4 Object-Oriented Programming (RKH)

A Lecturer wishes to create a program that lists his students sorted by the number of practical assignments they have completed. The listing should be greatest number of assignments first, sub-sorted by name in lexicographical order (A to Z).

A class StudentInfo stores the name and number of assignments completed for a student. Amongst other methods, it contains a void setCompleted(int n) method that allows changes to the number of completed assignments.

(a) Provide a definition of StudentInfo with an equals() method and a natural ordering that matches the given requirement. [9 marks]

(b) A TreeSet is used to maintain the StudentInfo objects in appropriate order. When setCompleted(...) is called on a StudentInfo object it is necessary to remove the object from the set, change the value and then reinsert it to ensure the correct ordering. This is to be automated by applying the Observer design pattern via classes UpdatableTreeSet and SubscribableStudentInfo. A partial definition of UpdatableTreeSet is provided below.

```java
public class UpdatableTreeSet extends TreeSet<SubscribableStudentInfo> {
    // To be called just before the StudentInfo object is updated
    public void beforeUpdate(SubscribableStudentInfo s) {
        remove(s);
    }
    // To be called just after the StudentInfo object is updated
    public void afterUpdate(SubscribableStudentInfo s) {
        add(s);
    }
}
```

(i) Extend StudentInfo to create SubscribableStudentInfo such that: multiple UpdatableTreeSet objects can subscribe and unsubscribe to receive updates from it; and the beforeUpdate(...) and afterUpdate(...) methods are called appropriately on the subscribed UpdatableTreeSet objects whenever setCompleted(...) is called. [6 marks]

(ii) Give a complete definition of UpdatableTreeSet that overrides the inherited methods boolean add(SubscribableStudentInfo) and boolean remove(Object) to automatically subscribe and unsubscribe to their arguments, as appropriate. You may ignore all other methods inherited from TreeSet. [5 marks]