name.substring(0,4);
if (nickName == name.substring(0,4));
   System.out.println("has real nickname");
else if (greet + name == greet + nickName)
        System.out.println("no real nickname");
    else System.out.println("hmmm...changed names?");
```

a) has real nickname
b) no real nickname
c) hmmm...changed names?
d) it's one of the three lines given in a, b, and c above, we can't tell which one without running the program
e) none, because there is at least one compile-time error

5. Given the following doubly linkedlist with a tail pointer,



What will the following segment of codes achieve?

```
DListNode curr = head;
while (curr != tail)
      curr = curr.next;
curr.next = head;
while (curr != head)
      curr = curr.prev;
curr.prev = tail;
```

i) Two singly circular linkedlists are created, one pointed by head and the other pointed by tail.
ii) The original doubly linkedlist will become doubly circular linkedlist.
iii) There will be run-time error
iv) Nothing happen

a) (i) only
b) (ii) only
c) (iii) only
d) (i) and (ii) only
e) (iv) only

6. Consider the following segment of codes. What is printed when it is executed?

```
class A {
   private int i = 10;
   public A() {
      this(20);
      System.out.print(“A default ”);
   }
   public A(int i) {
      System.out.print(“i in A is ” + i + “ ” );
   }
}
```

```
class B extends A {
   private int i = 20;
   public B() {
      this(30);
      System.out.print(“B default “);
   }
   public B(int i) {
      System.out.print(“i in B is “ + i + “ ”);
   }
}
```

```
public class C {
   public static void main (String [] args) {
      B b = new B(30);
   }
}
```

a) A default B default i in B is 30
b) A default i in A is 30 i in B is 30 B default
c) A default i in A is 10 B default i in B is 20
d) i in A is 20 A default i in B is 30
e) None of the above

7. Which of the following Java statements set even to true if n is even, and to false if n is odd? (n is an integer.) Assume n >= 0. (Even numbers are those integers which, when divided by 2, have a remainder of 0.)

```
i)      boolean even = (n/2.0 == (double)(n/2));
ii)     boolean even = (n % 2 == 0);
iii)    boolean even = (n div 2 == 0);
iv)     boolean even = (n % 2 == n/2);
```

a) (ii) only   b) (i) and (ii) only   c) (ii) and (iii) only
d) (iii) and (iv) only   e) (i), (ii) and (iv) only

8. Given the following generic Pair class

```
import java.util.*;
class Pair <T> {
       private T first;
       private T second;
       public Pair (T satu, T dua) {
             first = satu;
             second = dua;
       }
       public T getYi () {return first;}
       public T getEr() {return second;}
}
```

What would be printed by the following statements? Note that for both LinkedList and Vector in Java API, the add method adds the element to the back of the list and the get(index) method returns the element at the index position.

```
LinkedList < Pair<Integer> > List1;
Vector < LinkedList < Pair< Integer > > > V1
        = new Vector <LinkedList<Pair<Integer>>> ();
for (int j = 0;  j < 4; j++) {
    List1  = new LinkedList<Pair<Integer>();
    for (int k = 1; k < 3; k++)
        List1.add(new Pair<Integer>(j, k));
    V1.add(List1);
}
System.out.println(V1.get(2).get(1).getYi() + " and "
                         + V1.get(3).get(0).getEr());
```

a) 1 and 2　　b) 2 and 1　　c) 2 and 2

d) 3 and 1　　e) 3 and 2

9. Which LinkedList variations are good for the following applications:

i) A stack of books

ii) A queue at the canteen

iii) The CPU allocation to the processes that are currently running in the computer.

Use the abbreviations:

BLL(BasicLinkedList), TLL(TailLinkedList), CLL (CircularLinkedList)

a) (i) – TLL, (ii) – CLL , (iii) – BLL

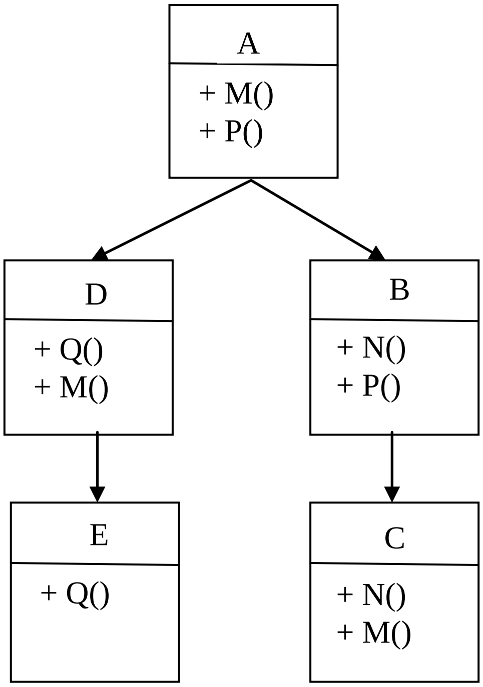
b) (i) – TLL, (ii) – BLL, (iii) – CLL

c) (i) – CLL, (ii) – BLL, (iii) – TLL

d) (i) – BLL, (ii) – TLL, (iii) – CLL

e) (i) – BLL, (ii) – CLL, (iii) - TLL

10.



Given the above class hierarchy where A is the super class and those below are the sub-classes. When a method is invoked, it prints the class name followed by the method name. For example, if the method N() in C is invoked, it prints C.N

Which of the following statements is/are TRUE?

i) A a = new C(); a.P(); will print B.P
ii) D d = new B(); d.Q(); will cause a compilation error
iii) B b = new C(); b.M(); will cause a compilation error
iv) A a = new E(); a.P(); will print A.P

a) (i), (ii) and (iv) only
b) (ii) and (iii) only
c) (i) and (iv) only
d) (ii), (iii) and (iv) only
e) All of them

11) Bonus question: You can score one mark for this question if you score less than 20 marks for the MCQ question.

You were told you can address Tan Sun Teck in many ways but he said you should not address him as what?

a) Sun Teck b) Dr Tan c) Teacher (in Chinese) d) Sir e) Prof Tan

12. Sparse matrices are matrices whose elements are predominantly zero. The codes below use an ArrayList of LinkedLists to implement a sparse matrice. It defines a class Element to store the column number and value for an element. Each row is represented by a LinkedList of Elements with non-zero values only. Few, if any, rows are all zeros and so the ArrayList is used to store a LinkedList for every row in ascending row order.

    Note that we are using the ArrayList and the LinkedList in Java API. Since they both implement List interface, you can reference the Appendix at the end of this paper and use the methods listed there.

```
class Element {
    public int column;
    public int value;
}
public class SparseMatrix {
    private int mRows; // Number of rows
    private int mCols; // Number of columns
    private ArrayList<LinkedList<Element>> mMatrix;
}
```

(a) Give two reasons why Element should not have public state. Provide a better Element class definition, one that must allow value to be mutated. [4 marks]

(b) Explain why ArrayList and LinkedList are appropriate choices in this context. [2 marks]

(c) Write a constructor for SparseMatrix that takes arguments specifying the number of rows and columns and initialises state appropriately. [3 marks]

(d) Write the member method get(int r, int c), which retrieves the value at row r and column c of the matrix. [8 marks]

(e) Write the method set(int r, int c, int v), which sets the value at row r and column c to v. If node is not already there, a new node must be created. If v is zero, remove the node.

[10 marks]

(f). If get() operations are more common than set() operations, suggest a better choice than LinkedList for the type of the inner list and indicate how the elements are stored in it.

[3 marks]

13. A private dental clinic wishes to computerise its patient information system (PIS). A patient must register with the clinic and the system needs to store their name, address and mobile telephone number. Each patient is given a unique seven digit patient number. The system will keep a count of how many patients the clinic currently has. Patients can book an appointment with a particular dentist; the system needs to store the date of the appointment and if the patient attended. A text message will be automatically sent out two working days before the appointment. After the appointment the dentist update the system with the cost of the treatment undertaken. A list of appointment statistics is required at the end of each week. This will be a summary of how many patients turned up and how many were no-shows. If a patient misses an appointment 3 consecutive times they will be charged $1 and double the previous charge if he/she misses the subsequent one. That is ($1, $2, $4, and so on). The penalty will be reset when the patient attends the appointment.

a) Design the required classes for the PIS. You only need to use UML boxes to indicate the attributes and methods in each class. State the purpose of the methods. You do not need to deal with the driver class. **(10 marks)**

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b) Use pseudo code to describe the algorithm for handling the appointments. You should indicate clearly which objects should be involved and how they interact. For example, Who is supposed to set up the appointment, who is supposed to send the reminder, who is supposed to record the charges and who is supposed to impose the fines, etc. If you simply repeat what is stated in the description above, you will not score any mark.

[12 marks]

c) Name the most suitable data structures which we discussed in this module for storing all the necessary information in the PIS. Explain your choice. **(4 marks)**

d) Is there any variable that you would make static in the system? Explain your answer. **(4 marks)**

Appendix: List interface

`boolean`	`add(E e)` Appends the specified element to the end of this list (optional operation).
`void`	`add(int index, E element)` Inserts the specified element at the specified position in this list (optional operation).
`boolean`	`equals(Object o)` Compares the specified object with this list for equality.
`boolean`	`contains(Object o)` Returns `true` if this list contains the specified element.
`E`	`get(int index)` Returns the element at the specified position in this list.
`int`	`indexOf(Object o)` Returns the index of the first occurrence of the specified element in this list, or -1 if this list does not contain the element.
`boolean`	`isEmpty()` Returns `true` if this list contains no elements.
`E`	`remove(int index)` Removes the element at the specified position in this list (optional operation).
`boolean`	`remove(Object o)` Removes the first occurrence of the specified element from this list, if it is present
`E`	`set(int index, E element)` Replaces the element at the specified position in this list with the specified element
`int`	`size()`Returns the number of elements in this list.

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