CS2102, B12

Exam 1

Name:

You have 50 minutes to complete the problems on the following pages. There should be sufficient space provided for your answers.

If a problem asks you to create a class hierarchy, we are looking for the interfaces, classes, and abstract classes that you would create for the problem. In particular:

- Include **implements** and **extends** statements
- Include field names and types
- Include method headers (names, return type, and input parameter types)
- Full credit requires that all types and implements/extends relationships are clear. Be sure your work is clear if you use class diagrams instead of Java syntax.
- You may omit constructors
- You may omit method bodies
- You may omit the `Examples` class (examples of data and test cases) unless a question asks otherwise

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Grading Summary

Exam starts on the next page

Topic	Max Points	Score
Q1: Set-based data structures	30	
Q2: When to use interfaces	7	
Q2: Java abstraction mechanisms	7	
Q2: Create a class hierarchy	15	
Q2: Protect data from access/modification	15	
Q3: Encapsulate data	30	

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1. **Topic: Data Structures**

   Draw an example (pictures, not code) of each of the following:

   (a) A heap containing the numbers 1 through 7 that is NOT a binary search tree (BST)

   (b) A binary search tree (BST) containing the numbers 1 through 7 that is NOT an AVL tree

   (c) A binary search tree (BST) in which the left subtree has height 2, the right subtree has height 3, but the BST is not an AVL tree (Hint: numbers 1 through 6 are enough to answer this)

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2. **Topic: Class Hierarchies (Classes, Abstract Classes, Interfaces) and Access Modifiers**

You are developing an application to help people manage their meetings and to-do lists (question 3 starts from the same code). The application contains the following classes (constructors omitted to save space):

```
class Date {
  _________ String month;
  _________ int day;
}

class Meeting {
  _________ String description;
  _________ Date when;
  _________ String location;
}

class Calendar {
  _________ LinkedList<Meeting> meetings;
  _________ LinkedList<String> toDoList;

  // produce list of appointments on the given date
  LinkedList<Meeting> getReminders(Date fordate) {
    LinkedList<Meeting> result = new LinkedList<Meeting>();
    for (Meeting m:meetings) {
      if (m.when.day==fordate.day && m.when.month.equals(fordate.month)) {
        result.addFirst(m);
      }
    }
    return result;
  }

  // check off a to-do list item
  void finishToDo(String toDoItem) {
    this.toDoList.remove(toDoItem);
  }
}
```

After the initial product release, you realize that your application needs to manage scheduled phone calls as well as in-person meetings. For each phone call, you need to store a description of what the call is about, the date for the call (ignore the time to simplify the problem), the number to call, and the name of the person to call.

(a) How could the original code have been written differently to let you make this change without editing any of the existing classes? Answer in text (do not write code or edit the above code).

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(b) Edit the code to replace the current `LinkedList` of meetings with a `LinkedList` containing both meetings and phone calls. If you introduce any new classes, provide class definitions to the same level of detail as the `Date` and `Meeting` classes. Provide any new interfaces in full; you only need to reproduce the original functionality (not add new features or methods). Do **NOT** encapsulate data for this question—just make the edit requested in this problem. Mark edits on the original code, using the space around the code and below for any new classes/interfaces.

(c) Fill in the blanks in the code with appropriate access modifiers that would also allow the code to compile *as written*. You do not need to write anything else for this part.

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3. **Topic: Encapsulation**

You are developing an application to help people manage their meetings and to-do lists (question 2 starts from the same code). For this question, use the code in its original form, NOT with any edits made in question 2.

```
class Date {
  String month;
  int day;
}

class Meeting {
  String description;
  Date when;
  String location;
}

class Calendar {
  LinkedList<Meeting> meetings;
  LinkedList<String> toDoList;

  // produce list of appointments on the given date
  LinkedList<Meeting> getReminders(Date fordate) {
    LinkedList<Meeting> result = new LinkedList<Meeting>();
    for (Meeting m:meetings) {
      if (m.when.day==fordate.day && m.when.month.equals(fordate.month)) {
        result.addFirst(m);
      }
    }
    return result;
  }

  // check off a to-do list item
  void finishToDo(String toDoItem) {
    this.toDoList.remove(toDoItem);
  }
}
```

(a) On the code itself, box off the code fragments that need to change in order to encapsulate the `meetings` data in the `Calendar` class. You only need to draw boxes to answer this part.

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(b) Provide classes and/or interfaces you would add in order to encapsulate the `meetings` data. Provide complete interfaces. For classes, provide variables and headers for methods that are not required by their interface. Include only variables and method headers needed to encapsulate the code on the previous page (don't add new features).

(c) Would well-encapsulated code require any changes to the comparison of dates in the `getReminders` method? Either explain needed changes briefly in text or justify why no changes are necessary (you do not need to write or edit code).

(end of exam)