



Faculty of Engineering, Mathematics and Science

School of Computer Science & Statistics

Integrated Computer Science Programme
Business and Computing Programme
Year 3

Hilary Term 2016

Information Management II

11 January 2016

Exam Hall

9:30 – 11:30

Prof. Séamus Lawless and Prof. Vincent Wade

Instructions to Candidates:

Attempt **three** questions. **Question 1 is mandatory.** Answer any **two** from questions 2, 3 and 4. All questions carry equal marks. Each question is scored out of a total of 25 marks. **Answer each question in a separate answer book.**

You may not start this examination until you are instructed to do so by the invigilator.

Materials Permitted for this examination:

None.

1. Pablo is a Colombian business man who runs a large export-oriented organisation. He uses various international transport agents to export a number of types of “product”, mostly of botanical origin. Before being exported, the “product” is stored at a number of locations around the country. Pablo has employees who perform different roles in the organisation, including manufacturing, security and debt collection. Pablo’s customers purchase “product” and each purchase should be recorded including the amount of product sold and the product type. Each customer deals with only one member of Pablo’s sales team.

- a) Using the notation described in class, draw an Entity Relationship Diagram for the above “real world” organisation. Map this Entity Relationship Diagram to a Relational Schema. Ensure you indicate the Primary Keys of your tables and any Foreign Keys. In addition, draw a Functional Dependency Diagram for this schema and ensure that the schema is in Boyce Codd normal form, explaining the steps of normalisation. State any assumptions that you make in your modelling of the database.

[10 Marks]

- b) Write SQL Commands to do the following:

- i. Pablo realises that he also needs to keep track of the supply of raw materials that he uses to make his products. He has a number of suppliers. Using the appropriate SQL command, create a “Supplier” table that is used to store entries for each of Pablo’s supplier. The table should have a “type” attribute, which should always have one of the following values “farmer”, “chemical” or “equipment”.

[4 Marks]

- ii. An employee of Pablo has retired in unfortunate circumstances while negotiating with a customer. Remove this employee from the database using the appropriate SQL command. How would referential integrity impact this procedure and what steps should be taken to avoid such issues?

[3 Marks]

[See next page for Q1 parts iii & iv]

- iii. Each customer has a credit limit with Pablo's organisation. Using the appropriate SQL command, update the Purchase table to add an attribute which records whether the purchase has been paid for or is outstanding. A new purchase can then only be entered if the cost added to the customers total unpaid purchases is below their credit limit. Using the appropriate SQL command, update your database so that when a new purchase is added, the outstanding balance and credit limit for each customer is checked to ensure the purchase can go ahead.

[5 Marks]

- iv. Write a retrieval command which returns a list of customer names and total value of all the purchases that that customer has made.

[3 Marks]

2.

- a) Compare and contrast Relational Databases with NoSQL Databases. What are the advantages and limitations of each? In what situations are NoSQL databases more beneficial to use?

[7 Marks]

- b) What would be the key considerations if choosing whether to use a NoSQL database or a Relational Database to store your data?

[3 Marks]

- c) Outline the three most common types of NoSQL databases and describe how they function.

[5 Marks]

- d) Discuss the benefits of replication in NoSQL databases. What problems does it help to solve?

[5 Marks]

- e) How does Sharding support the process of scaling in NoSQL databases. How does increasing scale in NoSQL compare with relational databases? What are the most common approaches to sharding?

[5 Marks]

3.

- a) Concurrently executing transactions can cause three key problems if they are not correctly scheduled. Discuss these problems, making reference to "Lost Update", "Temporary Update (Dirty Read)" and "Incorrect Summary".

[5 Marks]

- b) Serializable schedules are those which are said to be equivalent to a serial schedule. How is equivalence measured?

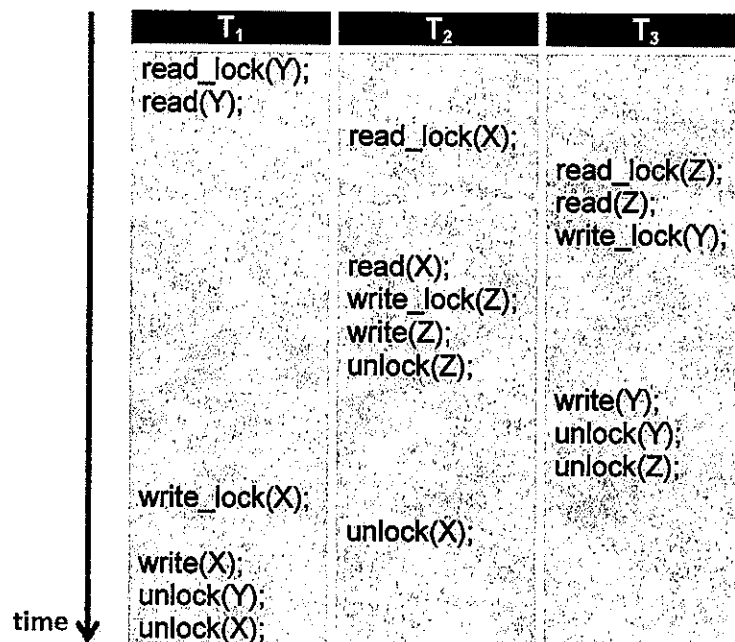
[5 Marks]

- c) Explain how concurrency control algorithms which are based upon locking techniques ensure that consecutively executing transactions do not interfere with each other's execution. What are the main two problems that locking algorithms help avoid, and how are they avoided? Make specific reference to the operation of the "Wait-Die" and "Wound-Wait" algorithms.

[5 Marks]

[See next page for Q3 parts d & e]

- d) Outline the operation of the "Wait-Die" algorithm. Indicate how "Wait-Die" would execute the following schedule. You may assume that T_1 is older than T_2 , and T_2 is older than T_3 . State any assumptions that you make in determining transaction operation ordering.



[4 Marks]

- e) Compare and contrast pure timestamp-based concurrency control with lock-based techniques. What problem(s) does timestamp ordering prevent?

[6 Marks]

4.

- a) Access Control is often used to secure a relational database. Discuss the various means by which a DBMS can manage access control. What are the potential risks involved in the management of access control? Illustrate, with examples, the dangers of propagation.

[5 Marks]

- b) Compare and contrast Discretionary Access Control and Mandatory Access Control in relational databases.

[3 Marks]

c)

- i. What SQL command(s) would be used to create a database object that displays a subset of attributes from two tables? Write the appropriate SQL command using two tables from question 1 of this paper to demonstrate.

[3 Marks]

- ii. Write the SQL command(s) that would be used to allow a user called "Andy Dwyer" to read and update the information contained within the object you created in part c) i. above.

[2 Marks]

- iii. How would you modify the command from part c) ii. to allow Andy to pass on this read and update access to other users?

[2 Marks]

- iv. Write the SQL command(s) that would be used to remove the permission to update from "Andy Dwyer".

[2 Marks]

[See next page for Q4 parts d & e]

- d) Distinguish between Security and Integrity in a relational database. Outline how both are implemented and managed. Define three basic types of integrity constraint that all relational databases must support.

[3 Marks]

- e) What operations on a database can violate referential integrity? What clauses can be specified in order to avoid violating referential integrity? Write the SQL statement to create one of the tables in Question 1 to help illustrate your answer.

[5 Marks]