CONTINUOUS EVALUATION EXAM

Exam of the Ordinary Call

Software Design and Analysis Project (2014/2015)

Your company wants to build an application to manage the urban *bike* rental in each of the self-service stations distributed throughout the city; each rental station consists of a parking lot controlled by a computer (that will run your application) with network connection to the central computer of the company. The application takes care of the local management in each rental station with all the functionality described below. However, please note that some functionality implies an implicit exchange (download or upload) of information with the company's central computer either at the beginning or end of the corresponding operation.

The application running in each rental station is configured with the number of electromagnetic *slots* available in its parking lot, which is initially empty. Each slot has its own identifier and may be vacant or occupied by a bike; the application can unlock these slots only to allow the start of a bike rental and the return of a bike. The start of a bike rental and the bike return (at the end of the rental) can be performed in different stations.

Bikes can be *hybrid* (with pedals and auto-rechargeable battery) or *classic* (without battery). In both forms they can be individual or familiar (with a child-carrier accessory). Their basic attributes (a unique identifier, date of first service, status, accumulated hours of use, slot that it occupies at this moment if it is parked, …) are similar for all types of bike; on the other hand, other aspects such as the type of applicable rate and the conditions of repair and maintenance are different for each type of bike.

To start a rental, the *customer* must enter his/her mobile number on the application; a *subscriber* customer must also enter a personal password; *occasional* customers do not have a personal password but will receive a verification code by SMS that they need to enter into the application to continue with the rental. The same application will be used by the technicians who are responsible for the bike maintenance and reparations. They will be authenticated by a special *id* and *password*. These technicians may request at the rental station a report of the bike malfunctions notified by the customers (as described below) and a report of bikes that, by its accumulated use, require a scheduled maintenance. With this information the technician may need to request the unlocking of certain slots to remove the corresponding bikes. They can also request that the application unlock slots for a return to the service of bikes the technician brings back after the reparation or maintenance is performed. Likewise, they may add new bikes to a parking lot (either the first day of activity of the rental station, or later if it becomes necessary) by entering each bike details and the slot where each bike will be located.

Occasional customers may request a rental of only one bike for a renting period of 3 hours. To do this, they select the desired type of bike and introduce the *payment data* (payment card's type, owner, number, expiration date and security code). Once the payment has been confirmed through the remote system of card payments, the application will show the slot id unlocked for the passenger to remove the rented bike.

Subscribers must have registered on the application, in any rental station, prior to their first rental. Such a registration involves introducing data that will be stored in the company's central computers (to be used in rentals from any station). These data include: payment data (the same as for occasional customers), personal password for authentication prior to renting, and the type of subscription selected by the customer. Subscriptions are characterized by 3 data: active period from the date of purchase (1 day, 7 days, 30 days, 6 months or 1 year), type of bikes that can be rented (only hybrid, only classical, or both), and number of bikes that can be rented simultaneously (1, 2 or 3). During the active period of its subscription, the subscriber may request a maximum of 4 rentals each day, with maximum duration of 3 hours per rental. The application calculates the price of each subscription and when the payment is accepted and carried out, the subscriber can proceed with the rental.

Subscribers can request rentals faster because, once they authenticate, the application shows the bike options available depending on their type of subscription, and the subscriber only needs to indicate the number of bikes of each type to rent. If these data are compatible with the subscription, the subscriber will see on the screen the slot ids that have been unlocked to remove its rented bikes. It should be noted that one subscription does not allow to have multiple simultaneous rentals. That is, as long as the subscriber has a rented bike, he/she cannot start the rental of another; this is so even in the case of a subscription that allows *simultaneous renting* of several bikes (because all because all of them must be rented at the same time).

The *termination of a bike rental* and the returning of bikes to a rental station with free slots in its parking lot require, as a first step, the introduction of the customer's mobile number. The rental may terminate with or without *incidents*, which may be related to a returning *delay* or a bike *malfunction*. When the rental is terminated after the limit, a penalty will be applied (either by charging the credit card in the case of occasional customers, or through a period of

suspension of the current subscription). When the customer indicates that he/she wants to report a bike malfunction, the application shows the options and fields to describe the malfunction, and whether this case of malfunction may yield a possible compensation due to the interrupted rental. If that is the case, the application will proceed to calculate and apply the bonus when a technician has verified that the description of the malfunction was correct. Whether or not there were incidents, the application finally shows on the screen the identifiers of slot ids that have been unlocked for the customer to return the bike that has rented. In the case of renting several bikes simultaneously, all of them must be returned at the same time in the same station.

The application will generate various reports to aid in the decision-making at the company. In particular, it must keep track of the malfunctions reported on each bike (whether it has been accepted or not by a technician); it should also provide information of every bike regarding the shortest period between failures, the monthly average number of failures, and the average time to repair their faults; likewise, it must keep records about the delays incurred by each customer (either subscriber or occasional) so that a decision can be made on denial of service to customers with a record of frequent delays.

QUESTIONS ARE NOT ALLOWED DURING THE EXAM

Your answers should be restricted to the questions posed in the exam. You might have to make some assumption about some detail that is not included in the statement. You can do it in a sound and reasonable way. These assumptions should be documented in your answer.

ANSWER EACH SECTION IN A SEPARATE SHEET

****** You must use UML notation in all your answers, so that they are formalized and standardized as any documentation for analysis and design of a software project should be. Expressing correct ideas in a language other than UML, it is not acceptable here. **********

Section 1. (2.25 points)
Draw the use cases diagram for the application that has been described

Section 2. (0.75 points)
Describe with detail the use case associated to a bike rental termination.

Section 3. (4 points)
Draw the class diagram of the application. Do not forget to include all attributes and methods that are needed in order to implement the functionality that has been described. It is not necessary to include constructors nor getter nor setter methods.

Section 4. (1.5 points)
Draw the state transition diagram that describes the behavior of the Bike class.

Section 5. (1.5 points)
Draw the sequence diagram that represents the process of registering a subscriber and requesting his first rental of two bikes, one familiar hybrid and one individual classical.

ANSWER EACH SECTION IN A SEPARATE SHEET