

University of St Andrews



DECEMBER 2017 EXAMINATION DIET

SCHOOL OF COMPUTER SCIENCE

MODULE CODE: IS5102

MODULE TITLE: Database Management Systems

EXAM DURATION: 2 hours

EXAM INSTRUCTIONS: (a) Answer three questions.
(b) Each question carries 20 marks.
(c) Answer questions in the script book.

YOU MUST HAND IN THIS EXAM PAPER AT THE END OF THE EXAM.

DO NOT TURN OVER THIS EXAM PAPER UNTIL
YOU ARE INSTRUCTED TO DO SO.

1. Database Modelling

- (a) Draw an ER diagram to model the following scenario:

A vehicle rental agency wants a database to contain information about their vehicles. Each vehicle has a unique registration number, a make, a manufacturer, type (e.g. small car, large car, van etc.), previous owner(s) and age. A vehicle may be used as a company vehicle, a holiday rental vehicle or both. Additional information stored about a company vehicle is the company leasing it, the duration and the price of the lease. For the holiday rental vehicles, number of seats and hourly hire cost need to be included. Details need to be kept about the service history of individual vehicles, which includes the service sequence number and date of each service. The name and contact details of the mechanic who conducted each service should also be stored.

Show clearly any cardinality or participation constraints for relationships in your diagram. State any assumptions you need to make. [8 marks]

- (b) Derive a relational schema for your ER diagram from part (a). Be sure to specify sensible attribute types, and any primary key, foreign key, and non-null constraints. [6 marks]

- (c) Give SQL queries over SQL tables corresponding to your relational schema from part (b) for the following queries:

- (i) List the registration numbers and age of all vehicles. [2 marks]
- (ii) List the types of company vehicles and number of vehicles of each such type that are stored in the database. [2 marks]
- (iii) List the names of all mechanics involved in the servicing of the third service of the vehicle with registration 'OFP 857'. [2 marks]

[Total marks 20]

2. Constraints in SQL databases

A game rental company seeks your help for designing a database. The following relations schemas have been defined:

```
customer = (customer_id, name, address, date_of_birth)
game = (game_id, publisher_id, name, genre, minimum_age)
rents = (customer_id, game_id, date)
publisher = (publisher_id, name)
```

- (a) Write suitable SQL DDL statements to create the tables as above. Include attribute types, primary and foreign key constraints. [6 marks]
- (b) Write SQL DML queries over the tables defined in part (a) to find:
 - (i) Names and addresses of all customers who have rented 3 or more games from 'Rovio Entertainment'. [2 marks]
 - (ii) The names and ages of customers who have rented a game in 2017 which had a minimum age of 12 or greater. [2 marks]
- (c) The rental company discovers a problem by using a proper database. Unfortunately games have been rented to underage customers in the past. Write a SQL trigger so that renting games to customers who are younger than the minimum age for the game does not happen any more (either ISO Standard SQL or MariaDB syntax is acceptable). [6 marks]
- (d) Instead of triggers, how would you use SQL authorisation to prevent underage rentals? Give SQL statements for how this would work. [4 marks]

[Total marks 20]

3. Unorganised data

A library has a stack of borrowing cards dating back many years. Each borrowing card has the following information:

Card No, Book Title, Author, Publisher, Publisher Address,
Acquisition Date, list of Borrowings.

The list of borrowings is a number of lines presenting data on when the book was borrowed. Each line has

Borrower Id, Borrower Name, Date Borrowed, Date Returned, Late
Fine.

There is one card per physical copy of a book in the library.

- (a) Define a functional dependency. What functional dependencies would you expect to have in the data on the borrowing cards? [4 marks]
- (b) Design a relational data model for the data from the borrowing cards. Make sure your answer is in 3rd Normal Form, and justify why it is. [8 marks]
- (c) How might you design Documents in a Document-Oriented Database like MongoDB for storing the data from the borrowing cards? Discuss what the common queries on the database might be, and how you would denormalise the data in MongoDB to handle such queries efficiently. (You are free to use MongoDB syntax if you wish, but incorrect syntax will not be penalised as long as your data design is clear). [8 marks]

[Total marks 20]

4. Data Models for Analysis

A grocery store approaches you to sort through their data on sales. They hold data on customers (name and address), products (with kind, e.g. Fruit, Vegetable, Household, and quantity in stock), and sales (date of sale, products and quantities sold). They also hold lots of records on customers' buying history, which associates customers with sales.

- (a) Sketch out a relational data model for this scenario. Make sure to specify your primary keys and foreign key constraints. State any assumptions you need to make. [6 marks]
- (b) Describe the four ACID properties for database transactions, giving an example transaction in the grocery store context above for each property. [6 marks]
- (c) How would you analyse the grocery store data to find customers who buy the same product? Describe the query or queries you would need over your relational model. Formal relational algebra or SQL notation is not required. [4 marks]
- (d) Describe a graph model of the grocery store data (for example in Graph Databases like Neo4J) that could be used to easily find customers who buy the same product, and describe how such customers can be identified in your model. [4 marks]

[Total marks 20]

*** END OF PAPER ***