

ICT330

Examination – July Semester 2019

Database Management Systems

Monday, 11 November 2019

1:00 pm – 3:00 pm

Time allowed: 2 hours

INSTRUCTIONS TO STUDENTS:

1. This examination contains **FOUR (4)** questions and comprises **FIVE (5)** printed pages (including cover page).
2. You must answer **ALL** questions.
3. All answers must be written in the answer book.
4. This is **an open-book examination**.

At the end of the examination

Please ensure that you have written your examination number on each answer book used.

Failure to do so will mean that your work cannot be identified.

If you have used more than one answer book, please tie them together with the string provided.

**THE UNIVERSITY RESERVES THE RIGHT NOT TO MARK YOUR
SCRIPT IF YOU FAIL TO FOLLOW THESE INSTRUCTIONS.**

Answer all questions. (Total 100 marks)

Question 1

BikeInSing is planning a bicycle sharing application. This application will track two types of bicycles: those with a child seat and those without. Each bicycle is given a unique bicycle number, and fitted with a smart lock and a tracker.

There are two types of accounts that registered customers can open: per ride and unlimited monthly pass. A customer can register for one or more accounts.

Per ride accounts allow more than one bicycle to be unlocked.

Monthly pass accounts allow only one bicycle to be unlocked at any time. When the bicycle is returned, the customer can then unlock another bicycle. The start date is recorded for monthly pass.

A ride must be tracked. In the event of an irregularity, BikeInSing will write to the customer through his email address with details of the ride such as the start time and start location, the end time and destination and the account used for the ride.

Construct a conceptual (ER) model from the statements of requirements to represent the data model for the BikeInSing, showing:

- (i) Entities, with entities name, relevant attributes and identifier. (12 marks)
- (ii) Relationships with maximum and minimum cardinalities and relationship name. (8 marks)

State your assumption(s) for only data requirements that are not specified.

Question 2

A passenger can own several travel passes for commute on trains. The cost of a ride is dependent on the number of stations between the start and end stations.

You are given the Ride table:

Ride (passengerId, travelPassId, startDatetimeOfRide, endDatetimeOfRide, startStation, endStation, numberOfStations, costOfRide)

- (a) Formulate and list the functional and multi-valued dependencies. Then, propose candidate key(s) for the table.

(8 marks)

- (b) For each MVD, state whether it is subsumed.

Normalise the table to BCNF and 4NF by applying **the BCNF approach**.

Show how you apply the steps to arrive at the tables, and at each iteration, explain whether each derived table is already in BCNF and 4NF (if applicable).

(10 marks)

- (c) Assemble your 4NF tables and constraints clearly.

- (i) Give each table in this form:

TABLE-NAME(col-name₁, col-name₂, ..., col-name_n)

- indicate (PK) against the primary key and
- indicate (FK) against the foreign keys, if any.

- (ii) State the referential integrity constraint(s), if any, **together with the correct table** in this form:

TABLE-NAME_x.col-name_{x1} ...col-name_{xn} must exist in

TABLE-NAME_y.col-name_{y1}...col-name_{yn}

(7 marks)

Question 3

- (a) Transform the ERD in Figure Q3(a) into a logical model, and then **implement only tables: Car and Rental**.

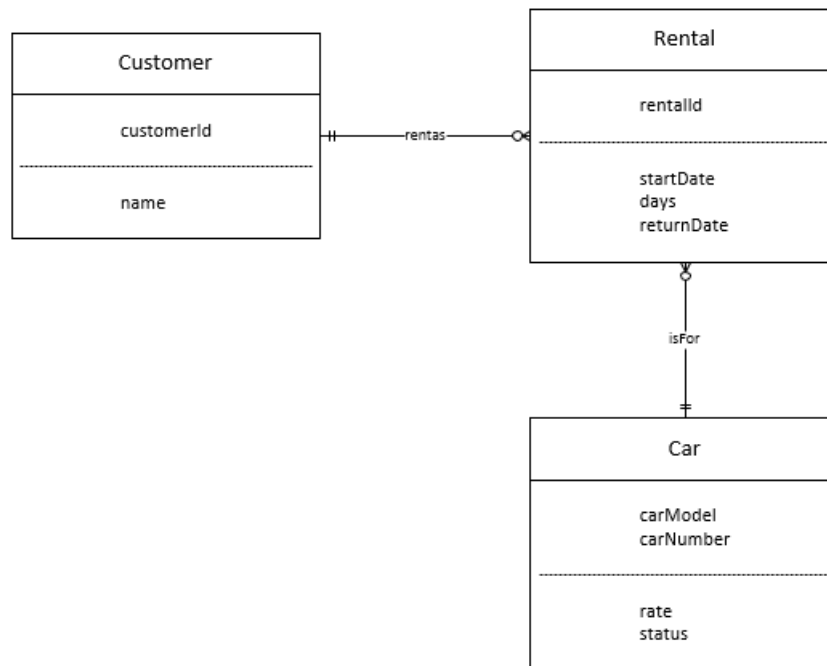


Figure Q3(a)

Assume the following:

- for the Customer table,
 - all columns except contact are required,
 - customerId is a surrogate key with value starting at 1001 and incremented by 1.
 - name is at most 30 characters long.
- for the Car table,
 - all columns are required,
 - car model is exactly 12 characters long.
 - car number is a whole number.
 - status is at most 20 characters long and is either under repair, in or out.
 - rate is \$70 to \$300 per day.
- for the Rental table,
 - all columns except returnDate are required,
 - rentalid is a surrogate key with value starting at 1 and incremented by 1.
 - returnDate must be a later date than or the same date as startDate
 - days must be at least 1.
- constraints
 - C1: Minimum cardinality between Customer and Rental is 1:N, M:O with delete and update disallowed.
 - C2: Minimum cardinality between Car and Rental is 1:N, M:O with delete and update disallowed.

(10 marks)

- (b) Formulate SQL queries to display the following resultsets:
- (i) Display the details of the cars currently under repair, listing the cars by descending rental rates.
 - (ii) Display the details of the customers and the number of rentals they have made for each car model. Include the details of customer who have not made any rental. For such customer, display the number of rentals as 0.
 - (iii) Display the details of customers who have rented cars with the model MPV. Use subquery.
- (15 marks)
- (c) Write and apply a trigger that prevents a customer from renting more than one car at any time. That is, the customer must return a car he has rented before making another rental. You may assume that if a car has not been returned, the return date for its rental is null.
- (10 marks)

Question 4

- (a) Demonstrate the basic techniques of concurrency control and (ACID) and their application.

Suppose there are 2 concurrent transactions: t_a and t_b , running at transaction level serializable, implemented using strict 2-phase locking. Both transactions t_a and t_b are performing a withdrawal on bank account 101.

- (i) Can a lost update problem occur? If the lost update problem can occur, explain how it arises through an example. If the lost update problem cannot occur, explain why.
- (ii) Can deadlock occur? If deadlock can occur, show how it arises through an example. If deadlock cannot occur, explain why.

(10 marks)

- (b) Suggest and describe:

- (i) a permission that should be given to bank customers.
- (ii) a permission that should not be given to bank customers.

(4 marks)

- (c) When there is a system crash, transactions that were still processing at the time of crash are rolled back during database recovery.

Explain the term rollback, how it is carried out and why it must be carried out.

(6 marks)

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