NATIONAL UNIVERSITY OF SINGAPORE

SCHOOL OF COMPUTING

SEMESTER I 2014/2015

CS1020: DATA STRUCTURES AND ALGORITHMS I

Mid Term Test

Time Allowed: 1.5 Hours

Matriculation Number:

INSTRUCTIONS TO CANDIDATES:

1. Write your matriculation number in the space provided above.
2. This examination paper consists of **TWELVE (12**) **MCQ questions and TWO (2) short questions.**
3. This examination paper comprises **Thirteen (13)** printed pages including this front page.
4. Answer the **MCQ** questions by shading the correct option on the OCR form and answer all the other questions directly in the space given after each question. If necessary, use the last page.
5. Marks allocated to each question are indicated. Total marks for the paper is **100**.
6. This is a closed book examination and you can write in pencil.

EXAMINER'S USE ONLY				
Questions	**Possible**	**Marks**	**Grader**	**Check**
MCQ 1- 12	48			
Q13	22			
Q14	30			
Total	100			

Section A: 12 MCQ (4 Marks each)

1. What is the output of the following program?

```
class Midterm1 {
      public static void main(String [] args) {
            Midterm1  myObj = new Midterm1();
            myObj.start();
      }
      void start() {
            String str1 = “I like”;
            String str2 = change(str1);
            System.out.println(str1 + “ “ + str2);
      }

   String change(String str) {
          str = str + “CS1020”.substring(0,4) + “10”;
          System.out.print(str + “ “);
          return “CS1020”;
   }
}
```

a. I like CS1010
b. I likeCS1020 I like CS1010
c. CS1010 I like CS1020
d. I likeCS1010 I like CS1020
e. CS1020 like I

2. Given a **circular doubly** linked list with head pointer, a programmer wrote the following code for swapping the values of the node pointed by a pointer **curr** and its next node:

```
Object temp = curr.item;
curr.item = curr.next.item;
curr.next.item = temp;
```

Which of the following statement is TRUE? "fail" means runtime error in the following statements.

a. The code will fail when **curr** points to the same node as the head pointer.
b. The code will fail when **curr** points to the last node in the linked list.
c. The code will fail when the linked list has two nodes only.
d. The code will fail when the linked list has one node only.
e. None of the above is true.

3. What is the output of the following program?

```
import java.util.*;
class Midterm3 {
    public static void main(String[] args) {
        Scanner scanner = new Scanner("hello 1 2.00 false");
        String str = scanner.next();
        int anInt = scanner.nextInt();
        float aFloat = scanner.nextFloat();
        boolean booleanValue = scanner.nextBoolean();
        System.out.println(str + ":" + anInt + ":" + aFloat
                           + ":" + booleanValue);
    }
}
```

a. The program will output nothing
b. hello:1:2.0:false
c. :1:2.0:false
d. The program has run-time error, argument for Scanner object must be “System.in”.
e. The program has compilation error, argument for Scanner object must be “System.in”.

4. What is the output of the following program?

```
class Midterm4 {
    public static void main(String [] args) {
            Midterm4  pObj = new Midterm4();
            pObj.start();
    }
    void start() {
        long [] a1 = {3, 4, 5};
        long [] a2 = change(a1);
        System.out.print(a1[0] + a1[1] + a1[2] + “ “);
        System.out.println(a2[0] + a2[1] + a2[2]);
    }
    long [] change(long [] a3) {
            a3[1] = 7;
            return a3;
    }
 }
```

a. 12 15 b. 15 15 c. 345 375 d. 3 4 5 3 7 5 e. 3 7 5 3 7 5

5. What is the output of the following program?

```
class A {
      public int i;
      protected int j;
}
class B extends A {
      public void display() {
          super.j = i + 1;
          System.out.println(i + " " + super.j);
     }
}
```

```
class Midterm5 {
    public static void main (String args []) {
           B obj = new B();
           obj.i = 1;
           obj.j = 2;
           obj.display();
    }
}
```

a) 2 2
b) 3 3
c) Compilation Error because the attribute j cannot be accessed in class B.
d) Compilation Error because the attribute j cannot be accessed in main method.
e) Both c) and d)

6. Given an interface ***F*** which has two method specifications, M1 and M2 and two classes ***B*** and ***C*** where ***B*** implements both M1 and M2 while C only implements M1, which of the following statements is/are **FALSE**?

i) Only ***B*** and ***C*** can be used as data type to declare variables in the program but not ***F***.
ii) We can create objects of both ***B*** and ***C.***
iii) Class ***C*** is automatically an abstract class without the explicit declaration.

a. Only i) and ii)
b. Only ii) and iii)
c. Only i) and iii)
d. All i), ii) and iii)
e. None of them

7. Consider the class relationship shown below.

```
class Bird {
        public void makeNoise()
                { System.out.println("chirp"); }
        public void move()
                { System.out.println("fly"); }
 }
```

```
    class Parrot extends Bird {
          public void makeNoise()
                { System.out.println("sing"); }
    }
```

```
class Owl extends Bird{
      public void makeNoise()
            { System.out.println("ow"); }
      public void move()
            { System.out.println(" flap"); }
 }
```

```
class Parakeet extends Parrot {
      public void move()
            { System.out.println("jump"); }

}
```

```
class Midterm7 {
        public static void main(String [] args) {
                Bird b1 = new Bird();
                Bird b2 = new Parrot();
                Parrot p1 = new Parrot();
                Parrot p2 = new Parakeet();
                Owl w1 = new Owl();
                Bird w2 = new Bird();
                b1.move(); b2.makeNoise(); p1.makeNoise();
                p2.move(); w1.makeNoise(); w2.move();
        }
}
```

What is the output of the above program?

a. fly
sing
chirp
jump
ow
flap

b. fly
sing
sing
jump
ow
fly

c. fly
chirp
chirp
fly
ow
fly

d. fly
chirp
sing
jump
ow
fly

e. jump
sing
sing
jump
ow
fly

8. You are required to write a method addSecond to add a new node to the second position of a linkedlist. getNext() and setNext() are the usual getter and setter methods in the ListNode class and head is pointing to the first node in the list.

```
/* Pre-condition: list contains at least one element
   Post-condition: new node containing Object o inserted at second position in list  */
   public void addSecond(Object o)
            { implementation code }
```

Which of the following could replace implementation code so that addSecond works as intended?

a) head.getNext(new ListNode(o, head.getNext()));
b) head.setNext(o, head.getNext());
c) head.setNext(new ListNode(o, head.getNext()));
d) head.setNext(ListNode(o, head.setNext()));
e) head = head.getNext();
   head.setNext(ListNode(o, head));

9. Sometimes it is useful to know where is the **median** element in a linked list in addition to the first or last element. In a list of **N** elements, the median element is the:

- **ceiling(N/2)th** element if **N** is odd
- **(N/2)th** element if **N** is even

For example, the median element in a list of 5 nodes is the 3rd node (counting from 1); the median element in a list of 4 nodes is the 2nd node.

Suppose we keep an extra pointer **_median** to keep track of the median element. Further assume that we only **add/remove items from the back of list**. Which of the following statement(s) regarding the update of **_median** pointer after every addition/removal of item is/are TRUE?

i. If singly linked list is used, then we may need up to **(N/2 – 1)** hops to update the **_median** pointer. (one hop means move from a node to the next node)
ii. If circular singly linked list with head pointer is used, then we may need up to **(N/2 – 1)** hops to update the **_median** pointer.
iii. If doubly linked list is used, then we need at most **1** hop to update the **_median** pointer.

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

10. Which of the following statements about generic declaration is/are **FALSE**?

i). We can only use S or T as the type variable during declaration.
ii). The types can only be instantiated with non-primitive data types.
iii). If we have a Pair <S, T> class, then S and T must be instantiated with two different data types.

a. i) only
b. ii) only
c. iii) only
d. i) and ii)
e. i) and iii)

11. What is the purpose of the following method if head is pointing to a singly linkedlist?

```
public void mysteriousMethod() {
    if(head == null) return;
    ListNode curr = head;
    while(curr.getNext() != null)
      { curr = curr.getNext();}
    curr.setNext(head);
    curr=head;
    head=head.getNext();
    curr.setNext(null);
}
```

a. Reverse the list
b. Make the first node to be the last node
c. Sort the elements in the list
d. It doesn't change anything in the list
e. None of the above

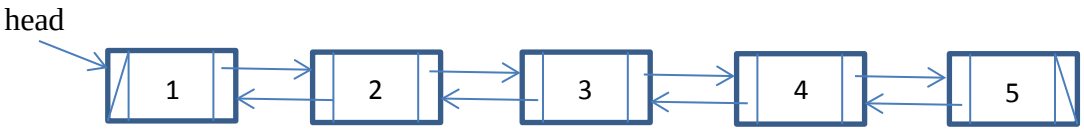
12. Which of the following statements is/are TRUE?

i) A single source file can contain any number of Class declarations but only one of the classes can be declared as public.
ii) A static method in a class should not refer to instance variables without creating an instance and cannot use "this" operator to refer the instance.
iii) A private variable may only be accessed within the class in which it is declared.

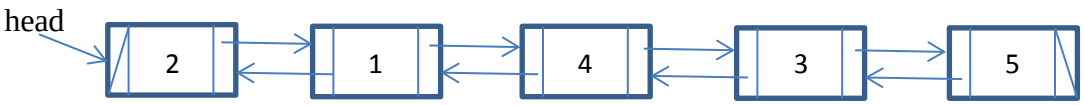
a. i) only
b. i) and ii)
c. ii) and iii)
d. i) and iii)
e. all i), ii) and iii)

Section B. Short Questions

13. Given a Doubly LinkedList with a head pointer, you are supposed to create a method in the Doubly LinkedList class to exchange the objects in the alternate nodes. If there is odd number of nodes, the last node will not be affected. For example, given the following Doubly LinkedList,



the method should convert it to the following:



Take note of the following restrictions for all the 3 parts in this question.
i) You are **not allowed** to use any other data structure in the methods
ii) You are **allowed** to use at most two more pointers in the methods

a) Write a method which takes out the objects in the nodes and swap them. (3 marks)

b) Write a method that takes the objects from the original list and create new nodes in a new Doubly LinkedList and set the head to this new list. (7 marks)
Please be reminded that you are only allowed to have 2 additional ListNode references.

c) Write a method that achieves the requirement without creating new nodes and not swapping the objects in the nodes. (12 Marks)

14. IVLE forum is a useful platform for students to discuss what they learnt in their modules and post queries when they faced problems. Design a system that allows students to post messages beneath specific topics. Topics are unique and displayed alphabetically, with associated messages displayed chronologically by creation date. Students are allowed to subscribe to a topic (i.e. be notified using the email when new messages are posted in that topic). Students should also be able to unsubscribe.

a. Identify all the objects involved in the system and indicate their logical relationships in the form Object1 is-a Object2 or Object1 has-a Object2. (4 marks)

b. For 3 of the objects identified, define their corresponding classes. You only need to specify the class name, the attributes and the methods in the class. For each method you identify, you should indicate the method heading, its purpose and its pre and post conditions. Getter and setter methods are not acceptable. (12 marks)

```
// class 1
```

// class 2

//class 3

c. Identify the most appropriate data structures from the Java API for the variables topics (the set of all topics) and messages (the set of all messages in a given topic). (4 marks)

d. Write the **algorithm** for adding a new topic to the forum and the **algorithm** to display all the messages. Note that the topics are unique and displayed alphabetically, with associated messages displayed chronologically by creation date. (10 marks)

// addTopic

// displayMessage

- **End of paper** -