

**NAPIER UNIVERSITY**  
**DEPARTMENT OF COMPUTING**

**FIRST DIET - SESSION 1997-98**

**DATABASE SYSTEMS 2 – MODULE NO: CS22004**

**DATE:** 28 MAY 1998

**TIME ALLOWED:** 2 HOURS

START TIME: 1300 HOURS

FINISH TIME: 1500 HOURS

**EXAMINERS:**

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**QUESTION PAPER DATA**

Number of Questions - FIVE

Number of Pages – FIVE

**INSTRUCTIONS TO CANDIDATES**

Answer any THREE questions

USE SEPARATE SCRIPT BOOK FOR EACH QUESTION

## SCENARIO

(To be used in several of the following questions)

Arfur Daley Enterprises runs a high quality car sales operation for which they provide a complete customer after sales service. In order to provide this service they keep records of the service needs of each type of car that they sell. This information includes how often a service is required in terms of the number of months between services and the distance covered. A car is serviced either when a predefined period has elapsed or the vehicle has covered a specific distance, whichever is the sooner. A record is kept of the names and addresses of car owners. For each car that a customer owns a record is kept of the registration number of the car, the type of car, the date it was sold to the customer, the recorded distance travelled by the vehicle and the average distance undertaken by the owner per month. When a customer makes a booking for a service a record is kept of the registration number of the vehicle and the date for which the service has been booked. Finally, a record is kept of the service history of a car which includes the dates upon which the vehicle was serviced, the registration number of the vehicle and the vehicle mileage when the service was carried out.

The primary goal of the computer system is to be able to send reminders to customers that a vehicle they own is due for service.

The following gives the structure of a suitable set of tables to hold this information. Table names are shown as **TABLE\_NAME**, Column names are shown as **COLUMN\_NAME**. A description of the column is given in lower case letters.

### OWNERS

CUSTOMER_ID	unique customer identification number
NAME	customer name
ADDRESS	customer address
PHONE_NUMBER	customer phone number

### CARS

REGISTRATION_NUMBER	vehicle registration number
CUSTOMER_ID	customer identification of car owner
CAR_TYPE	type of car
DATE_SOLD	date of sale of vehicle to owner
INITIAL_DISTANCE	distance of vehicle on day of sale
AVE_MONTHLY_DISTANCE	average monthly distance covered by owner

### SERVICE\_REQUIREMENTS

CAR_TYPE	unique identification of a car type
FREQUENCY_BY_MONTHS	interval in months between services
FREQUENCY_BY_DISTANCE	normal distance covered between services

### SERVICE\_HISTORY

REGISTRATION_NUMBER	vehicle registration number
DATE_SERVICED	date of service
DISTANCE	recorded distance from vehicle

### SERVICE\_BOOKING

REGISTRATION_NUMBER	vehicle registration number
DATE_OF_SERVICE	date booked for service

1. (a) Give the definition of a functional dependency and determine the functional dependencies in the tables given in the Arfur Daley scenario, stating any assumptions made. (5)
- (b) Prior to normalisation of the Arfur Daley scenario, unwanted functional dependencies may have existed.
  - (i) Explain the different types of functional dependencies which must be checked during the normalisation process, stating at which stage they must be checked. (4)
  - (ii) Suggest an example relation based on the scenario which illustrate each of these dependencies and show what should be done as a result of them being found. (6)
- (c) Discuss the advantages and disadvantages of normalisation for relational databases with regards to maintenance and querying of the database. (10)

Total marks [25]

2. (a) What is referential integrity and why is it a crucial aspect of the relational data model? (6)
- (b) Suggest suitable referential constraints for the tables in the Arfur Daley scenario. (9)
- (c) Construct SQL statements for each of the following queries and in each of them highlight the role played by the referential constraints.
  - (i) Give the name and address of those customers who own more than two cars serviced by Arfur Daley. (5)
  - (ii) For each car booked for a service today determine what the recorded distance of the car should be if the vehicle had travelled the normal distance between services. (5)

Total marks [25]

3. Codd's 12 Rules:

- (1) Information Rule
- (2) Guaranteed Access Rule
- (3) Systematic Treatment of Null Values
- (4) Catalogue Rule
- (5) Comprehensive Data Sub-language Rule
- (6) View Updating Rule
- (7) High-level Insert, Update & Delete Rule
- (8) Physical Data Independence Rule
- (9) Logical Data Independence Rule
- (10) Integrity Independence Rule
- (11) Distribution Independence Rule
- (12) Non-Subversion Rule

Discuss the influence each of Codd's rules has had on the development of commercial database management systems, giving examples where appropriate.

Total marks [25]

4. (a) Define logical data independence, and describe briefly the advantages it brings. (4)
- (b) Discuss the advantages and disadvantages of views as a way to achieve logical data independence in relational database systems. (5)
- (c) The following two views are required, based on the Arfur Daley Enterprises database example; write a relational algebra expression that defines each of the required views. (Note: the views defined should contain *only* the required information).
- (i) A view showing the type and registration number of each recorded vehicle, along with the name and address of its owner. (4)
- (ii) A view showing, for each vehicle booked in for a service, the date of that service, along with the name and address of the vehicle's owner. (4)
- (d) In the case of changes of address, it is proposed to update the OWNERS table through each of the views defined in part (c). For both of views (i) and (ii), say whether this update is possible, and explain why. (Assume that only the customer\_id can provide a primary key for the OWNERS table). (8)

Total marks [25]

5. (a) Explain how the concept of a three level architecture is applied to a database system. (6)
- (b) Explain the role of primary and secondary indexes in optimising access to database storage. (6)
- (c) Arfur Daley want to invite all customers who own cars more than two years old to a reception to encourage them to purchase a newer car. They have 500 customers who own 750 cars, of which 250 cars are up to one year old and 300 cars are between one and two years old. The blocking factor for customers is 4 and for cars is 25. Determine estimates, showing all your assumptions and intermediate results, and then comment on the cost of the query.

```
SELECT    name, address
FROM      owners o, cars c
WHERE     o.customer_id = c.customer_id
          AND date_sold < '1-Jun-1996'
```

assuming

- (i) no indexes have been defined
- (ii) A primary key index having 3 levels on customer\_id for table OWNERS and a secondary index having 4 levels on customer\_id for tables CARS have been defined. (13)

Total marks [25]

END OF PAPER