UNIVERSITY OF DUBLIN
TRINITY COLLEGE

Faculty of Engineering, Mathematics and Science

School of Computer Science & Statistics

Integrated Computer Science Programme **Hilary Term 2015**
BA (Mod) Business & Computing
Annual Examinations

CS3041: Information Management II

Prof. Séamus Lawless and Prof. Vincent Wade

Thursday, 8th January 2015 **Luce Upper** **09:30 – 11:30**

Instructions to Candidates:

Answer **three** questions in total
Answer **either** question 1 **or** question 2
Questions 3 and 4 are mandatory
All questions carry equal marks.
Answer each question in a separate answer book.

Materials permitted for this examination:

None

1. Nigel runs a large import-focused business based in Dublin. He uses various international suppliers to import a number of types of "product", such as a range of large garden gnomes. Once imported, the "product" is stored at a selection of locations around the city. Nigel has employees who perform different roles in the organisation, including distribution, sales and debt collection. Nigel's customers typically purchase a selection of "product" and have individual credit arrangments. Each customer transaction should be recorded including the amount of product sold and the product type. Each customer deals with only one member of Nigel'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. Create a "Shipping" table that stores entries for shipping companies associated with particular suppliers. This will allow Nigel to keep track of the transport companies that his suppliers use to ship the "Product".

      [3 Marks]

(Question 1 continues on next page)...

...(Question 1 continues from previous page)

ii. Retrieve a list of customer names and the quantity of one particular "product" type that each of these customers has purchased in 2014.

[4 Marks]

iii. Update the Product table to keep a running total of the amount of stock on hand, as Nigel wants to always be certain that he has enough stock to service his customers. A transaction should only be allowed if Nigel has a sufficient amount of product in stock. Update your database so that when a new transaction is added, an assessment of the available stock in made to ensure there is enough available.

[5 Marks]

iv. Remove a customer from the database who is no longer available to do business after a "disagreement" over payment. Care should be taken with regard to referential integrity.

[3 Marks]

2. The Rugby World Cup will be held in England in 2015 and you have been tasked by the organisers to design a database for the tournament. Twenty international teams will take part and are divided into four groups of five teams. Each team plays in a minimum of four games, one against each of the other teams in their group. Each team has a squad of players and each player plays in a position in the team. Each game takes place in one of 13 stadiums being used in the competition. The result of each match and any point scorers must be recorded. The database should provide a means of identifying the leading points scorer of the tournament.

   a) Using the notation described in class, draw an Entity Relationship Diagram for the above real world event. 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) Using the appropriate SQL command, create the database table from your Entity Relationship Diagram that stores an entry for each game that is played during the World Cup.

   [3 Marks]

(Question 2 continues on next page)...

...(Question 2 continues from previous page)

c) Each team in the Rugby World Cup is required to register a squad of 23 players. When a player is added to the database, their position must be specified. Using the appropriate SQL command, update your database to include a position attribute where players are stored (demonstrate this command even if your database already has a position attribute). When adding a new player to a team, how could the database ensure that there is sufficient space in the squad? Demonstrate the SQL command that would be used to perform this validation.

[5 Marks]

d) Write SQL Commands to do the following:

i. Add an entry for a new player whom the Irish team have decided to add to their squad at the last minute. The player's position is winger.

[2 Marks]

ii. Retrieve the names of all the Teams, the Stadia that they will be playing in and the times and dates of those games. This will help the organisers produce a printable schedule for the fans of each team.

[3 Marks]

iii. Remove the Stadium table from the database. What issues could this cause with other tables in the database? How would these issues be avoided?

[2 Marks]

3.

a) When are operations in a schedule deemed to be in conflict? Illustrate with an example.

[3 Marks]

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

[4 Marks]

c)

i. Explain how concurrency control algorithms which are based upon locking techniques ensure that concurrently executing transactions do not interfere with each other's execution. Make reference to both binary and read-write locking.

[3 Marks]

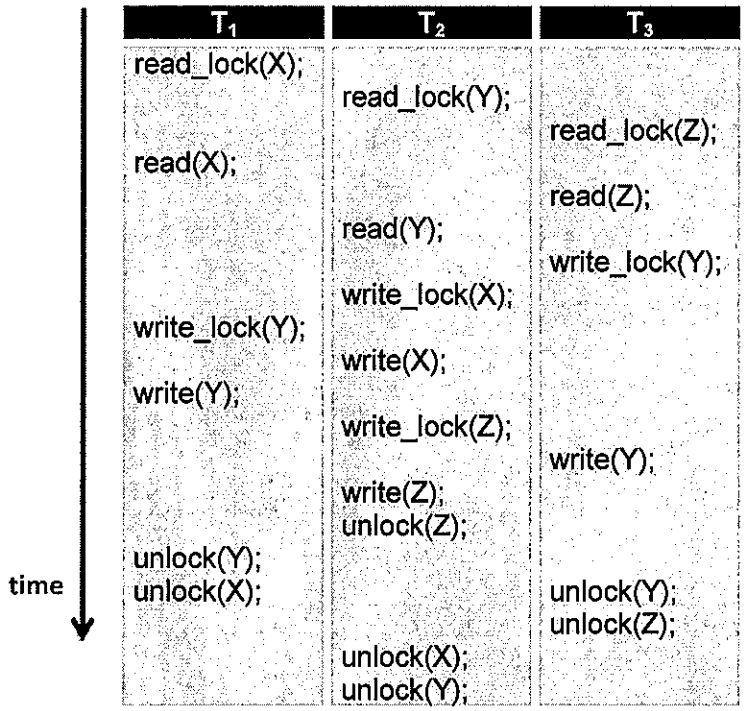
ii. Two-phase locking is an additional locking protocol. Discuss two-phase locking and the benefits it offers.

[2 Marks]

(Question 3 continues on next page)...

...(Question 3 continues from previous page)

d) Outline the operation of the "Wound-Wait" algorithm. Indicate how "Wound-Wait" 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.



[5 Marks]

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

[3 Marks]

f) What timestamp values must be stored for each data item in a database? What process occurs when a transaction issues a Read, and when a transaction issues a Write?

[5 Marks]

4.

a) What is a database constraint? Distinguish between explicit constraints and semantic constraints. Define three basic types of integrity constraint that all relational databases must support.

[5 Marks]

b) Cascading Updates and Deletes can be used to avoid violating what type of constraint? Explain, in detail, how cascading works. Use a CREATE TABLE statement for one of the tables in question 1 or 2 of this paper to help illustrate your answer.

[5 Marks]

c) 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]

d)

i. What SQL command(s) would be used to allow a user called "Don Draper" to read and update the information contained within a selected table in your database? How would you modify this command(s) to allow Don to pass on these permissions to other users?

[3 Marks]

ii. What SQL command(s) would be used to remove the permission to update from "Don Draper"?

[2 Marks]

Question 4 continues on next page)...

...(Question 4 continues from previous page)

e) 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?

[5 Marks]