Data Structures and Programming

Final Exam Programming Question

You are given a Java program that manages the operations of a fitness center. The center has a list of classes, a list of members, and a list of users. The list of users is provided in the file **`users.txt`**. Each user has an id, username, and password. Users with an ID that starts with the letter "M" are members of the gym who can enroll in classes. Users with an ID that starts with the letter "A" are administrators who can view the total income of the gym and the popular classes. The list of members is provided in the file **`members.txt`**. Each member has an ID, name, and a list of classes they are enrolled in. The list of classes is provided in the file **`classes.txt`**. Each class has a code, name, time in minutes, fees in dollars, and the number of members enrolled in the class. The program allows the users to login using a username and password. Once the login credentials are validated, the program will allow the users, who are members, to view/add/drop classes. The program allows the users, who are administrators, to view the gym income from each member and the total income, and the list of classes ranked by popularity.

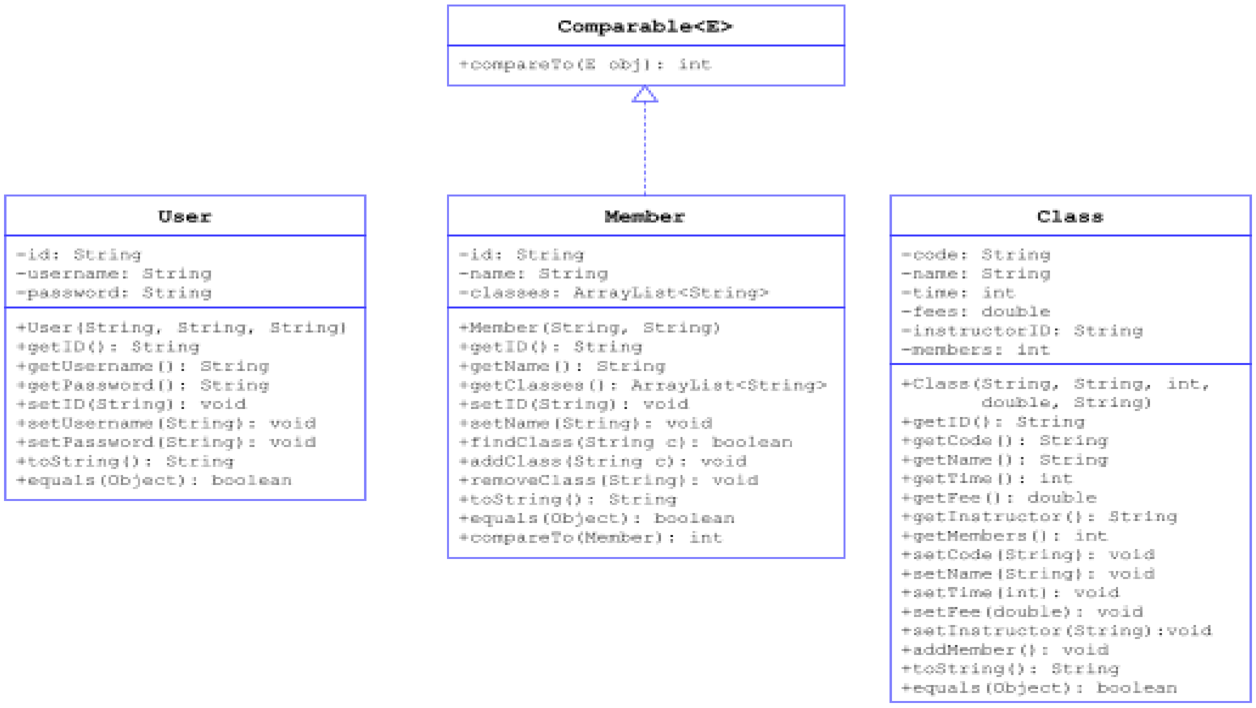
The given program is at 70% of its completion. Complete the following tasks to deliver a working program to the fitness center. A sample run is provided at the end of this document to test your code.

Write the definition of the following methods

1. **`ArrayList<E> toList()`** in the class **`BST`**: this method is **recursive** and returns an array list with the values of the BST nodes traversed in order.
2. **`void sort(Comparator<E> c)`** in the class **`LinkedList`**: this method sorts the linked list using the comparator object **`c`**. The method should use the bubble sort algorithm provided below for an arraylist. **The sort method should not use the method `get(int)`** from the class LinkedList.

```
/**  Bubble Sort Method
 *  @param list to be sorted
 */
public static <E extends Comparable<E>> void
                                    bubbleSort(ArrayList<E> list) {
   boolean sorted = false;
   for (int k=1; k < list.size() && !sorted; k++) {
      sorted = true;
      for (int i=0; i<list.size()-k; i++) {
        if (list.get(i).compareTo(list.get(i+1)) > 0) {
           swap(list, i, i+1);
           sorted = false;
        }
      }
   }
}
```

Use the definitions of the classes **`User`**, **`Member`**, and **`Class`** as provided and illustrated in the UML diagram below. Go over the code of each class to understand the attributes and the interface of each class.



The test class **`GymManager`** is provided with six completed methods (**`main()`**, **`readMembers()`**, **`readClasses()`**, **`login()`**, **`printAll()`**, and **`printMyClasses()`**) and four empty or incomplete methods you will write. Go over the code of the main function and the completed methods to understand the overall behavior of the program, then complete the following:

3. Write the definition of the method **`void readUsers(HashMap<String,User> hm, String filename)`** to read the file **`filename`** into the hashmap **`hm`**. The method is invoked with the file name `users.txt`. The text file contains a list of users with the following information: user id, username, and user password (separated by a space).
4. Complete the definition of the method **`void memberOperations(Scanner scan, String id, BST<Member> members, LinkedList<Class> classes)`** to add and drop classes (cases 3 and 4 inside the switch statement). See the sample program run for the behavior of the two operations.

The method **`void adminOperations(LinkedList<Class> classes, BST<Member> members)`** for the gym administrators displays the income from each member, the total income, and the classes ranked by popularity. This method calls the two methods described below:

5. Write the definition of the method **`void printIncome(LinkedList<Class> classes, BST<Member> bst)`** to print the income of the gym showing the total payment from each member and the total income for the gym.
6. Complete the definition of the method **`void sortClasses(LinkedList<Class> classes, BST<Member> bst)`** to print the classes sorted in descending order of the number of enrolled members. The method should iterate through the bst members to find the members enrolled in each class and update the data member **`members`** for each class in the list **`classes`**. The list **`classes`** is then sorted using an object of the comparator class provided inside the method. After the call to the method **`sort`**, write the code to print the sorted list.

The method l**`ogin()`** throws an exception of type **`InputMismatchException`** if the user enters an invalid username.

7. In the main method, handle the exception thrown by the method **`login()`**.
8. Determine the time complexity of the methods **`toList()`** in the class **`BST`** and the methods **`printIncome()`** and **`sortClasses()`** in the class **`GymManager`**. Add the time complexity as a comment before the methods' header.

As a guide, the programming question has 8 tasks to complete. These are numbered from 1 to 8 in purple.

Submit the following files on course site:

`HashMap.java`,

`BST.java`,

`LinkedList.java`,

`User.java`,

`Member.java`,

`Class.java`, and

`GymManager.java`

Sample runs of the program are provided below to test your code.

Sample RUN 1: Invalid username

```
-----------------------------------------------------------------
Enter username: lfe
Invalid username (must be 3 letters followed by 3 digits).
```

Sample RUN 2: Incorrect username or password for three times

```
-----------------------------------------------------------------
Enter username: lfe212
Username not found. Try again.

Enter username: lfe218
Enter password: }BM+]D_R4$qO1
Password incorrect. Try again.

Enter username: lfe218
Enter password: }BM+]_D_R4$qO1
Password incorrect. Try again.

Incorrect username or password more than 3 times.
Terminating the program...
```

Sample RUN 3: The logged in user is a gym member

```
-----------------------------------------------------------------

Enter username: lfe218
Enter password: }BM+]`D_R4$qO1

Select an operation:
1: View My Classes
2: View All Classes
3: Add Class
4: Drop Class
5: Logout
1
Code      Name                      Duration (minutes)   Cost
CF2       Cardiac_Fitness_Level_2   90                   $250.00
C         Cycling                   60                   $110.00
```

```
Select an operation:
1: View My Classes
2: View All Classes
3: Add Class
4: Drop Class
5: Logout
2
Code       Name                     Duration (minutes)  Cost
B&B        Bike&Barre               45                  $100.00
BC         Boot_Campo               30                  $180.00
CF1        Cardiac_Fitness_Level_1  45                  $130.00
CF2        Cardiac_Fitness_Level_2  90                  $250.00
CS         Core_Synergy             60                  $100.00
C          Cycling                  60                  $110.00
GY         General_Yoga             30                  $85.00
AY         Advanced_Yoga            90                  $200.00
T          Tabata                   45                  $100.00
Z          Zumba                    60                  $120.00

Select an operation:
1: View My Classes
2: View All Classes
3: Add Class
4: Drop Class
5: Logout
3
Code       Name                     Duration (minutes)  Cost
B&B        Bike&Barre               45                  $100.00
BC         Boot_Campo               30                  $180.00
CF1        Cardiac_Fitness_Level_1  45                  $130.00
CF2        Cardiac_Fitness_Level_2  90                  $250.00
CS         Core_Synergy             60                  $100.00
C          Cycling                  60                  $110.00
GY         General_Yoga             30                  $85.00
AY         Advanced_Yoga            90                  $200.00
T          Tabata                   45                  $100.00
Z          Zumba                    60                  $120.00

Enter the code of the class you want to add
Z
Class added successfully.
```

```
Select an operation:
1: View My Classes
2: View All Classes
3: Add Class
4: Drop Class
5: Logout
1
Code      Name                     Duration (minutes)   Cost
CF2       Cardiac_Fitness_Level_2  90                   $250.00
C         Cycling                  60                   $110.00
Z         Zumba                    60                   $120.00

Select an operation:
1: View My Classes
2: View All Classes
3: Add Class
4: Drop Class
5: Logout
4
Code      Name                     Duration (minutes)   Cost
CF2       Cardiac_Fitness_Level_2  90                   $250.00
C         Cycling                  60                   $110.00
Z         Zumba                    60                   $120.00

Enter the code of the class you want to drop
C
Class dropped successfully.

Select an operation:
1: View My Classes
2: View All Classes
3: Add Class
4: Drop Class
5: Logout
1

Code      Name                     Duration (minutes)   Cost
CF2       Cardiac_Fitness_Level_2  90                   $250.00
Z         Zumba                    60                   $120.00
```

```
Select an operation:
1: View My Classes
2: View All Classes
3: Add Class
4: Drop Class
5: Logout
5
Thank you for your visit!
```

Sample RUN 4: The logged in user is an administrator

```
----------------------------------------------------------------

Enter username: haa212
Enter password: Z7Ty;g#;iYC7|

Member ID      Member name               Classes        Amount
M100029        Eun,Coody                 [CF1, BC]      $310.00
M100181        Willow,Kusko              [BC, Z, GY]    $385.00
M100204        Dominique,Dickerson       [GY, B&B, BC]  $365.00
M100279        Lucy,Treston              [T, Z, BC]     $400.00
M100280        Salome,Lacovara           [B&B, GY, AY]  $385.00
M100283        Elke,Sengbusch            [BC, T, CS]    $380.00
M100556        Janine,Rhoden             [T, GY, B&B]   $285.00
M101050        Diane,Devreese            [CF1, CS]      $230.00
M101071        Yoko,Fishburne            [Z, BC]        $300.00

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M197804        Mona,Delasancha           [AY, AY]       $400.00
M198041        Teddy,Pedrozo             [B&B, AY, GY]  $385.00
M198069        Donte,Kines               [Z, CF2]       $370.00
M198174        Delmy,Ahle                [C, GY]        $195.00
M198209        Catarina,Gleich           [CF2]          $250.00
M198213        Lynelle,Auber             [CF1, B&B, CS] $330.00
M199209        Gracia,Melnyk             [BC, CS, CS]   $380.00
M199317        Yolando,Luczki            [BC]           $180.00
M199734        Rima,Bevelacqua           [CF1, CF2, GY] $465.00
M199932        Izetta,Funnell            [Z, Z, CS]     $340.00
Total Income                                           $133090.00
```

```
Class                          # Enrolled Members
Zumba                          113
General_Yoga                   106
Bike&Barre                     98
Cardiac_Fitness_Level_2        98
Boot_Campo                     96
Core_Synergy                   96
Tabata                         96
Cycling                        95
Cardiac_Fitness_Level_1        93
Advanced_Yoga                  86
```